



CORAL REEF CONSERVATION PROGRAM

Draft Programmatic Environmental Impact Statement

2019



COVER SHEET

- a. Title: Coral Reef Conservation Program
- b. Subject: Draft Environmental Impact Statement (DEIS)
- c. Lead Agency: Office of Coastal Management (OCM), National Ocean Services (NOS), National oceanic and Atmospheric Administration (NOAA)
- d. Cooperating Agency: No cooperative agency
- e. Abstract: NOAA is preparing a Draft Programmatic Environmental Impact Statement (DPEIS) for continued implementation of its Coral Reef Conservation Program (CRCP) which provides for coral reef conservation and restoration consistent with its strategic plan throughout the U.S. jurisdictions of the Atlantic Ocean, which includes the Gulf of Mexico, South Atlantic and Caribbean Sea, the Pacific Ocean, which includes the Pacific Island Region, and priority international areas (i.e., the wider Caribbean, the Coral Triangle, the South Pacific, and Micronesia).
- NOAA proposes to continue implementing the CRCP through coral reef conservation and restoration activities such as internal, agency-funded and executed activities and by providing financial and technical assistance to Federal, State, and local agencies, private organizations, and academic institutions. The CRCP would continue to focus funding and activities on combating strategic threats to and restoration of coral reefs, guided by the *Coral Reef Conservation Program Strategic Plan* (CRCP Strategic Plan; NOAA 2018a), and future iterations of a programmatic strategic plan.
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- g. Transmittal: This Draft EIS on the continued implementation of NOAA's CRCP is being made available to the public on or about December 13, 2019, as required by the National Environmental Policy Act of 1969.¹

¹ National Environmental Policy Act of 1969, as amended (42 U.S.C. §§ 4321–4347)

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- Appendix G The CRCP Impacts Matrix
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246 **List of Acronyms**

ARMS	Autonomous Reef Monitoring Structures
AUV	Automated underwater vehicle
BMP	Best management practices
CEQ	Council on Environmental Quality
CNMI	The Commonwealth of the Northern Mariana Islands
CRCP	Coral Restoration Conservation Program
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DAWR	Guam Division of Aquatic and Wildlife Resources
DCMMs	Discretionary conservation and mitigation measures
DPEIS	Draft Programmatic Environmental Impact Statement
EEZ	Exclusive economic zone
EFH	Essential fish habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FGBNMS	Flower Garden Banks National Marine Sanctuary
FMG	Florida Middle Grounds
FMP	Fishery Management Plan
FONSI	Finding of no significant impact
GDP	Gross domestic product
GHG	Greenhouse gas
HAPC	Habitat area of particular concern
HMS	Highly migratory species
LAA	Likely to Adversely Affect
LID	Low Impact Development
MMA	Marine Managed Areas
MMPA	Marine Mammal Protection Act

MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NESDIS	National Environmental Satellite, Data, and Information Service
NHO	Native Hawaiian Organization
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NRHP	National Register of Historic Places
NGLA	Northern Guam Lens Aquifer
OAR	Office of Oceanic and Atmospheric Research
OCS	Office of Coast Survey
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PDARP	Programmatic Damage Assessment and Restoration Plan
PEIS	Programmatic Environmental Impact Statement
PRIMNM	Pacific Remote Islands Marine National Monument
PWC	Personal watercraft
PVC	Polyvinyl chloride
ROV	Remotely operated vehicle
SCUBA	Self-contained underwater breathing apparatus
SHPO	State Historic Preservation Officer
TEV	Total economic value
THPO	Tribal Historic Preservation Officer
USCRTF	U.S. Coral Reef Task Force
USFWS	U.S. Fish and Wildlife Service
USVI	U.S. Virgin Islands

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249 **Executive Summary**

250 The National Oceanic and Atmospheric Administration (NOAA) is preparing a Draft Programmatic
251 Environmental Impact Statement (DPEIS) for continued implementation of its Coral Reef Conservation
252 Program (CRCP). The CRCP funds and conducts coral reef conservation and restoration activities
253 throughout the U.S. jurisdictions of the Atlantic Ocean, including the Gulf of Mexico, South Atlantic and
254 Caribbean Sea, the Pacific Ocean, including the Pacific Island Region, and priority international areas
255 (i.e., the wider Caribbean, the Coral Triangle, the South Pacific, and Micronesia).

256 The Council on Environmental Quality regulations recognize the discretionary preparation of PEISs for
257 agency programs (40 C.F.R. § 1502.4(b)), and NOAA has decided to exercise its discretion to prepare a
258 PEIS for the continued operation of the CRCP. Based on early internal agency scoping, NOAA identified
259 the potential for significant impacts to certain resources, impacts that could result in public controversy as
260 the result of implementing program activities. In addition, the CRCP is a nationwide program extending
261 across seven state and territorial jurisdictions with the potential to affect multiple sensitive marine
262 resources as well as socio-economics. NOAA further intends for the PEIS to create efficiencies by
263 establishing a framework for future “tiering.” As CRCP activities are proposed for implementation, to the
264 extent additional NEPA review is required, it will rely on the analysis set forth in the PEIS and focus on
265 location specific effects. (40 C.F.R. § 1508.28, 1502.20).The programmatic scope of this document and
266 its intended future use in CRCP environmental decision making are described more fully in Chapter 1,
267 Sections 1.6 through 1.8. NOAA’s decision to prepare a PEIS for the CRCP is a program specific
268 decision and does not reflect a broader agency policy.

269 The CRCP seeks to address an increasing number of threats faced by coral reefs, including pollution,
270 unsustainable fishing practices, and global climate change. According to the World Resources Institute,
271 more than 60% of the world's reefs are under threat from local stressors, like fishing and land-based
272 pollution (Burke et al., 2011). That number jumps to 75% when local threats to reefs are combined with
273 the threat of thermal stress from a changing climate. As a result of increasing threats to coral reef
274 resources, 22 species of coral found in U.S. waters are now listed as threatened under the Endangered
275 Species Act of 1973 (ESA) (16 U.S.C. §1531 *et seq.*). Given their economic, cultural, and ecological
276 value, it is now more important than ever to address and attempt to mitigate or reverse the threats
277 impacting coral reef ecosystems.

278 Pursuant to the Coral Reef Conservation Act of 2000 (CRCA), 16 U.S.C. § 6401, *et seq.*, the
279 proposed action is to preserve, sustain, and restore the condition of coral reef ecosystems; to
280 promote the wise management and sustainable use of coral reef ecosystems to benefit local
281 communities and the nation; and to develop sound scientific information on the condition of
282 coral reef ecosystems and the threats to these ecosystems. NOAA proposes to continue
283 implementing the CRCP in accordance with the CRCA, as guided by the *Coral Reef Conservation*
284 *Program Strategic Plan* (CRCP Strategic Plan; NOAA 2018a) and future iterations of a programmatic
285 strategic plan. This DPEIS addresses the direct, indirect, and cumulative environmental effects of the
286 CRCP until 2040, which aligns with the planning horizon of the CRCP Strategic Plan.

287 The types of activities the CRCP anticipates implementing are described further in Chapter 2 of this
288 document, but include:

- 289 • Monitoring, mapping, and research (e.g., scuba surveys, use of underwater autonomous vehicles,
290 coral sampling, fish sampling and tagging, and bathymetric echosounders);
- 291 • Coral restoration and interventions (e.g., coral nursery and outplanting, removal of invasive and
292 nuisance species, and addressing coral disease);
- 293 • Watershed management and restoration (e.g., small-scale construction projects designed to
294 minimize sediment and pollutant runoff to coral habitats, such as restoring vegetative cover and
295 use of, rain gardens, culvert repair, stream bank stabilization, retention ponds, or constructed
296 wetlands);
- 297 • Reduction of physical impacts to coral reef ecosystems (e.g., buoy installation and marine debris
298 removal); and
- 299 • Outreach/education and program operations.

300 Projects implemented or funded by the CRCP vary in terms of their size, complexity, and geographic
301 location. CRCP projects often benefit coral species and habitats found within coral reef ecosystems and
302 the communities that rely on the coral reef ecosystem for nutrition, recreation, and shoreline protection.
303 The CRCP conducts monitoring to gather data on the condition of coral reef ecosystems to support
304 conservation and restoration efforts and related management decisions. NOAA facilitates CRCP activities
305 in coordination with its non-federal partners through grants and cooperative agreements. The CRCP
306 works with a variety of partners that include other federal agencies, state and territorial governments and
307 agencies, research and academic institutions, non-governmental organizations, and community groups in
308 both the Pacific and Atlantic Oceans to conserve tropical/subtropical coral reef ecosystems across
309 multiple states and territories using a targeted approach focused on local issues. These activities are
310 prioritized based on available funding and the effectiveness of each activity at responding strategically to
311 threats to coral ecosystems.

312 NOAA also conducts its own CRCP activities using appropriated funds. This work brings together
313 expertise from across NOAA for a multidisciplinary approach to studying these complex ecosystems
314 toward the goal of more effective management. The CRCP works closely with NOAA scientists in the
315 National Ocean Service (NOS); National Marine Fisheries Service (NMFS); Office of Oceanic and
316 Atmospheric Research (OAR); and National Environmental Satellite, Data and Information Service
317 (NESDIS). The CRCP also supports capacity building in other nations that have coral ecosystem
318 resources. The CRCP is leading efforts in the U.S. to study and conserve the coral reef ecosystem for
319 current and future generations. (See Sections 2.2, 2.2.1, and 2.2.5 and Figure 1-2.)

320 As noted, this document will assess the direct, indirect, and cumulative environmental impacts of
321 NOAA's proposed action to continue funding and otherwise implementing coral reef conservation and
322 restoration activities through its existing programmatic framework for implementing the CRCP consistent
323 with its obligations under the CRCA and Executive Order 13089, Coral Reef Protection, of 1998. As
324 explained below, the analysis in this DPEIS is programmatic (i.e., more general) in nature and does not
325 purport to evaluate the environmental impacts of project-level activities. It identifies a suite of coral reef
326 conservation activities that CRCP supports to conserve and restore coral reef ecosystems. This DPEIS
327 evaluates the potential impacts to the human and natural environments expected to be caused by the
328 implementation of these activities. As such, it sets the stage so that future decisions by NOAA at the
329 project-specific level can be reviewed and included under, or effectively tiered from, this programmatic

330 analysis. The DPEIS is also intended to include information that may be incorporated by reference in
331 other NOAA NEPA reviews and documents.

332 This document provides a programmatic-level environmental analysis to support NOAA’s proposal to
333 continue implementation of the CRCP. The DPEIS takes a broad look at issues and programmatic-level
334 alternatives (compared to a document for a specific project or action) and provides guidance for future
335 activities to be carried out by NOAA. In addition to providing a programmatic analysis, NOAA intends to
336 use this document to approve future project-specific actions, so long as the activity being proposed is
337 within the range of alternatives and scope of potential environmental consequences, and does not have
338 significant adverse impacts. Any future project-specific activities proposed by NOAA that are not within
339 the scope of alternatives or environmental consequences considered in this DPEIS will require additional
340 analysis under NEPA but may rely, as appropriate, on analyses and information included herein.

341 In addition to providing a programmatic, tiered approach to NEPA, NOAA also intends for this DPEIS to
342 establish a framework for programmatic compliance with other environmental statutes such as the ESA,
343 Magnuson-Stevens Act (MSA), National Marine Sanctuaries Act (NMSA), Coastal Zone Management
344 Act (CZMA), Marine Mammal Protection Act (MMPA), and other applicable statutes, acknowledging
345 that specific activities may require development of more focused and refined analysis. To this end,
346 NOAA has initiated ESA Section 7 consultations on a programmatic level with NMFS and the U.S. Fish
347 and Wildlife Service. Similar approaches are being explored for consultations to address Essential Fish
348 Habitat (EFH), National Marine Sanctuaries Act, and National Historic Preservation Act (NHPA)
349 compliance.

350 This DPEIS also relies on and incorporates by reference several pre-existing NEPA documents and other
351 relevant analyses that have considered effects of activities on coral ecosystems. Where the document
352 incorporates by reference, the information incorporated is summarized and the relevant document and
353 location of the information within the document are cited.

354 This DPEIS contains four chapters:

355 ***Chapter 1 - Introduction and Purpose and Need*** describes the purpose and need for the action, as well as
356 background information on the CRCP and its activities.

357 ***Chapter 2 - Alternatives*** describes the three alternatives considered in this DPEIS. The “no action”
358 alternative is the continued implementation of the existing CRCP Strategic Plan, which seeks to reduce
359 land-based sources of pollution, improve fisheries sustainability, increase resilience to climate change,
360 and restore viable coral populations. A second alternative and third alternative, Alternatives 1 and 2,
361 respectively, as well as those alternatives considered but rejected from further analysis, are also described.

362 ***Chapter 3 - Affected Environment*** generally describes the baseline physical, biological, and social
363 environments of areas likely to be affected by the CRCP. The affected environment associated with the
364 proposed action is substantial, including all coral reef habitats in U.S. state and territorial waters, plus
365 offshore habitats and coastal areas that influence or affect coral reef ecosystems within the U.S. Exclusive
366 Economic Zone, and coral reef habitats in some tropical and subtropical countries outside of the United
367 States. This chapter is a snapshot of existing conditions and provides the context related to the present
368 condition of resources.

369 **Chapter 4 - Environmental Consequences** describes the potential direct, indirect, and cumulative
370 environmental impacts of Alternative 1 and Alternative 2 when compared with the No Action Alternative.
371 NOAA is also required by other statutes to ensure that these actions are analyzed for their impact to the
372 natural and human environment, including, but not limited to, ESA-listed species and their designated
373 critical habitats, managed fisheries, and EFH. This chapter also identifies and describes other applicable
374 legal requirements.

375 Appendices to the document describe, among other things, the proposed discretionary conservation and
376 mitigation measures (DCMMs) associated with Alternative 2 as well as mitigation measures and best
377 management practices (BMPs) currently implemented under the CRCP and common to all alternatives.

378 **Alternatives**

379 The National Environmental Policy Act (NEPA) requires that any federal agency proposing a major
380 action (that is not categorically excluded) consider reasonable alternatives. To warrant detailed evaluation
381 by NOAA, an alternative must be reasonable and meet the purpose and need (see Section 1.5). Screening
382 criteria are used to determine whether an alternative is reasonable. After applying the screening criteria to
383 an identified range of considered alternatives, only three alternatives were brought forward for detailed
384 review in the DPEIS.

385 Based on the purpose and need for action (see Section 1.5), an alternative for implementation of the
386 CRCP must meet the following criteria to be considered a reasonable alternative carried forward for
387 detailed consideration. Each alternative must:

- 388 ● Seek to meet NOAA's duties and obligations and be consistent with the authorities specified by
389 Congress in the CRCA;
- 390 ● Seek to meet one or more goals established by the CRCP Strategic Plan;
- 391 ● Be implemented in a manner that ensures compliance with applicable statutory requirements
392 protecting natural and cultural resources; and
- 393 ● Be implemented in a manner that is practicable from economic, technological, and policy
394 standpoints.

395 No Action Alternative – Continued operation of the CRCP based on addressing the three primary threats
396 (i.e., fishing impacts, land-based sources of pollution, and climate change) and supporting research, coral
397 restoration, and intervention techniques to respond rapidly to imminent threats, such as increased
398 bleaching and disease, to corals and coral reef ecosystems. CRCP operations currently include
399 monitoring, mapping and research activities, watershed and coral reef restoration, reduction of physical
400 impacts to coral reef ecosystems, outreach and education, and program support. The No Action
401 Alternative would continue to require implementation of avoidance, minimization, and mitigation
402 measures listed in Appendix A, whereas the DCMMs listed in Appendix B may be implemented on a
403 project-by-project basis but not as a requirement. Because this is a programmatic analysis of the CRCP's
404 continued implementation (where program activities are being analyzed as opposed to a single specific
405 project action) with no change in management direction, the No Action Alternative is interpreted herein
406 as “no change from current management” (CEQ 1981).

407 Alternative 1 – Operation of the CRCP to address the three primary threats (i.e., fishing impacts, land-
408 based sources of pollution, and climate change) through monitoring, mapping, and research (see Section
409 2.3.1) and watershed management and restoration (see Section 2.3.3). Alternative 1 does not include

410 activities to restore viable coral populations (i.e., coral restoration and interventions [see Section 2.3.2],
 411 and reduction of physical impacts to coral reef ecosystems [see Section 2.3.4.]). This alternative would
 412 refocus CRCP’s resources and efforts solely on the three primary threats to corals. Alternative 1 would
 413 continue to require implementation of avoidance, minimization and mitigation measures listed in
 414 Appendix A. The DCMMs listed in Appendix B may be utilized on project-by-project basis.

415 Alternative 2 – No Action Alternative plus required implementation of the DCCMs in Appendix B.
 416 Alternative 2 differs from the No Action Alternative in that the DCMMs (Appendix B) will cease to be
 417 discretionary. The DCMMs would be required for all projects funded or conducted by the CRCP. The
 418 CRCP would have one required set of avoidance, minimization, and mitigation measures that consists of
 419 Appendix A and Appendix B.

420 Table E-1 summarizes the suite of activities the CRCP would implement under each of the proposed
 421 alternatives.

422 *Table E-1. Alternatives Summary*

	No Action Alternative	Alternative 1	Alternative 2
Monitoring, mapping, and research	X	X	X
Coral restoration and interventions:	X	--	X
Watershed management and restoration	X	X	X
Reduction of physical impacts to coral reef ecosystems	X	--	X
Outreach/education and program operations	X	X	X
Continued compliance with mandatory mitigation measures (Appendix A)	X	X	X
Requirement of discretionary conservation and mitigation measures (Appendix B)	--	--	X

423
 424 Under all alternatives, the CRCP would continue to be implemented using available appropriations,
 425 across four NOAA line offices, using a mix of internal and external funding, across existing geographic
 426 areas, and in collaboration with similar partners. The CRCP would continue to conduct program activities
 427 in compliance with mandatory mitigation measures developed in compliance with applicable
 428 environmental laws such as the ESA and CWA.

429 **Analysis**

430 A brief comparison summary of adverse impacts and benefits among alternatives is provided in the table
 431 below (E-2). The summary provides context and intensity of potential impacts using D for direct, I for

432 indirect, S for short-term, L for long-term, etc., and combining these indicators of context, followed by
433 the range of anticipated impact intensity (i.e., negligible to moderate). For example, an adverse impact
434 that is expected to be direct, short- to long- term in duration, local, and negligible to minor, will appear in
435 the table as D/S-L/L, negligible to minor, with further explanation of the potential impact(s).

436 The CRCP anticipates the adverse environmental impacts for all of the alternatives range from negligible to
437 major. Many of the impacts would be temporary and local. While table E-2 provides a full summary of
438 impacts, the primary adverse impacts from CRCP activities by activity category are:

- 439 • Monitoring, mapping, and research: direct injury and/or mortality to corals and fish from
440 sampling and temporary changes in species behavior due to in-water activities;
- 441 • Coral restoration and interventions: risk of spread of pathogens and invasive species from
442 transplanting corals and in-water intervention activities, and direct injury and possible
443 mortality to corals due to collection used in nurseries and for intervention
444 development/research;
- 445 • Watershed management and restoration: temporary disturbance of terrestrial species and
446 sedimentation due to earthmoving activities; and
- 447 • Reduction of physical impacts to coral reef ecosystems: temporary disturbance from
448 installation of buoys and the removal of marine debris.

449
450 ***No Action Alternative, Alternative 1, and Alternative 2.*** All three alternatives would result in benefits
451 from monitoring, mapping, and research activities that will support data collection and perform research
452 critical to managing corals and associated coastal and marine resources. All three alternatives would
453 implement watershed restoration and management activities that would reduce erosion, stormwater
454 runoff, and sediment and other pollutant loading into downstream and coastal waters. Benefits would be
455 direct and indirect, both short- and long-term, and local to the specific project location. Stabilized
456 sediments (e.g., trails and roads) would restore natural hydrology and reduce sedimentation and erosion in
457 terrestrial, aquatic, wetland, and floodplain habitats; restore flood storage capacity of wetlands and
458 floodplains; and restore habitat for listed species. Reductions in sediments and pollutants in coastal waters
459 would improve water quality and benefit coastal and marine habitats such as corals, seagrasses,
460 mangroves, fish, and fisheries. No differences in beneficial impacts are expected among the three
461 alternatives for “monitoring, mapping, and research” and “watershed management and restoration”
462 activities.

463 ***No Action Alternative and Alternative 2.*** Only the No Action Alternative and Alternative 2 would
464 implement “coral restoration and interventions” and “reduction of physical impacts” activities to directly
465 address impacts to corals from climate change and benefit corals and associated habitats and biota. Both
466 alternatives include transplanting and outplanting corals, development of coral nurseries, reducing
467 invasive species and diseases associated with corals, and reducing physical impacts to corals from marine
468 debris and vessel anchoring. Benefits would be direct and indirect, long-term, local to larger scale, and
469 minor to major, depending on the project. Because coral reefs are not expected to recover without
470 intervention, these alternatives are the only two that would support the recovery and restoration of coral
471 reefs.

472 **Alternative 1.** Alternative 1 would likely have the fewest beneficial impacts because it eliminates the
 473 activities to restore viable coral populations (i.e., "coral resotation and interventions" and "reduction of
 474 physical impacts to coral reef ecosystems"). While some adverse of impacts related to implementing
 475 "coral restoration and interventions" and "reduction of physical impacts to coral reef ecosystems" would
 476 be avoided by not conducting these activities, it is expected that this avoidance in adverse impacts would
 477 not outweigh the benefits gained by implementing activites to restore corals and reduce physical impacts.

478 **Alternative 2.** Alternative 2 includes required implementation of all DCMMs in Appendix B. Mandating
 479 these measures will further reduce potential impacts of many of the proposed activities. DCMMs
 480 (Appendix B) would be implemented in addition to mitigation measures and BMPs that are currently
 481 implemented by the CRCP listed in Appendix A and would be expected to further benefit coral reefs and
 482 associated habitats and biota. Expected benefits to coral reefs would be the same as for the No Action
 483 Alternative, with potentially greater, albeit negligible, benefits.

484 The three alternatives' potential adverse impacts range from direct to indirect, short- to long-term, local to
 485 larger in scale, and from negligible to major. Benefits under the No Action, Alternative 1, and Alternative
 486 2 are anticipated to be both direct and indirect, both short and long term, and potentially both local and
 487 large scale, depending on the project.

488 *Table E-2. Summary of the impacts to resources anticipated under the alternatives. The CRCP's discretionary conservation and*
 489 *mitigation measures (DCMMs) are provided in Appendix B. Resources are analyzed for both terrestrial and coastal and marine*
 490 *environments where relevant. Context factors are abbreviated as: Direct and/or Indirect (D-I)/Short- to Long-term (S-L)/Local to*
 491 *Large Scale (L-LS), followed by intensity descriptions of negligible to major.*

Resources	No Action Alternative Continued Implementation of the Current CRCP	Alternative 1 Current CRCP without Coral Reef Restoration/Intervention and Reducing Physical Impacts to Coral Reefs	Alternative 2 Current CRCP with Addition of Required DCMMs
Physical Environment			
Sediments and Soils	Adverse Impacts. Terrestrial - D/S/L, negligible to minor due to erosion, sedimentation, compaction, potential introduction of pollutants into soils during monitoring, construction, herbicide use, other watershed proposed activities. Coastal waters: D/S/L, negligible to minor due to sediment resuspension and deposition during vessel	Adverse Impacts. Terrestrial - same as for the No Action. Coastal - D/S-L/L, negligible to moderate. Combined adverse impacts to sediments under this alternative are due to continued damage from anchoring and accumulation of marine debris. Benefits. D/S-L/L, negligible to minor, due to	Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs. Benefits. Same as No Action, but with additional, negligible benefits due to DCMMs such as additional dive and vessel training, seafloor habitat avoidance, decontamination of equipment, use of mooring buoys or live boating, etc.

	<p>and other in-water activities. Additional long-term, negligible to moderate impacts possible from large projects such as stormwater ponds, road stabilizations, and vessel removals.</p> <p>Benefits. D-I/S-L/L-LS, negligible to major due to reduced erosion and land loss, sediment and other pollutant loadings to coastal waters, improved soil and sediment quality, stabilized substrates, reduced debris and contamination, and acquisition of data critical to resource management.</p>	<p>elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>that reduce the amount of disturbance.</p>
<p>Terrestrial Habitats and Biota</p>	<p>Adverse impacts. D/S/L, negligible to minor displacement of fish, wildlife, and vegetation due to sound, runoff, altered hydrology, herbicide use, habitat loss due to construction and other watershed proposed activities; invasive species introduction and loss of native species.</p> <p>Benefits. D/S-L/L, negligible to moderate benefits due to potential increased quality of native habitat for foraging, nesting, and migratory stops for birds and other terrestrial wildlife; restored habitat due to reduced erosion and improved water quality for instream fish and wildlife.</p>	<p>Adverse impacts. D/S/L, negligible to minor, same as No Action, due to watershed proposed activities in terrestrial habitats.</p> <p>Benefits. D-I/S-L/L, negligible to moderate, due to continued mapping, monitoring, and research, and watershed restoration and management activities.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional negligible water quality and habitat improvements due to DCMMs such as erosion and sediment controls and reduced herbicide concentrations.</p>

<p>Wetlands and Floodplains</p>	<p>Adverse impacts. D/S/L, negligible to minor impacts to wetlands and floodplains due to temporary construction activities and introduction of sediments, other pollutants, and invasive species.</p> <p>Benefits. D-I/S-L/L-LS, negligible to moderate due to potential for restored flood capacity, soil rehydration, and increase in native habitat due to reduced erosion and improved water quality.</p>	<p>Adverse impacts. D/S/L, negligible to minor same as No Action, negligible to minor due to watershed proposed activities in terrestrial habitats.</p> <p>Benefits. D-I/S-L/L-LS, same as No Action, negligible to moderate due to information available to support future conservation and management efforts.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional negligible water quality and habitat improvements due to DCMMs such as erosion and sediment controls and reduced herbicide concentrations.</p>
<p>Water Resources</p>	<p>Adverse Impacts. <u>Terrestrial:</u> D/S/L, negligible to minor due to potential for erosion and transport of sediments/other pollutants generated from construction and other activities (see sediments and soils above) and conveyed into downstream and coastal waters. <u>Coastal waters:</u> same as terrestrial with additional impacts from land-based sediments and pollutants, resuspension of sediments due to vessels and other in-water activities associated with monitoring and coral transplanting, and potential contamination from debris.</p> <p>Benefits. D-I/S-L/L, negligible to major due to reduced sediments and other pollutant loadings to downstream waters, potential contamination from marine</p>	<p>Adverse impacts. <u>Terrestrial.</u> D/S/L, negligible to minor impacts. Same as No Action. <u>Coastal waters:</u> D/S/L, negligible to minor impacts due to potential resuspension of sediment from anchoring and marine debris into the water column.</p> <p>Benefits. D-I/S-L/L, and negligible to moderate due to watershed restoration and management activities and continued monitoring, mapping, and research activities.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, but with additional, negligible, benefits due to DCMMs such as additional dive and vessel training, seafloor habitat avoidance, use of mooring buoys and live boating, and others that reduce the opportunity for resuspension of sediments into the water column.</p>

	debris, and major benefits due to acquisition of data critical to management.		
Biological Environment			
Seagrasses	<p>Adverse impacts. D/S/L, negligible to minor due to temporary disturbance during monitoring/surveying, other in-water activities (esp. propeller scars), debris removal, installation of mooring buoys, and coral proposed activities.</p> <p>Benefits. D-I/L/L-LS, negligible to moderate due to reduced sediment and nutrient loading from watershed, reduced disturbance/damage from permanent moorings and debris/contamination, habitat stabilization due to potential coral reef recovery.</p>	<p>Adverse Impacts. D/S-L/L, negligible to moderate due to continued damage from anchoring and accumulation of marine debris, as well as potential loss of buffering effects of coral reefs.</p> <p>Benefits. D/S-L/L, negligible to minor due to elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, but with additional, negligible, benefits due to DCMMs such as additional dive and vessel training, seafloor habitat avoidance, use of mooring buoys and live boating, and others that reduce contact with resource.</p>
Mangroves	<p>Adverse impacts. D-I/S/L, negligible to minor, similar to disturbances described in sediment and soils.</p> <p>Benefits. D-I/S-L/L-LS, negligible to moderate to native mangroves due to reduced sediment and nutrient loadings from the watershed, reduced wave energy and sedimentation due to coral recovery, reduced disturbance and contamination due to permanent moorings and debris removal.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate due to discontinued coral restoration efforts and continued damage from anchoring and accumulation of marine debris.</p> <p>Benefits. D/S-L/L, negligible to minor due to elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, but with additional, negligible benefits due to a reduction of indirect adverse impacts of sediment and pollutant loadings into coastal waters, potential impacts from anchors and marine debris, and erosion as a result of required DCMMs.</p>

<p>Corals and other associated invertebrates and algae</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate from temporary disturbance during monitoring, surveying, research, mooring buoy, coral reef restoration, and debris removal activities; potential for disease, corallivores, and invasive species that may increase due to transplanting and outplanting activities.</p> <p>Benefits. D-I/S-L/L-LS, negligible to major due to reduced invasive species, acquisition of data available for recovery and management; reduced runoff from watershed, debris removal, reduced anchoring, and increased recovery due to transplanting and outplanting of corals, control of disease, corallivores, and invasive species, other activities that increase the potential for recovery of coral reefs.</p>	<p>Adverse impacts. D-I/S-L/L-LS, negligible to major due to discontinued coral restoration efforts and continued damage from anchoring and accumulation of marine debris.</p> <p>Benefits. D/S-L/L, negligible to minor due to elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, but with additional, negligible, benefits due to DCMMs such as additional restrictions on the amount of coral removed for transplants, additional decontamination protocols, and further reductions in physical contact with coral to reduce potential for physical damage, disease, corallivore, and invasive species impacts to corals.</p>
<p>Fish</p>	<p>Adverse impacts. D-I/S/L, negligible to minor impacts due to temporary disturbance and loss of habitat during monitoring, surveying, research, mooring buoy installation, debris removal, and coral reef restoration.</p> <p>Benefits. D-I/S-L/L-LS, negligible to major due to reduced watershed runoff, improved water quality and habitat; potential for restored reef habitat and increase in data for resource management.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate due to continued damage from coral reef habitat loss and anchoring and accumulation of marine debris.</p> <p>Benefits. D/S-L/L, negligible to minor due to elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional, negligible benefits due to DCMMs such as additional sediment and erosion control to improve water quality, reduced physical contact with habitats, and sound protocols to further reduce potential sound impacts.</p>

<p>Invasive Species</p>	<p>Adverse impacts. D-I/S-L/L-LS, negligible to moderate due to potential increases in invasive species due to disturbance and incidental introductions via revegetation materials, transplants, vessels, equipment, trucks, etc.</p> <p>Benefits. <u>Terrestrial:</u> D-I/S-L/L-LS, negligible to major due to opportunities for native species to re-establish due to reduced erosion or revegetation. <u>Coastal and marine waters:</u> interventions to reduce invasive species would support recovery of corals and associated biota.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate due to discontinued coral restoration efforts and continued disturbance from anchoring and accumulation of marine debris, resulting in continued introduction and establishment of invasive species.</p> <p>Benefits. D/S-L/L, negligible to minor due to the elimination of CRCP components that address invasive species.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional negligible benefits due to required DCMMs to reduce the concentration of herbicides used for vegetation management and to reduce the risk of introducing invasive species (as well as disease and corallivores) during coral restoration and intervention activities.</p>
<p>Regulatory Environment</p>			
<p>Essential Fish Habitat</p>	<p>Adverse impacts. D/S/L, negligible to minor disturbance and loss of habitat for fisheries during monitoring, surveying, research, mooring buoy installation, debris removal, and coral reef proposed activities.</p> <p>Benefits. D-I/S-L/L-LS, negligible to major due to restoration of reef and associated habitats (mangroves and seagrasses) due to reduced sediment loading, improved water quality, reduced derelict fishing gear and other debris, and additional data for EFH management.</p>	<p>Adverse impacts. D-I/S-L/L-LS, negligible to moderate due to discontinued coral restoration efforts and continued damage from anchoring and accumulation of marine debris.</p> <p>Benefits. D-I/S-L/L-LS, negligible to minor due to elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional, negligible benefits due to DCMMs such as additional sediment and erosion control to improve water quality, reduced physical contact with habitats, and sound protocols to further reduce potential sound impacts.</p>

<p>Protected Species</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate due to disturbance/displacement of organisms or habitat due to water quality, hydrologic alteration, or excavation during watershed proposed activities, temporary disturbance during surveying and research activities; potential use of herbicides; other potential impacts would require consultation.</p> <p>Benefits. D-I/L/L-LS, negligible to major due to proposed activities that reduce erosion and sedimentation; negligible to major due to invasive species control, road and trail stabilization, and habitat improvements for listed species.</p>	<p>Adverse impacts. D-I/S-L/L-LS, negligible to moderate due to discontinued coral restoration efforts and continued damage from anchoring and accumulation of marine debris.</p> <p>Benefits. D/S/L, negligible to minor due to the elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional negligible water quality benefits and reduced impacts to habitats from in-water activities due to DCMMs such as additional protocols to reduce physical contact with sea floor and potential sound/echosounder impacts, monitor vessel speeds, use of BMPs.</p>
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Socioeconomic Environment

<p>Cultural Resources</p>	<p>Adverse impacts. D-I/S-L/L, permanent, negligible to minor due to section 106 SHPO consultation to identify resources and subsequent unlikely disturbance except to remove or document an object or structure that is discovered.</p> <p>Benefits. D/L/L-LS, negligible to moderate due to the potential discovery and/or acquisition of data to support protection of these resources and protection from erosion and runoff.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to minor due to the prior consultation with SHPO to avoid impacting these resources.</p> <p>Benefits. D-I/L/L, negligible to moderate due to potential documentation, recovery, and protection of cultural resources.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts, due to DCMMs.</p> <p>Benefits. Same as No Action, with additional negligible benefits due to required DCMMs protocols to reduce sedimentation into or physical contact with potential resources.</p>
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<p>Public Health and Safety</p>	<p>Adverse impacts. D-I/S-L/L, negligible to minor due to closure of public and private areas for safety during periods of monitoring or research activities. Benefits. D-I/S-L/L-LS, negligible to moderate due to benefits to coastal storm surge and shoreline protection.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate due to continued accumulation of debris and the potential for adverse impacts to public health and safety. Benefits. D-I/S-L/L, negligible to minor, due to the elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action alternative. Benefits. Same as No Action alternative.</p>
	<p>Adverse impacts. D-I/S-L/L, negligible to minor due to potential interruptions in activities. Benefits. D-I/S-L/L, negligible to moderate include data acquisition and information to improve public health and safety.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to major due to discontinued coral restoration efforts and continued damage from anchoring and accumulation of marine debris. Benefits. D/S-L/L, negligible to moderate, due to the elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action alternative. Benefits. Same as No Action alternative.</p>

493 1. INTRODUCTION

494 1.1 NOAA's Role in Conserving Coral Reef Ecosystems

495 Healthy coral reef ecosystems are among the most biologically diverse, culturally significant, and
496 economically valuable on Earth. They provide billions of dollars in food, jobs, recreational opportunities,
497 coastal protection, and other important goods and services to people around the world.

498 Coral reefs face an increasing number of threats, including pollution, unsustainable fishing practices, and
499 global climate change. More than 60% of the world's reefs are under threat from local stressors, like
500 fishing and land-based pollution (Burke et al., 2011). That number jumps to 75% when local threats to
501 reefs are combined with the threat of thermal stress from a changing climate. As a result of increasing
502 threats to coral reef resources, 22 species of coral found in the United States (U.S.) waters are now listed
503 as threatened under the Endangered Species Act (ESA) (Burke et al., 2011).

504 The National Oceanic and Atmospheric Administration (NOAA) established the Coral Reef
505 Conservation Program (CRCP) in 2000 to carry out the policies and purposes of the Coral Reef
506 Conservation Act (CRCA), 16 U.S.C. § 6401, *et seq.* In compliance with the CRCA, the CRCP
507 strives to protect, conserve, and restore the nation's coral reefs by maintaining healthy ecosystem
508 function. The CRCP brings together expertise from across NOAA for a multidisciplinary
509 approach to studying these complex ecosystems toward the goal of more effective management
510 of coral reefs. The CRCP works closely with NOAA scientists in the National Ocean Service
511 (NOS); National Marine Fisheries Service (NMFS); Office of Oceanic and Atmospheric
512 Research (OAR); and National Environmental Satellite, Data, and Information Service
513 (NESDIS). The CRCP also works with a variety of partners that include other federal agencies,
514 state and territorial governments and agencies, research and academic institutions, non-
515 governmental organizations, and community groups in both the Pacific and Atlantic Oceans to
516 conserve tropical/subtropical coral reef ecosystems across multiple states and territories using a
517 targeted approach focused on local issues. Finally, the CRCP supports capacity building in other
518 nations that have coral ecosystem resources.

519 The CRCP is leading efforts in the U.S. to study and conserve the coral reef ecosystem for
520 current and future generations. A more detailed description of the CRCP's history, framework
521 and management is provided below.

522 1.2 Programmatic Scope

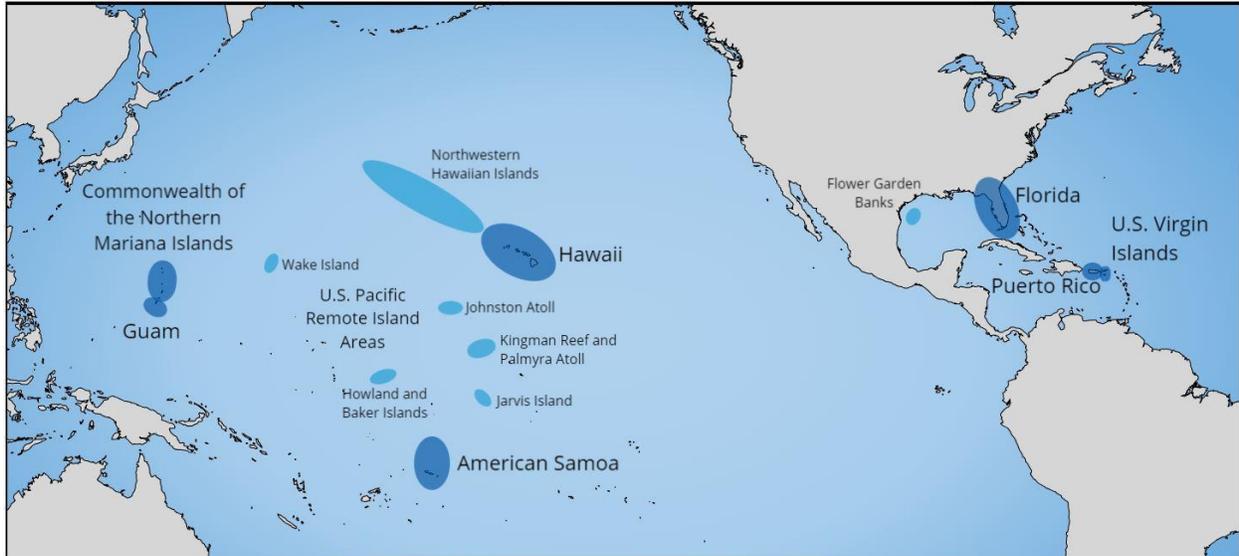
523 NOAA is preparing a Draft Programmatic Environmental Impact Statement (DPEIS) for coral reef
524 conservation and restoration activities as part of the implementation of the CRCP Strategic Plan
525 throughout the U.S. jurisdictions of the Atlantic Ocean, which includes the Gulf of Mexico, South
526 Atlantic and Caribbean Sea, and the Pacific Ocean, which includes the Pacific Island Region (Figure 1-1),
527 and priority international areas (i.e., the wider Caribbean, the Coral Triangle, the South Pacific, and
528 Micronesia; Figure 1-2).

529 The CEQ regulations expressly recognize and encourage the discretionary preparation of PEISs for
530 agency programs (40 C.F.R. § 1502.4(b)), and NOAA has decided to exercise its discretion to prepare a
531 PEIS for the continued operation of the CRCP. Based on early internal agency scoping, NOAA identified

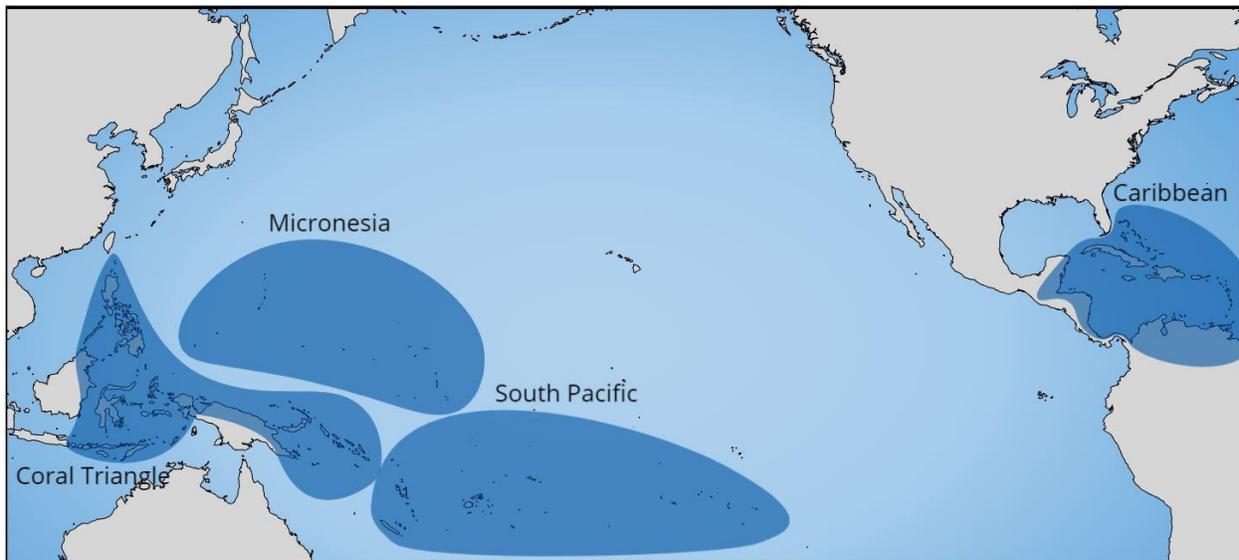
532 the potential significant impacts to certain resources, including some activities that may be highly
533 controversial, as the result of implementing program activities. In addition, the CRCP is a nationwide
534 program extending across seven State and Territorial jurisdictions with the potential to affect multiple
535 sensitive marine resources as well as socio-economics. NOAA further intends for the PEIS to create
536 efficiencies by establishing a framework for future “tiering.” As CRCP activities are proposed for
537 implementation, to the extent additional NEPA review is required, it will rely on the analysis set forth in
538 the PEIS and focus on location specific effects (40 C.F.R. §§ 1508.28, 1502.20). The programmatic scope
539 of this document and its intended future use in CRCP environmental decision making are described in
540 Sections 1.6 through 1.8. NOAA’s decision to prepare a PEIS for the CRCP is a program-specific
541 decision and does not reflect a broader agency policy.

542 This document will assess the direct, indirect, and cumulative environmental impacts of NOAA’s
543 proposed action to continue funding and otherwise implementing coral reef conservation and restoration
544 activities through its existing programmatic framework for implementing the CRCP consistent with its
545 obligations under the CRCA and Executive Order 13089, Coral Reef Protection. Projects implemented or
546 funded by the CRCP vary in terms of their size, complexity, and geographic location. CRCP projects
547 often benefit coral species and habitats found within coral reef ecosystems and the communities that rely
548 on the coral reef ecosystem for nutrition, recreation, and shoreline protection. The CRCP conducts
549 monitoring to gather data on the condition of coral reef ecosystems to support conservation and
550 restoration efforts. NOAA facilitates CRCP activities in coordination with its non-federal partners
551 through grants and cooperative agreements. These activities are prioritized based on available funding and
552 the effectiveness of each activity at restoring coral reefs or responding strategically to threats to coral
553 ecosystems. This DPEIS identifies and evaluates the general environmental impacts, issues, and concerns
554 related to the comprehensive management and implementation of the CRCP, and includes potential
555 mitigation. NOAA analyzed the No Action Alternative and two Alternatives in this DPEIS (Section
556 2.4.3).

557 NOAA anticipates that environmental effects will be caused by site-specific, project-level activities
558 implementing the CRCP. Therefore, this DPEIS will support tiered, site-specific National Environmental
559 Policy Act (NEPA) reviews by narrowing the spectrum of environmental impacts to focus on project-
560 level reviews as needed. NOAA also intends for this DPEIS to establish an environmental decision-
561 making framework for compliance with other environmental statutes such as the ESA and the MMPA.
562 For example, NOAA will use the information and analysis in this DPEIS to initiate ESA Section 7
563 consultation with NMFS for listed marine species and the U.S. Fish and Wildlife Service (USFWS) for
564 terrestrial species and freshwater fish species that may be affected by CRCP implementation. NOAA is
565 conducting a programmatic review to ensure that the underlying activities would not adversely impact
566 essential fish habitat, protected species, or other species. In addition, information generated from CRCP
567 activities will enable NOAA and other managers to determine which strategies can protect corals and
568 coral reef ecosystems throughout the seven U.S. jurisdictions and identified international priority areas.



569
 570 Figure 1-1. The CRCP's U.S. Coral Areas. The dark blue areas highlight the U.S. States and territories where the bulk of the
 571 CRCP's activities take place. The lighter blue areas highlight the remote areas where the CRCP mainly supports periodic
 572 monitoring and assessment.



573
 574 Figure 1-2. The CRCP's International Priority Areas. The dark blue areas highlight the general international regions where the
 575 CRCP mainly supports capacity building

576 1.3 History of the CRCP

577 The following is a brief history¹ of the establishment and implementation of the CRCP, including its plans
 578 and policies. As noted above, NOAA established the CRCP in 2000 to help fulfill NOAA's

¹ The following is a list of reference documents that have been developed and guided management of the CRCP over the years: National Action Plan to Conserve Coral Reefs (2000, <http://www.coralreef.gov/about/CRTFAxnPlan9.pdf>); National Coral Reef Action Strategy (2002, <http://www.coris.noaa.gov/activities/actionstrategy/>); 2007 External Review Panel Final Report, https://repository.library.noaa.gov/view/noaa/479/noaa_479_DS1.pdf; Roadmap for the Future (2008) <https://www.coris.noaa.gov/activities/roadmap/crcproadmap.pdf>; NOAA Coral Reef Conservation Program Goals &

579 responsibilities under the CRCA and Executive Order 13089, Coral Reef Protection. NOAA is
580 responsible for providing external funding through the Coral Reef Conservation Grant Program and the
581 Coral Reef Conservation Fund, as authorized under Sections 204 and 205 of the CRCA, respectively, and
582 implementing the National Program, as authorized under Section 207. These programs primarily target
583 activities that are in tropical/subtropical coral reef ecosystems including colonized hard bottom habitats
584 (e.g., spur-and-groove reefs, individual and aggregated patch reefs, and gorgonian-colonized pavement
585 and bedrock); uncolonized hardbottom (e.g., reef rubble and uncolonized bedrock); mesophotic reefs (30-
586 150 meters [m], ~100-500 ft) that are linked to shallow-water coral reefs (<30 m; ~100 ft) (i.e., have a
587 meaningful ecological connection between the mesophotic area and associated shallow-water coral reefs);
588 submerged vegetation (e.g., seagrass and macroalgae); mangroves and other emergent vegetation; and
589 unconsolidated sediments (e.g., sand and mud).

590 In addition to the CRCA, the CRCP has been guided by a series of national strategy, planning, and
591 guidance documents. Initially the CRCP addressed the priorities and objectives laid out in the *National*
592 *Action Plan to Conserve Coral Reefs* (USCRTF, 2000) and the *National Coral Reef Action Strategy*
593 (NOAA, 2002). The *National Action Plan* was produced by the U.S. Coral Reef Task Force (USCRTF)
594 pursuant to Executive Order 13089, and the *National Coral Reef Action Strategy* was developed by
595 NOAA, through the CRCP, pursuant to section 203 of the CRCA. Both documents identified two
596 overarching goals: (1) understand coral reef ecosystems and the natural and anthropogenic processes that
597 determine their health and viability and (2) reduce the adverse impacts of human activities. These two
598 goals encompassed the following 13 conservation strategies: (1) create comprehensive maps of all U.S.
599 coral reef habitats, (2) conduct long-term monitoring and assessments of trends, (3) support strategic
600 research to respond to major threats, (4) incorporate human dimensions into coral reef conservation
601 strategies, (5) create an expanded network of coral reef marine protected areas, (6) reduce impacts of
602 extractive uses, (7) reduce habitat destruction, (8) reduce pollution, (9) restore damaged reefs, (10) reduce
603 global threats, (11) reduce impacts from international trade, (12) improve Federal accountability and
604 coordination, and (13) create an informed public.

605 In 2002, the USCRTF called for each of the seven U.S. jurisdictions containing coral reefs (i.e., U.S.
606 Virgin Islands [USVI], Puerto Rico, Florida, Hawaii, American Samoa, Guam, and the Commonwealth of
607 the Northern Mariana Islands [CNMI]) to develop *Local Action Strategies*, which were locally-driven
608 roadmaps addressing fishing impacts, land-based sources of pollution, recreational overuse and misuse,
609 lack of public awareness, climate change and coral bleaching, and disease, as well as additional locally-
610 relevant threats (i.e., invasive species and over population). These *Local Action Strategies* documents
611 contained a variety of projects to be implemented over a three-year period (roughly 2004-2006). From
612 2000 through 2008, the CRCP funded and/or implemented a variety of projects that addressed the goals
613 and objectives of the *National Action Plan*, the *National Coral Reef Action Strategy*, and the jurisdictional
614 LASs.

Objectives 2010-2015, https://permanent.access.gpo.gov/lps124467/3threats_go.pdf; NOAA Coral Reef Conservation Program International Strategy 2010-2015, ftp://ftp.library.noaa.gov/noaa_documents.lib/CoRIS/intl_strategy_2010-2015.pdf; Jurisdictional Management Priority Setting Documents, https://www.coris.noaa.gov/activities/management_priorities/; Jurisdictional Capacity Assessments, https://www.coris.noaa.gov/activities/capacity_assessment/.

615 In 2007, the CRCP conducted its first external review, during which a panel of experts provided an
616 independent assessment of the CRCP's effectiveness in achieving its mandates and provided
617 recommendations for improving its impact and performance in the future. The review panel
618 recommended that the CRCP (1) retain the mission of supporting effective management and sound
619 science; (2) consolidate and sharpen its place-based goals and objectives; (3) increase emphasis on
620 management-relevant science; (4) focus more on addressing impacts related to climate change and
621 unsustainable fishing; and (5) expand the CRCP's international presence. To address the findings of the
622 external review, the CRCP developed the *Roadmap for the Future* (2008) document, which outlines
623 CRCP's principles and priorities and National-level responsibilities.

624 To make the most of limited resources and to reverse the general decline in coral reef ecosystem health
625 that has occurred over the past several decades, the CRCP narrowed the focus of its National Program to
626 address three threats: fishing impacts, land-based sources of pollution, and climate change. These three
627 threats were widely accepted as having the largest influence on coral decline at the time the roadmap was
628 prepared and continue to be some of the top threats facing the ecosystem. The National-level CRCP
629 responsibilities included providing maps of all U.S. coral reef ecosystems appropriate for management
630 and conducting biophysical and socioeconomic monitoring and assessments to track coral reef status and
631 trends over time and in jurisdictions.

632 To implement the proposed changes, the CRCP created three working groups made up of NOAA and
633 non-NOAA experts, who provided recommendations to address each of the three threats. The results of
634 this collaborative effort was the *NOAA Coral Reef Conservation Program Goals & Objectives 2010-2015*
635 document, which outlined priorities for the domestic component of the CRCP, and the *NOAA Coral Reef*
636 *Conservation Program International Strategy 2010-2015* document, which outlined priorities for the
637 international component of the program. Additionally, the CRCP worked with each of the seven U.S.
638 coral reef jurisdictions to develop a set of strategic coral reef management priorities and conducted
639 capacity assessments to identify the support needed to address the identified priorities.

640 In 2016, the CRCP completed a second review of its science and changes were suggested to better
641 balance existing and emerging priorities that optimize coral reef conservation outcomes as a part of its
642 adaptive management cycle. This resulted in a new strategic plan: the CRCP Strategic Plan. The CRCP
643 Strategic Plan focuses on improving fisheries sustainability, reducing land-based sources of pollution,
644 addressing climate change impacts, and restoring viable coral populations. The CRCP supports activities
645 to reach conservation goals for corals, coral recruitment habitat, key fishery taxa, and water quality.
646 NOAA's CRCP must be implemented in accordance with legal and policy requirements. These
647 compliance requirements generally fall into two categories: those that are necessary to meet the
648 requirements of the CRCA as implemented by agency strategies, plans, and policies; and those necessary
649 to meet the requirements of other NOAA mandates (e.g., ESA, MMPA, Magnuson-Stevens Fishery
650 Conservation and Management Act, Coastal Zone Management Act, etc.) and other Federal mandates
651 (e.g., National Historic Preservation Act, National Environmental Policy Act, etc.). While the goals and
652 objectives of the CRCP are intended to lead to short- and long-term conservation benefits to the coral reef
653 ecosystem, activities implementing the program to achieve conservation benefits may affect natural and
654 cultural resources. Effects often need to be addressed through applicable regulatory processes and
655 associated mitigation measures.

656 **1.4 Summary of NOAA’s Proposed Action**

657 NOAA proposes to continue implementing the CRCP through coral reef conservation and restoration
658 activities such as internal, agency-funded and executed activities and by providing financial and technical
659 assistance to Federal, State, and local agencies, private organizations, and academic institutions. This
660 proposed action would enable the CRCP to continue focusing its funding and activities on the
661 conservation of coral reefs, guided by the CRCP Strategic Plan and future iterations of a programmatic
662 strategic plan. The types of activities the CRCP anticipates implementing are described further in this
663 document. The CRCP will continue to be implemented across multiple coral reef ecosystems located in
664 the seven U.S. jurisdictions, the U.S. Pacific Remote Islands Marine National Monument, the Gulf of
665 Mexico, and targeted international areas (i.e., the wider Caribbean, Coral Triangle, the South Pacific, and
666 Micronesia). The geographic extent is depicted in Figures 1 and 2, above, and program structure and
667 activities are described in detail in the description of the proposed action and alternatives (Sections 2.2
668 and 2.3). This DPEIS addresses the environmental effects of the CRCP until 2040 to align with the
669 planning horizon of the CRCP Strategic Plan. NOAA identifies in this document a suite of conservation
670 and restoration activities that NOAA believes will most effectively conserve and restore coral reefs,
671 habitats, and ecosystems guided by the CRCP’s foundational documents for the next couple of decades.
672 This DPEIS evaluates the potential impacts to the human and natural environment of implementing these
673 activities and provides a framework so that future decisions by NOAA at the project-specific level can be
674 covered by or effectively tiered from this programmatic analysis.

675 **1.5 Purpose and Need**

676 ***1.5.1 Purpose***

677 The purpose of the proposed action is for NOAA, through the CRCP, to effectively and efficiently
678 conserve coral reef ecosystems and work to ensure their continued existence and sustained use for the
679 Nation and future generations pursuant to the CRCA.

680 NOAA must implement the program according to the CRCA, other NOAA and Federal mandates,
681 internal NOAA policy and guidance, and the strategic plan priorities, implementation of which may shift
682 and evolve over time. Implementation activities identified through collaboration and coordination with
683 partners will minimize risks, mitigate threats, and restore function to coral reef ecosystems. In sum,
684 NOAA needs to manage the CRCP through an efficient management framework designed to ensure that
685 maximum program funding is devoted to coral reef conservation and recovery.

686 ***1.5.2 Need***

687 Coral reef ecosystems are rapidly declining in health globally. Widespread acute and chronic threats to
688 coral habitats adversely affect their ecosystem functions and services. Threats, such as impacts from
689 climate change, unsustainable fishing practices, and land-based sources of pollution alter and degrade,
690 and in certain circumstances, lead to the mortality of coral reef ecosystems. Thus, there is an urgent need
691 for NOAA to evaluate and implement activities to support long-term conservation and recovery of coral
692 reef ecosystems. The vulnerability (or danger) of not acting aggressively is to risk losing, perhaps
693 catastrophically, the globally and highly substantial ecological, societal, and economic benefits provided
694 by coral reef ecosystems.

695 **1.6 Scope of this Document**

696 This DPEIS provides a programmatic-level assessment of the potential impacts of NOAA’s CRCP and its
697 implementation on the human environment, including biological and physical resources. A programmatic
698 approach is used when initiating or reevaluating a federal program for compliance with NEPA. It takes a
699 broad look at issues and alternatives, and provides a baseline for future management actions.

700 Programmatic documents are often intended to ensure NEPA compliance, as well as facilitate compliance
701 with other applicable laws and regulations such as the ESA, for management and other activities over a
702 certain period before a formal review is again initiated. This DPEIS assesses the potential direct, indirect,
703 and cumulative impacts of the alternatives. The chapters that follow describe the activities proposed for
704 continued implementation of the CRCP and potential alternatives (Chapter 2), the affected environment as
705 it currently exists (Chapter 3), and the probable direct, indirect, and cumulative impacts on the human
706 environment that may result from the continued implementation of the proposed CRCP activities and
707 alternatives (Chapter 4). The scope of this DPEIS covers coral reef conservation activities funded,
708 authorized, or conducted by the CRCP that:

- 709 ● Contribute to coral reef conservation in accordance with Federal statutes, Executive Orders, and
710 NOAA strategies and policies;
- 711 ● Generally take place in shallow and mesophotic marine waters of USVI, Puerto Rico, Florida,
712 Hawaii, American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, Flower
713 Garden Banks National Marine Sanctuary, Papahānaumokuākea Marine National Monument, the
714 Pacific Remote Islands Marine National Monument (see Figure 1-1), and targeted international
715 regions including the wider Caribbean, the Coral Triangle, the South Pacific, and Micronesia (see
716 Figure 1-2);
- 717 ● Involve the transiting of these waters in various-sized research vessels, the deployment of divers
718 and instruments into the water to characterize, sample, and monitor living marine resources and
719 their environmental conditions and conduct in-water conservation and restoration activities,
720 and/or use active acoustic devices for navigation and remote-sensing purposes.

721 The program and its supported activities are described in detail in the Description of the Proposed Action
722 (Sections 2.2 and 2.3).

723 The DPEIS covers both short-term and long-term environmental effects generally expected to occur as a
724 result of implementing typical CRCP activities. This DPEIS does not cover activities other than those
725 included in the description of the proposed action. Any information not included in this DPEIS may need
726 to be captured in project-level, tiered NEPA documents. Therefore, some proposed activities may require
727 further environmental impact assessments and compliance with other consultation, approval, or
728 permitting requirements before a decision on whether to proceed is made. The analysis provided by this
729 DPEIS is intended to support and integrate compliance with the ESA, Magnuson-Stevens Act (MSA)
730 (pertaining to EFH), National Marine Sanctuaries Act (NMSA), Coastal Zone Management Act (CZMA),
731 MMPA, and other applicable statutes, acknowledging that specific activities may require development of
732 more focused and refined analyses.

733 This DPEIS also relies on and incorporates by reference several pre-existing NEPA documents and other
734 relevant analyses that have considered effects of activities on coral reef ecosystems. Where the document
735 incorporates by reference, the information incorporated is summarized and cited.

736 1.7 Tiering

737 As discussed, this DPEIS establishes a tiered environmental review process for the CRCP. Tiering refers
738 to the coverage of general matters in broader or programmatic NEPA documents (such as national
739 program or policy statements) with subsequent narrower statements or environmental analyses (such as
740 regional or basin-wide program statements or, ultimately, site-specific statements) by incorporating by
741 reference the general discussions in the broader or programmatic NEPA documents and concentrating
742 solely on the issues specific to the statement subsequently prepared (40 C.F.R. § 1508.28). If the impacts
743 of a site-specific action are fully covered in this DPEIS, no further NEPA review would be required, and
744 such determination would be documented in a memorandum for the record. If the impacts are not fully
745 covered, a project-specific NEPA review would be required. The programmatic analysis included in this
746 DPEIS provides a comprehensive analysis of the CRCP's activities by evaluating programmatic activities
747 and impacts, thereby allowing decision-makers to tier future project-specific analyses from the DPEIS.
748 Tiering future project-specific analyses would reduce or eliminate duplicative documentation by focusing
749 future project analyses, if needed, on project-specific issues. For example:

- 750 ● When decision-makers review a proposed coral reef conservation project and determine that it
751 falls within the scope of the proposed action and impacts in the DPEIS, the decision-makers may
752 prepare a memorandum for the record in accordance with NOAA's NEPA procedures, NOAA
753 Administrative Order 216-6A and its Companion Manual (NAO 216-6A), documenting that the
754 impacts of the proposed action are included in the scope of the DPEIS, and proceed without
755 further NEPA review. The criteria for making this determination are set forth in the Companion
756 Manual at Section 5.A and include verifying that the existing analysis is valid in light of any new
757 information or circumstances and the direct, indirect, and cumulative effects that would result
758 from implementation of the new proposed action are similar to those analyzed in this PEIS;
- 759 ● When decision-makers from another NOAA program office review a proposed action that is
760 substantially similar to the actions evaluated in the DPEIS and determine that it falls within the
761 scope of the proposed action and impacts in the DPEIS, the decision-makers may prepare a
762 memorandum for the record in accordance with NOAA's NEPA procedures, NOAA
763 Administrative Order 216-6A and its Companion Manual (NAO 216-6A), documenting that the
764 impacts of the proposed action are included in the scope of the DPEIS, and proceed without
765 further NEPA review;
- 766 ● When decision-makers review proposed coral reef conservation activities and determine that
767 project-specific impacts may require additional environmental analysis, they would prepare
768 NEPA documents for the activities that tier from this DPEIS if the conditions and environmental
769 effects described in the DPEIS are still valid and address any exceptions or additional information
770 beyond the scope of the DPEIS;
- 771 ● If a NEPA analysis for a subsequent activity differs from the analysis provided at the
772 programmatic level (e.g., best practices that were assumed in this analysis are not incorporated as
773 part of a proposed project), that difference would be described in the tiered NEPA analysis to
774 indicate whether the significance of impacts differs from the significance presented in this
775 DPEIS. If the impacts of a future project are analyzed in an EA tiered to this DPEIS, and found to
776 be not significant, the environmental assessment would produce a Finding of No Significant
777 Impact (FONSI) and proceed;

- 778 • If the impacts of an activity were found to be significant and/or beyond the scope of impacts
779 disclosed in this DPEIS, those impacts would be evaluated in a tiered or independent NEPA
780 document; and
- 781 • When decision-makers from other NOAA program offices review proposed actions to which the
782 impacts analyses and mitigation measures evaluated in this document are relevant, they may
783 incorporate the analyses by reference to streamline environmental review.

784 **1.8 Scope of Environmental Resources, Impacts, and Issues**

785 Based on coordination and consultation with internal agency subject matter experts, expert Federal and
786 State agency staff, and other stakeholders, as well as public comments received during scoping, NOAA
787 has identified the important environmental resources, impacts, issues, and concerns. NOAA has given
788 these important environmental resources, impacts issues, and concerns detailed evaluation in this DPEIS.
789 Given the nature of the CRCP and its activities, certain elements of the biological and physical
790 environment were removed from detailed evaluation as NOAA determined that these would either not be
791 affected by program activities or that the impacts would be negligible or discountable (Section 4.2.2).
792 Chapter 3, which provides a detailed Description of the Affected Environment, provides an explanation of
793 our approach. Where the CRCP decided not to carry elements of the biological and physical environment
794 forward for detailed description and analysis, the CRCP provides a summary explanation in Chapter 4 of
795 this document. Elements that receive no further consideration are not evaluated in the environmental
796 impacts discussed in Chapter 4.

797 **1.9 Public Involvement**

798 On July 11, 2018, NOAA published a Notice of Intent (NOI) to prepare an EIS in the Federal Register 83
799 FR 32099. NOAA reviewed and addressed comments received in preparing this DPEIS. This DPEIS will
800 be circulated to relevant Federal agencies and stakeholders with an interest in coral reef conservation and
801 restoration and then filed with the Environmental Protection Agency (EPA). A Notice of Availability
802 (NOA) will be published in the Federal Register which will initiate a 45 day public comment period.
803 Public comments submitted during the comment period will be reviewed and appropriate responsive
804 changes will be included in the Final PEIS. NOAA will include a chapter explaining how it addressed
805 public comments.

806 **1.10 Statutory/Regulatory Compliance Requirements**

807 Pursuant to the CRCA, NOAA is the federal agency that administers the CRCP and its activities
808 evaluated in this DPEIS. These activities may trigger a broad range of regulatory compliance processes
809 because they may cause adverse impacts to public trust resources that are regulated by various statutes.
810 Table 1-1 presents a brief summary of some of these applicable laws. This information is provided to aid
811 the reader in understanding the material presented later in the DPEIS and is not intended to be a complete
812 listing of all statutes, orders, or regulations applicable to the proposed action and alternatives. All activities
813 will be reviewed to determine whether other statutory compliance requirements are triggered, and
814 compliance would occur on a case-by-case basis as necessary (Devaney Memo, 2014; Friedman Memo,
815 2017).

Law	Summary of Law
Coral Reef Conservation Act of 2000 (CRCA)	The purpose of the CRCA is to: (1) preserve, sustain, and restore the condition of coral reef ecosystems; (2) promote the wise management and sustainable use of coral reef ecosystems to benefit local communities and the Nation; (3) develop sound scientific information on the condition of coral reef ecosystems and the threats to such ecosystems; (4) assist in the preservation of coral reefs by supporting conservation programs, including projects that involve affected local communities and nongovernmental organizations; (5) provide financial resources for those programs and projects; and (6) establish a formal mechanism for collecting and allocating monetary donations from the private sector to be used for coral reef conservation projects.
Marine Mammal Protection Act (MMPA)	The MMPA protects all marine mammals, including cetaceans (i.e., whales, dolphins, and porpoises), pinnipeds (i.e., seals and sea lions), sirenians (i.e., manatees and dugongs), sea otters, and polar bears within the waters of the U.S. The MMPA requires that an incidental take authorization be obtained for the unintentional “take” of marine mammals incidental to activities.
Endangered Species Act (ESA)	The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. Under the ESA, species may be listed as either endangered or threatened. "Endangered" refers to a species that is in danger of extinction throughout all or a significant portion of its range. "Threatened" refers to a species that is likely to become endangered within the foreseeable future. ESA also provides for the designation and protection of critical habitat, specific geographic area(s) that contains features essential to the conservation of a threatened or endangered species. Section 7 (a)(2) requires the agencies, through consultation with the U.S. Fish and Wildlife Service or the NMFS, to ensure their activities are not likely to jeopardize the continued existence of listed species, or destroy or adversely modify their critical habitat.
Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act or MSA)	The MSA is the primary law governing marine fisheries management in U.S. federal waters. First passed in 1976, the MSA fosters long-term biological and economic sustainability of our nation's marine fisheries out to 200 nautical miles from shore. Key objectives of the MSA are to (1) prevent overfishing, (2) rebuild overfished stocks, (3) increase long-term economic and social benefits, (4) use reliable data and sound science, (5) conserve essential fish habitat (under the 1996 amendment Sustainable Fisheries Act), and (6) ensure a safe and sustainable supply of seafood. The MSA includes provisions concerning the identification and conservation of Essential Fish Habitat (EFH),

	<p>which is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Federal agencies that authorize, fund, or undertake actions that may adversely affect EFH must consult with NMFS, and NMFS must provide conservation recommendations to federal and state agencies regarding actions that would adversely affect EFH.</p>
The National Marine Sanctuaries Act (NMSA)	<p>The NMSA authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. Section 304(d) Act requires interagency consultation between NOAA and federal agencies taking “likely to injure” a sanctuary resource. A permit or other approval is required to conduct an activity within a sanctuary that is otherwise prohibited.</p>
Coastal Zone Management Act (CZMA)	<p>The CZMA provides for the management of the nation’s coastal resources, including the Great Lakes. The goal is to “preserve, protect, develop, and where possible, to restore or enhance the resources of the nation’s coastal zone.” The CZMA requires that federal actions which have reasonably foreseeable effects on any coastal use (land or water) or natural resource of the coastal zone be consistent with the enforceable policies of a state's federally approved coastal management program.</p>
National Historic Preservation Act (NHPA)	<p>The NHPA requires Federal agencies to take into account the effects of their undertakings, such as construction projects, on properties covered by the NHPA, such as historic properties, properties eligible for listing on the National Register of Historic Places, or properties that an Indian Tribe regards as having religious and/or cultural importance.</p>
Clean Water Act (CWA)	<p>The CWA regulates surface water quality in states, territories, and authorized tribal lands. Under Section 404 of the CWA, the U.S. Army Corps of Engineers requires that an interested party obtain a permit before filling, constructing on, or altering a jurisdictional wetland (33 U.S.C § 1344).</p>
Fish and Wildlife Coordination Act	<p>The Fish and Wildlife Coordination Act requires that federal agencies consult with the USFWS, the NMFS, and State agencies for activities that affect, control or modify waters of any stream or bodies of water, in order to minimize the adverse impacts of such actions on fish and wildlife resources and habitat.</p>

818 **2. DESCRIPTION OF PROPOSED ACTION AND**
819 **ALTERNATIVES**

820 **2.1 Proposed Action**

821 Pursuant to the CRCA, NOAA proposes to continue implementing the CRCP activities in order “to
822 preserve, sustain, and restore the condition of coral reef ecosystems; to promote the wise management and
823 sustainable use of coral reef ecosystems to benefit local communities and the Nation; and to develop
824 sound scientific information on the condition of coral reef ecosystems and the threats to these
825 ecosystems.” The CRCP Strategic Plan focuses CRCP’s efforts to ensure compliance with the CRCA.
826 The CRCP Strategic Plan includes four areas of work, which are described below in Section 2.2. Section
827 2.3 describes the activities the CRCP conducts in furtherance of these four areas of work. The existing
828 CRCP framework, which consists of external grants, contracts, and internal funding for NOAA programs
829 and offices, supports these coral reef conservation activities. This DPEIS includes a description of the
830 proposed action appropriate to the programmatic decision being made. It, therefore, does not describe the
831 number, scale, and location of projects as decisions regarding funding and project proposal, approval, and
832 implementation vary over time. Rather, the description of the proposed action clearly describes the
833 component activities that would predictably be implemented over time and the jurisdictions in which the
834 program is implemented. Therefore, the description is qualitative, not quantitative. Chapter 3 describes
835 the current condition of the resources in which these activities would likely be implemented, and Chapter
836 4 predicts the types of impacts that could occur as a result of implementing the described activities. This
837 approach is programmatic and provides sufficient information to predict the general impacts anticipated
838 from implementation of the CRCP. Project-specific impacts, as explained below, will be evaluated, as
839 necessary on a case-by-case basis where the specific parameters of the scope and scale of each proposed
840 action would be clearly described. Describing the proposed action in this way provides a foundation to
841 properly evaluate the context and intensity of impacts at a programmatic scale.

842 The types of activities the CRCP anticipates implementing are described further in Chapter 2.3 of this
843 document, but include these five categories of activities:

- 844 • Monitoring, mapping, and research (e.g., scuba surveys, use of underwater autonomous vehicles,
845 coral sampling, fish sampling and tagging, and bathymetric echosounders);
- 846 • Coral restoration and interventions (e.g., coral nursery and outplanting, removal of invasive and
847 nuisance species, and addressing coral disease);
- 848 • Watershed management and restoration (e.g., small-scale construction projects designed to
849 minimize sediment and pollutant runoff to coral habitats, such as restoring vegetative cover and
850 use of, rain gardens, culvert repair, stream bank stabilization, retention ponds, or constructed
851 wetlands);
- 852 • Reduction of physical impacts to coral reef ecosystems (e.g., buoy installation and marine debris
853 removal); and
- 854 • Outreach/education and program operations.

855 **2.2 Overview of the CRCP Strategic Plan**

856 The CRCP Strategic Plan focuses efforts on four areas of work, which are supported through cross-cutting
857 functions. These four areas are improving fisheries sustainability, reducing land-based sources of
858 pollution, increasing resilience to climate change impacts, and restoring viable coral populations. The
859 cross-cutting functions of the CRCP include research, mapping, monitoring, social science,
860 communications, and capacity building. Domestically, the CRCP supports on-the-ground and in-the-water
861 actions (described in Section 2.3, below) to meet the Strategic Plans’s goals and objectives and to
862 conserve coral reef ecosystems through resilience-based management in the seven U.S. coral reef
863 jurisdictions. Internationally, the CRCP focuses its support and effort on capacity building under four
864 focus areas: (1) working with regional initiatives to build marine protected area networks and strengthen
865 local management capacity to improve and maintain resilience of coral reef ecosystems and the human
866 communities that depend on them; (2) developing and implementing tools and practices to more
867 effectively observe, predict, communicate, and manage climate change; (3) strengthening local and
868 national capacity and policy frameworks to reduce impacts of fishing on coral reef ecosystems; and (4)
869 strengthening policy frameworks and institutional capacities to reduce impacts to coral reef ecosystems
870 from pollution due to land-based activities.

871 ***2.2.1 Improve Fisheries Sustainability***

872 To improve fisheries sustainability, the CRCP is working closely with the fisheries management agencies
873 of the seven states and territories, four regional fishery management councils, as well as NOAA Fisheries
874 to support sustainable coral reef fisheries in U.S. waters. Sustainable fisheries management also depends
875 on the engagement and cooperation of fishers, local communities, and other key stakeholders, which the
876 CRCP helps facilitate. U.S. fisheries management is a model for the world and best practices will be
877 shared to build capacity for sustainable management in foreign governments located within the four
878 regions that are connected to U.S. coral reef ecosystems. The CRCP focuses on advancing ecosystem-
879 based approaches and improving essential data collection and capacity building activities to support the
880 effective use of existing coral reef fisheries management and enforcement tools.

881 This will be accomplished by:

- 882 ● Focusing on key fishery taxa that are ecologically important for reef conditions and particularly
883 vulnerable to overfishing;
- 884 ● Filling priority data gaps for fisheries’ managers, aiming to better understand ecological
885 sustainability for coral reef ecosystems, and promptly delivering data and results;
- 886 ● Connecting management partners with successful tools and strategies for adaptive management
887 and sufficient enforcement and compliance; and
- 888 ● Improving the way CRCP works, including increasing comparability and sharing of data,
889 engaging more partners, and developing more effective communication products.

890 ***2.2.2 Reduce Land-Based Sources of Pollution***

891 The second area of focus is reducing land-based sources of pollution such as sediment, nutrients, and
892 other pollutants transported in surface waters, runoff, groundwater seepage, and atmospheric deposition
893 into coastal waters that degrade water quality. The health of U.S. coral reef ecosystems depends on
894 effective management of land-based activities in adjacent coastal and upland regions. The CRCP utilizes
895 an integrated watershed management approach that includes comprehensive management plans to identify

896 sources, baseline characterizations to understand the full suite of impacts, prioritized management
897 responses, and detailed plans regarding partner roles and responsibilities. The CRCP continues to support
898 the installation of stormwater control BMPs and provides technical assistance to support performance
899 monitoring and assessments. The CRCP also supports capacity building and multilateral coordination to
900 advance watershed management efforts within the U.S. jurisdictions and, to a limited extent,
901 internationally.

902 ***2.2.3 Increase Resilience to Climate Change***

903 The third area of work addresses the impacts of climate change, including ocean acidification, on coral
904 reef ecosystems, emphasizing a conservation approach that focuses on resilience-based management.
905 Resilience refers to the capacity of a system to resist and recover from disturbance, and maintain structure
906 and function to provide ecosystem services. Resilience-based management has recently been adopted as
907 an effective approach for integrating climate change considerations into coral reef management by several
908 international and domestic partners. As part of this effort, the CRCP is focusing on three concepts: (1)
909 providing an understanding of past and present impacts, and projecting future impacts to coral reefs
910 caused by climate change and associated responses such as coral bleaching; (2) assessing and
911 understanding likely social and ecological responses to climate change; and (3) supporting the
912 identification and prioritization of management actions to support ecosystem resilience and human well-
913 being.

914 ***2.2.4 Restoring Viable Coral Populations***

915 The fourth area of work is focused on maintaining and restoring viable, functioning coral reef ecosystems.
916 To achieve this, the CRCP is implementing a multi-prong approach that addresses local stressors such as
917 invasive species and anchoring impacts, while simultaneously repopulating key reefs. The CRCP supports
918 research, on-the-ground actions to prevent additional losses of corals and their habitat, and coral
919 restoration using intervention techniques (e.g., stress hardening and assisted gene flow) to create resilient,
920 genetically diverse, and reproductively viable populations of key coral species. These intervention
921 techniques are expected to facilitate the adaptation of coral reef ecosystems to evolving environmental
922 conditions. Additionally, the CRCP will improve the use of regulatory mandates to prevent loss of coral
923 and coral reef habitat through supporting technical knowledge transfer to permitting agencies,
924 encouraging consistent use of BMPs, and informing mitigation options with appropriate restoration
925 techniques.

926 ***2.2.5 Cross-Cutting Functions***

927 In addition to the four areas of focus, the CRCP supports cross-cutting functions, including research,
928 mapping, monitoring, social science, communications, and capacity building at a national and
929 international scale. The CRCP:

- 930 ● Supports topic-based research needs identified within the areas of work to meet our
931 objectives and long-term conservation goals.
- 932 ● Maps coral reefs throughout the seven jurisdictions for multiple purposes.
- 933 ● Continues to implement the National Coral Reef Monitoring Program. This program
934 documents and identifies the status and trends of U.S. coral reef ecosystems to provide an
935 ecosystem perspective to support informed conservation and management via monitoring
936 fish, benthic, climate, and socioeconomic variables in a consistent and integrated manner.

937 Historically, the National Coral Reef Monitoring Program activities in the U.S. Pacific
938 (American Samoa and U.S. Remote Pacific Island Areas, Mariana Archipelago (Guam
939 and the Commonwealth of the Northern Mariana Islands, and Main Hawaiian Islands)
940 occur on a triannual rotation. The Caribbean activities have taken place biannually
941 rotating between Puerto Rico and U.S. Virgin Islands, and the activities in Florida take
942 place every other year.

- 943 ● Aims to apply advanced social science approaches, particularly the combination of bio-
944 physical and human dimensions (social and economic) research to identify results and
945 outcomes that will better inform decision-making and policy for coral reef conservation.
- 946 ● Recognizes the value of an informed and engaged public, empowered to act for coral reef
947 ecosystem conservation. The CRCP conducts outreach efforts and will utilize new,
948 innovative tools to increase awareness and stewardship of coral reef ecosystem resources.
- 949 ● Builds capacity by providing science for management support and by transferring
950 knowledge among international and domestic partners.

951 **2.3 CRCP Activities to Support the Strategic Plan**

952 In order to meet the goals and objectives outlined in the Strategic Plan, the CRCP conducts monitoring,
953 mapping, research, restoration, and outreach and education. This includes the broad-scale coral reef
954 monitoring, which documents the status and trends of U.S. coral reef ecosystems and provides an
955 ecosystem perspective to support informed conservation and management. Table 2-1 depicts how the
956 activities listed below are mapped to the focus areas of the CRCP Strategic Plan.

Table 2-1. Implemented activities under the CRCP mapped to focus areas in the strategic plan

Activity	CRCP Areas of Focus			
	Improve Fisheries Sustainability	Address Land-based Sources of Pollution	Address Climate Change	Restore Viable Coral Populations
Monitoring, Mapping, and Research				
Biological Monitoring				
SCUBA and/or Snorkel Surveys	X	X	X	X
Stationary Cameras	X	--	--	X
Fisheries Monitoring and Detection Using Echosounder	X	--	--	X
Geological and Oceanographic Monitoring				
<i>Moored Instruments, and Water Quality Monitoring</i>	X	X	X	X
<i>Antifouling and Lubricants for Instruments</i>	X	--	X	--
<i>Drifters</i>	X	--	X	X
<i>Automated Underwater Vehicles and Remotely Operated Vehicles</i>	X	--	X	--
<i>Marine Sediment Monitoring</i>	X	--	X	--
<i>Terrestrial Sediment Monitoring</i>	X	X	X	--
Socioeconomic Monitoring	X	X	X	X
Coral Reef Mapping				
<i>In-water Echosounder</i>	X	--	X	--
<i>Aerial</i>	X	X	X	X
<i>Satellite</i>	--	X	X	X
Common Research Activities				

Tagging				
<i>Fish</i>	X	--	--	--
<i>Shark</i>	X	--	--	--
<i>Corals</i>	--	--	X	X
Collection of biological samples				
<i>Coral</i>	--	X	X	X
<i>Fish and Other Invertebrates</i>	X	--	--	--
<i>Algae/Seagrass</i>	--	X	X	X
Coral Restoration and Interventions				
Coral Restoration				
<i>In-situ Nursery Development/ Enhancement</i>	--	--	--	X
<i>Nursery Maintenance</i>	--	--	--	X
<i>Coral Transplantation</i>	--	--	--	X
Other Coral Interventions				
<i>Urchin Propagation and Outplanting</i>	--	--	--	X
<i>Invasive and Nuisance Algae Control/Removal</i>	--	--	--	X
<i>Corallivore Control</i>	--	--	--	X
<i>Coral Disease Control</i>	--	--	--	X
<i>Coral Genomics, Stress Hardening, and Survival Analysis</i>	--	--	--	X
<i>Potential Future Coral Intervention Activities</i>	--	--	--	X
Watershed Management and Restoration				

Technical Support for Watershed Management Plans	--	X	--	--
Vegetative Planting	--	X	--	--
Unpaved Road/Trail Stabilization	--	X	--	--
Stormwater Control Best Management Practices				
<i>Bioretention Cells (Rain Gardens)</i>	--	X	--	--
<i>Baffle Boxes</i>	--	X	--	--
<i>Culvert Repair or Replacement</i>	--	X	--	--
<i>Curb/Grate Inlet Basket (with Filter)</i>	--	X	--	--
<i>Swale</i>	--	X	--	--
Stormwater Pond/Sediment Basins	--	X	--	--
Constructed Wetlands	--	X	--	--
Low Impact Development	--	X	--	--
Streambank and Ghut Stabilization	--	X	--	--
Fencing	--	X	--	--
Elevated Boardwalks and Delimitation of Sensitive Areas	--	X	--	--
Reduce Physical Impacts to Coral Reef Ecosystems				
Boat Mooring Buoy Installation				
<i>Recreational/Day Use Moorings</i>	--	--	--	X
<i>Storm Buoys</i>	--	--	--	X
<i>Marker Buoys</i>	--	--	--	X
Debris Removal	--	--	--	X
Outreach/Education and Program Operations				

Outreach/Education				
<i>Signage</i>	X	--	--	X
<i>In-situ Education Activities</i>	X	X	X	X
<i>Other Outreach Activities</i>	X	X	X	X
Data Analysis and Modeling	X	X	X	X
Program and Interagency Coordination/Administration	X	X	X	X
Operational Activities (Vessels)	X	X	X	X

958

959 **2.3.1 Monitoring, Mapping, and Research**

960 The CRCP supports monitoring, mapping, and, research by supporting NOAA offices and programs and
961 through its external grant program. This section describes these techniques in general terms, but for more
962 information on the CRCP's current and historic monitoring efforts, see
963 <https://www.coris.noaa.gov/monitoring/>.

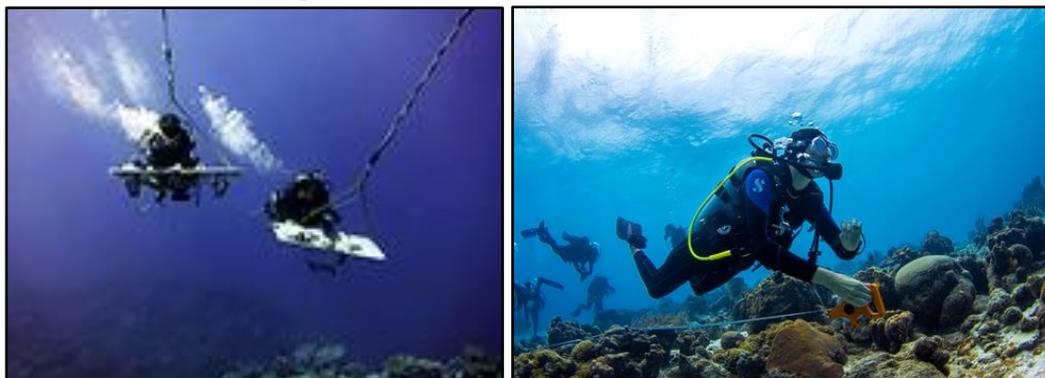
964 **2.3.1.1 Biological monitoring**

965 Biological monitoring is the collection of observations related to biological indicators of coral reef
966 ecosystem health. These indicators can include diversity, abundance, size, distribution, and habitat
967 composition and complexity of benthic species, reef fish, and other motile invertebrates diversity,
968 distribution, abundance, and size. These biological data are collected through different types of self-
969 contained underwater breathing apparatus (SCUBA) diver/snorkeler-based, visual or photographic
970 surveys or though the placement of cameras in strategic locations to collect images over a period of time.

971 **SCUBA and/or Snorkel Surveys**

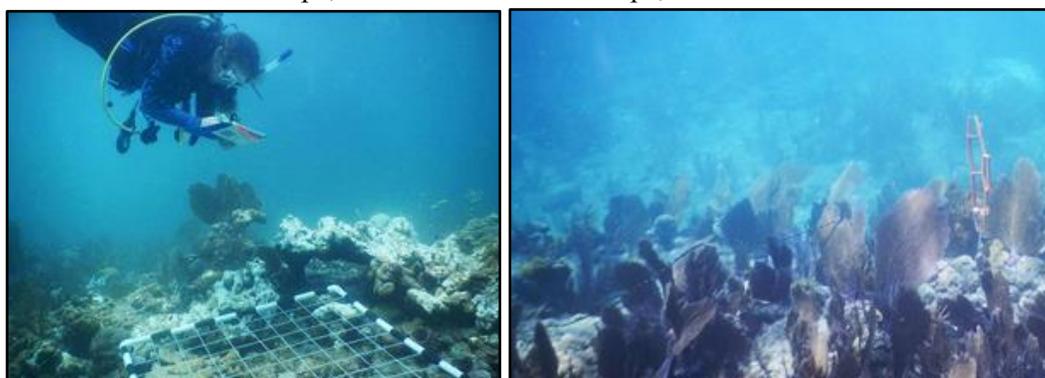
972 Biological monitoring of coral reef ecosystems involving divers using in-water techniques (e.g., SCUBA
973 and snorkel surveys) includes techniques such as roving surveys, stationary point counts, radial surveys,
974 towed diver surveys, and belt transect surveys. These techniques are conducted in shallow-water coral
975 reef and mesophotic ecosystems. For roving surveys, the diver/snorkeler hovers above the reef or swims
976 along a predefined path and records the selected species on an underwater data sheet and/or with
977 photographic/video documentation; diver contact with the bottom is rarely made. For stationary point
978 counts, divers can stand or kneel in a particular area, preferably in sandy patches, as hovering may cause
979 the fish community to remain low in the substrate hindering effective countability. Divers conducting
980 radial surveys temporarily place a weighted (2-9 lb of dive weights tied together with a size about 10 cm
981 x 15 cm [4 in x 6 in]) buoyed line (1-2m [3-6.5 ft] high) in an area that does not have live coral and then
982 attach a 10 m (~33 ft) line to the top of the buoy. One diver swims the line out to its full extent and holds
983 the end of the line for the survey; the divers constantly tend the line and move it over any areas of higher
984 relief and return to the desired depth once over the higher relief area. This allows for the same distance
985 from the center to be maintained even if the depth changes. The other diver "mans" the line at the

986 midpoint, keeping it from snagging on the bottom, as they swim slowly around in a circle. Towed diver
987 surveys (Figure 2-1) involve a boat towing divers, who visually collect information on the benthos and
988 fish population while maintaining a certain height above contour of the reef. Belt transects (Figure 2-2)
989 involve the deployment of lightweight fiberglass tapes. The organisms of interest are examined in a belt
990 (a predetermined width on either side of and depth above the line), directly under the tape, or at certain
991 points along the tape. Heavy-duty metal reels are placed on hard, non-living substrate or in sand to anchor
992 one end of the line, while a lead weight anchors the other end. Once the weighted end is in place,
993 researchers either deploy the tape prior to conducting the survey or count fish while swimming along the
994 selected deployment path. The tape is used solely as a guide to determine the area of examination. In
995 general, these surveys involve temporary deployment of the transect tape in a line parallel or
996 perpendicular to depth gradients. The tapes, metal reels, and lead weights are removed from the reef once
997 the transect observations are complete.



998
999
1000
Figure 2-1. Two towed divers conducting coral reef surveys. (left) *Source: NOAA*
Figure 2-2. A diver laying out a measured transect line. (right) *Source: NOAA*

1001 Additional monitoring techniques involve the temporary deployment of quadrats and light chains.
1002 Quadrats (i.e., polyvinyl chloride [PVC] or hollow aluminum squares of various sizes that may be
1003 subdivided into smaller areas by a grid) are laid randomly or at certain points along a transect tape, and
1004 the organisms are assessed within the quadrat. Most quadrats are made up of PVC pipe (Figure 2-3).
1005 Chains are generally brass or stainless steel, with very small links (e.g., a few mm to cm width) and are
1006 used to assess the rugosity (bathymetric relief) of the reef (Figure 2-4). These chains are deployed along
1007 the bottom similar to a transect tape, but unlike the transect tape, the chain follows the contour of the reef.



1008
1009
1010
Figure 2-3. Diver conducting a temporary quadrat survey. (left) *Source: Kelli O'Donnell*
Figure 2-4. A weighted rugosity line. (right) *Source: Kelli O'Donnell*

1011 For repeated surveys at fixed sites (permanent transects), researchers often mark the bottom with pins or
1012 other permanent landmarks secured in hard ground, rubble, or sediment areas where they will not impact
1013 living corals (Figures 2-5 and 2-6). The most permanent pins are rebar or stainless steel rods or pins
1014 (0.63-2.54 cm [0.25-1 in] diameter) and are either driven into the seabed by divers using hand-held
1015 hammers, or inserted into a hole (1.9-3.2 cm [0.75-1.25 in] diameter) in the seabed created by divers
1016 using a pneumatic drill. These holes may be filled with a marine epoxy to hold the pin in place. To assist
1017 with relocating the markers, the pins may also be marked with small floats on stainless steel leaders, and
1018 labeled with a tag.



1019 Figure 2-5. A permanent transect marker is hammered into place in American Samoa.
1020 *Source: American Samoa Coral Reef Ecosystem Monitoring Program*
1021



1022 Figure 2-6. A permanent transect marker with small float on a reef.
1023 *Source: The Nature Conservancy*
1024

1025 During various monitoring activities to measure growth or spread of disease, divers used hand-placed
1026 calipers or flexible tapes. Hand-placed calipers and flexible transect tapes used for measuring and video
1027 monitoring purposes remain in contact with small portions of coral colonies for brief periods lasting 30
1028 minutes or less.

1029 ***Stationary Cameras (Not Moored to Seafloor)***

1030 Stationary cameras are designed to sample the distribution, relative abundance, and size composition of
1031 reef fish and associated characteristics of their habitat. One type of system can be deployed with weights
1032 that hold the camera at depth for a predetermined amount of time (30-60 min). The majority of stationary

1033 cameras are buoyed to the surface so the entire device can be recovered. A few systems are baited to
1034 attract fish, while other systems are passive. Another method involves temporarily securing small
1035 cameras, such as GoPro™ cameras, to non-living components of the reef using zip ties.

1036 ***Fisheries Monitoring and Detection Using Echosounder***

1037 Fish spawning aggregations are commonly located with echosounder equipment; the CRCP incorporates
1038 by reference the activities described in Section 9 of Appendix A and Chapter 4.2.4 to 3.1.1 and 3.1.1.1 of
1039 the Draft Programmatic Environmental Assessment for Fisheries and Ecosystem Research Conducted and
1040 Funded by the Southeast Fisheries Science Center (SEFSC, 2016). This equipment generates sounds at
1041 frequencies between 12-300 kHz. The relatively low power echosounders are directed at the water
1042 column or the seabed directly beneath the vessel. For example, the CRCP has supported activities on the
1043 R/V Nancy Foster that have used the Kongsberg/Simrad EK60 split-beam echosounder operating at
1044 frequencies of 38, 120, and 200 kHz. When in use, the power is set to the lowest possible level, nominally
1045 200 dB re: 1 PA, with a duty cycle of less than 10 Hz. Beam is maintained at less than 12 degree angle,
1046 which focuses the sound downward, with a small beam width.

1047

1048 ***2.3.1.2 Geological and Oceanographic Monitoring***

1049 Geological and oceanographic monitoring includes the analysis of chemistry/nutrients, water temperature,
1050 ambient sound level, ocean circulation, sedimentation, and pollution data to understand long-term natural
1051 processes and their effects on coral ecosystems and the analysis of episodic storms and other high energy
1052 events to understand their short-term impacts. Many of these analyses involve the use of temporarily
1053 moored instruments to passively collect data or the physical collection of samples for laboratory analysis.

1054 ***Instruments Moored to the Seafloor***

1055 Moored instruments are typically deployed to passively measure oceanographic parameters at specific
1056 locations. Moored instruments may include cameras, wave and tide recorders, acoustic Doppler current
1057 profilers, salinity sensors, ecological acoustic recorders, fish acoustic tag receivers, subsurface
1058 temperature recorders, water samplers, carbon dioxide and pH sensors, sea-surface temperature recorders,
1059 bioerosion monitoring units (blocks of calcium carbonate), calcification accretion units, Coral Reef Early
1060 Warning System buoys, Moored Autonomous $p\text{CO}_2$ buoys, autonomous reef monitoring structures, and
1061 subsurface ocean data platforms (Figures 2-7 and 2-8). These instruments passively collect information
1062 about water velocity and level, salinity, carbonate chemistry, natural ocean sounds, temperature, wind
1063 speed and direction, and light penetration. Many of these automated sensors are temporarily deployed by
1064 divers and are retrieved at a later time (hours to days to months up to 12 months); however, some
1065 instruments can be left for longer periods (years) or permanently, which requires periodic (i.e. monthly,
1066 quarterly, annual or biannual) maintenance (i.e., battery changes and sensor cleaning), retrieval, or
1067 replacement by divers. Divers conduct light cleaning *in-situ* using cloths to wipe off sensors. Those
1068 instruments that require more extensive cleaning are brought to land or aboard a ship to be cleaned. When
1069 an instrument is replaced, the new instrument is placed on the same footprint as the instrument that was
1070 removed.

1071 In some cases, sensors are held in place by anchors composed of concrete, cement block, metal, or
1072 manufactured anchors, such as modular anchor for underwater instruments (MAUI) anchors. In other
1073 cases, sensors are cable-tied to stainless steel poles or to “sand anchors” screwed into the nonliving
1074 bottom, including non-living reef, rubble, or sand, or to mangrove prop roots. MAUI anchors are

1075 fabricated from metal and are encapsulated by a thick layer of polyurethane (e.g., Rhino Liner™) or PVC
1076 can also be used to hold instruments in place. A common metal used in anchor blocks is lead, because of
1077 its high density. Anchors typically weigh between 5 and 1200 lbs (2.2 and 544 kg, respectively) with a
1078 maximum seabed footprint of 91.44 cm x 121.92 cm (3 ft x 4 ft). The largest MAUI anchors that the
1079 CRCP uses in the Pacific are 400 lbs (181 kg) with a 91.44 cm x 30.48 cm (3 ft x 1 ft) footprint. In
1080 shallower water, divers place the anchors on the seabed. Anchors weighing more than a few pounds are
1081 lowered using lift bags so they can be precisely located on the seabed. While the anchors may support
1082 more than one type of instrument, they are not typically deployed close together and are usually deployed
1083 on separate sides of an island or embayment. Divers inspect, recover, service, and replace instruments
1084 used for long-term monitoring. During the inspections, anchors are replaced, if needed. Some sensors may
1085 have small floats to hold them up right.



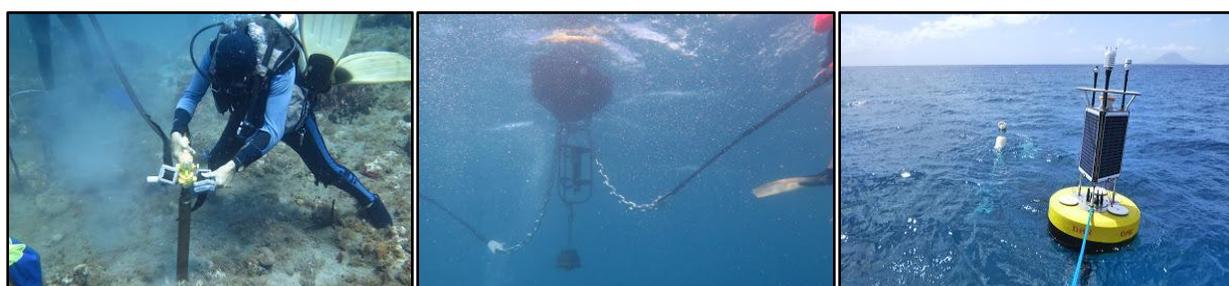
1086
1087 Figure 2-7. Short-term and long-term moored instruments deployed at Jarvis Island by the NOAA Pacific Islands Fisheries
1088 Science Center. The yellow crates are the temporary deployment (1-3 days) of water sampling units) and the CTD and pH
1089 sensors (in the metal cage). The Calcification Accretion Unit and an Autonomous Reef Monitoring Structure (the square
1090 structures) towards the right in the photo are the longer-term deployments (~3 yrs). *Source: NOAA Pacific Island Fisheries*
1091 *Science Center*



1092
1093 Figure 2-8. A subsurface temperature recorder (STR) zip-tied to the reef in the Pacific. This is also deployed for ~3
1094 years. *Source: NOAA Pacific Island Fisheries Science Center*

1095 The Coral Reef Early Warning System (CREWS) Network is a collection of marine environmental
1096 monitoring buoys (Figure 2-9). The buoys are Nexsens Model CB-950 with instruments chosen to
1097 measure certain environmental variables. The target depth range for the buoy anchor placement is

1098 approximately 9 m (30 ft) to 15 m (50 ft). To install the inverted U-anchor, divers use a core barrel drill to
 1099 make two 6.4 cm (2.5 in) wide, 61 cm (2 ft) deep holes that are 30.5 cm (12 in) apart into the ocean
 1100 bottom (dead coral of many years) in which stainless steel pins are inserted and surrounded by cement.
 1101 When drilling, divers use a non-petroleum, vegetable based hydraulic oil, and reduced-weight, non-
 1102 conductive hydraulic hoses to reduce hose sagging onto the bottom. The inverted U-anchor is cemented
 1103 into the drilled holes and allowed to harden for five days before the installation of the surface buoy. The
 1104 buoy installation involves pulling the buoy out by small boat, then attaching mooring lines, stretch-
 1105 capable StormSoft™ lines attached to nylon lines-plus-chain near the ocean surface, to the two stainless
 1106 steel pins on the bottom. This gives the buoys the capacity to move with the tide, as well as with large
 1107 waves. The anchor pins have a very high tensile strength - up to 10,000 lb (4,536 kg)- and are unlikely to
 1108 be pulled out by movement of the buoys. Local environmental management agency divers clean the
 1109 buoyed sensors every two weeks using sponges.



1110
 1111 Figure 2-9. CREWS buoy installation. Left: The core barrel drill; Center: Buoy before attachment underneath the water; Right:
 1112 buoy above water. Source: NOAA Atlantic Oceanographic and Meteorological Laboratory

1113 ***Antifouling and Anti-corrosion agents***

1114 Some CRCP-supported projects use a petroleum-based lubricant and sealant that is compounded
 1115 specifically to cling to metal and other surfaces, to provide long-term lubrication and prevent corrosion or
 1116 rust on instruments. Lubricants seal out water and contaminants. The lubricant is particularly effective on
 1117 bearings, water pumps, O-rings, gaskets, water filters, motors, and valves that must operate in hot or cold
 1118 water, along seams, exposed to pool chemicals, or in salt water. Aqua Shield™ is applied to the moving
 1119 metal parts (nuts and bolts) in moorings to prevent seizing and allows for functional use of the part during
 1120 instrument replacement. Aqua Shield™ is insoluble, floats on water, and does not appear to degrade in
 1121 salt water as instruments collected after deployment appear to have the same amount of Aqua Shield™ as
 1122 when deployed years prior. Currently, ecological testing has not occurred on this product. When used in
 1123 CRCP activities, only a small amount (< 1 oz [29 ml]) is applied to deployed instruments.

1124 ***Drifters and Floats***

1125 The CRCP occasionally supports the use of drifters and floats to study ocean currents and eddies and
 1126 verify satellite data. This information can be used in a variety of models such as those used to predict
 1127 larval connectivity and dispersal or hydrodynamic connections between coral reef marine protected areas.

1128 Drifters or floats typically have three to four major components: (1) body, (2) sails, (3) floats, and (4) a
 1129 data collection/transmitter package. They can be made of non-biodegradable components such as plastic
 1130 tubes and cloth or vinyl sails or made of biodegradable materials such as wood, hemp cloth, and rope. The
 1131 collection/transmitter package tracks movement using a global positioning system (GPS) and may also
 1132 collect other data such as surface temperature, salinity, wind speed, or other ocean properties. These

1133 shallow-water drifters are typically deployed from boats/ships and passively move with the currents for a
1134 period of time, days/weeks to indefinitely.

1135 ***Automated Underwater Vehicles (AUVs) and Remotely Operated Vehicles (ROVs)***

1136 The CRCP occasionally supports the use of AUVs and ROVs. AUVs are programmed to follow a course
1137 of action, and ROVs are tethered to the ship and are under the active control of ship-based operators and
1138 observers.

1139 The CRCP has supported and may support the use of AUVs, such as Slocum gliders. Past CRCP activities
1140 have included the deployment of gliders from NOAA vessels. The CRCP incorporates by reference this
1141 activity as described in Section 2.14 of the Environmental Assessment for National Center for Coastal
1142 Ocean Science (NCCOS) Surveying and Mapping Cruise Activities in Puerto Rico and the United States
1143 Virgin Islands (USVI) for April 5-26, 2016 (NOAA, 2016a) and Section 3.1.8.3 of the of the OCS PEA
1144 (2013), which provides a general description of AUVs used in survey activities.

1145 ROVs are used for delineation and identification of seafloor habitats. Observers controlling ROVs
1146 monitor the vehicles during their deployment. ROVs are tethered to the boat and are lowered by a power
1147 winch into depths of 10-150 m. ROVs operate approximately 1 m above the seafloor along a
1148 predetermined transect for a set duration, which is controlled/maintained by an operator using thrusters.
1149 The ROV and ship speed is typically 0.5-1 kts during ROV deployments. The ship operates only using Z-
1150 drives (no propellers) during ROV deployment. The ROV provides real-time video display, navigation,
1151 and depths. When using a ROV the operator can maintain the height above the seabed by controlling the
1152 amount of tether deployed from the ship. Small ROVs may be launched by hand from shore or small
1153 boats. These small units will be used for small-scale exploration and site documentation and may also be
1154 used to collect water quality data.

1155 ***Water Quality Monitoring***

1156 Water samples are used to collect information about vertical salinity, temperature structure, chlorophyll-*a*,
1157 nutrients, microbes, microscopic biota, carbonate chemistry, and contaminants. Monitoring of water
1158 quality involves the collection of seawater samples at various depths and locations either from a boat
1159 using a deployment water sample bottle using a line or a diver to collect samples from a certain depth.
1160 Depth casts from a boat collect water samples at various intervals and provide information about vertical
1161 salinity and temperature structure of the water column. The amount of water collected varies based on the
1162 intended analysis and typically ranges from 100 mL (3.38 oz) to 5 L (1.32 gallons) per sample.

1163 ***In-Water Sediment Monitoring***

1164 Marine sediment samples are used to quantify chemical contaminants in the sediments, toxicity of those
1165 sediments, and identification of benthic infaunal community. Collected sediments are analyzed in
1166 laboratory settings for grain size, mineral makeup, and/or contaminants. Sediments are collected using a
1167 variety of methods depending on layer of sediment targeted, surface, subsurface, or level of disturbance.
1168 Surface sediments are generally collected using grabs, which are deployed from the water surface, or by
1169 hand using a shovel or trowel. Subsurface sediments are generally collected with gravity corers and hand
1170 corers. For hand corers, a diver may push the core to the desired depth in soft sediment or use the metal
1171 cap and hammer to drive the core into firmer sediment. Sediment pore-waters are sometimes collected to
1172 characterize nutrient and/or carbonate chemistry dynamics, as well as measure potentially harmful toxins
1173 and contaminants. Small wells are placed within sediments to known depths, and interstitial waters are

1174 removed, either by submersible pump or suction, after wells have equilibrated with sediment pore waters
1175 (several hours to days).

1176 The assessment of the accumulation of terrestrial-based sediments and resuspended marine sediments on
1177 the coral reef ecosystems can be measured using multiple techniques including: bulk optic instruments
1178 (transmissometers and nephelometers), data loggers, sediment traps, sediment pods, tiles, and probing a
1179 stainless steel ruler through the sediment. Bulk optic instruments are used to determine water clarity and
1180 estimate suspended sediment concentrations. Data loggers are deployed to measure turbidity over varied
1181 time periods to track changes in sedimentation over time. In-water sediment traps are containers deployed
1182 in the water column for the purpose of (a) acquiring a representative sample of the material settling
1183 vertically through the water column and (b) providing an integrated particle collection rate and particle
1184 properties over the time of deployment. Each of these techniques requires temporary (1-24 months)
1185 deployment of equipment (traps, pods, instruments) in soft sediments near or in coral reefs, seagrass beds,
1186 and/or stream mouths. Sediment traps are commonly made from PVC drain pipes (between 1-10 inches
1187 wide and 2-30 inches in length) closed at one end and attached to a length of rebar that is driven into the
1188 sediments. Sediment pods are typically made from cement-filled large PVC irrigation pipes (6-20 inches
1189 in diameter and 8-10 inches in length) with metal eye bolts screwed into the sides. Sediment pods and
1190 other instruments can be weighed down with cinder blocks or other weighted bases or held into place
1191 using rebar driven into soft sediments. The optic instruments and data loggers can be deployed along with
1192 the sediment tubes or pods and are also secured to the rebar, using the mooring methods described above
1193 (Section 2.3.2.1), or by attaching the instruments to existing structures (e.g., docks or bridges).

1194 ***Terrestrial Sediment Monitoring***

1195 Loads of terrestrial sediment are estimated using a variety of methods often including erosion control
1196 pins, sediment traps, flumes/weir, water level data loggers, turbidity meters, and/or peak crest gages.
1197 Erosion control pins and similar methods measure the vertical erosion or accretion of sediment in specific
1198 locations, which can then be multiplied over a large area to provide a crude estimate of mass sediment
1199 eroded or accreted. Sediment traps are placed downgrade of bare soils or restoration actions to quantify
1200 sediment mass collected at these sites to understand contributions from the land cover/use. These traps are
1201 designed to accommodate the conditions of the site and come in various forms. Depending on the type of
1202 sediment trap used, it may require digging a small trench or installing silt fencing to collect the sediment.
1203 Flumes and weirs are also used to funnel surface runoff and sediments into a concentrated area to quantify
1204 the volume of runoff and the amount of sediment that may be eroded from drainage areas. Each of these
1205 techniques requires temporary deployment of equipment, which may also be accompanied by minor
1206 construction (impacting a small areas 1-8 cm [0.5-3 in]) to install the equipment (e.g., flume/weir,
1207 sediment trap). Placement of flume and weirs are site specific; in some cases they are placed on roads and
1208 other times in streams. Typically, they are installed on land, never in nearshore habitats, which may or
1209 may not be within the coastal zone. Water level data loggers, turbidity meters, and peak crest gages are
1210 installed to provide an understanding of the volume and rate of storm flows and sedimentation in streams.
1211 Deployment often includes the temporary installation of a PVC casing to either house the data logger or
1212 used to quantify peak stage in a stream. The equipment is then removed following completion of the study
1213 (typically within a year).

1214 *2.3.1.3 Socioeconomic Monitoring*

1215 Various methods are used to collect information from coral reef stakeholders including specific users and
1216 the general public. This involves the collection of socioeconomic variables, including demographics in
1217 coral reef areas, human use of coral reef resources, as well as knowledge, attitudes, and perceptions of
1218 coral reefs and coral reef management. Some of these methods include resident surveys (primary data
1219 collection) in U.S. coral reef jurisdictions. Other data collection approaches may include the collation of
1220 information (secondary data collection) from the U.S. Census Bureau and Bureau of Economic Statistics
1221 on coral reef-related economic activities.

1222 *2.3.1.4 Coral Reef Mapping*

1223 The CRCP continues to map U.S. coral reef resources, which supports the CRCP's efforts to manage and
1224 monitor coral reef ecosystems. To map U.S. coral reefs, the CRCP uses remote sensing (aerial and
1225 satellite imagery), multibeam echosounders, and side-scan echosounder. Divers or ROVs are used to
1226 ground truth the information and to assist in the characterization of benthic habitats. This information is
1227 then used to develop maps.

1228 *In-Water Echosounder Mapping*

1229 Some reef environments are characterized and mapped using a multibeam echosounder and backscatter
1230 system and/or towed side-scan echosounder. Multibeam and side-scan echosounder systems are attached
1231 to the research vessel and do not contact the benthos or any of the attached organisms. Ship-based
1232 multibeam echosounders collect bathymetric and acoustic imagery in depths 0 to 3,000 m (1.86 mi). The
1233 specifications described below and the activities to be conducted are also incorporated by reference from
1234 Section 3.1.1 and 3.1.1.1 of OCS PEA (2013), which generally describes how hydrographic surveys are
1235 performed and the functions (including sound frequency range) of echosounder technology.

1236 The CRCP mapping activities typically use NOAA vessels equipped with a downward pointing
1237 multibeam echosounders manufactured by Kongsberg (e.g., EM2040, EM710) or Reson (e.g., Seabat).
1238 The frequency of the Reson echosounder is 200 or 400 kHz with a bandwidth of 1 kHz for operational
1239 depths from 10-100 m (32-328 ft). The Kongsberg frequencies are between 65-100 kHz with an effective
1240 operational depths of 100-2,000 m (0.06-1.24 mi). Both types of echosounder are downward-oriented
1241 from the hull and spread up to 140 degrees across the ship width and by only 1-3 degrees along the track.
1242 Power is set to the lowest possible level (approximately 190-210 dB re: 1 PA with a duty cycle or "ping
1243 rate" also set to the lowest possible level 10-30 Hz).

1244 *Aerial Mapping*

1245 Aerial mapping may involve hyperspectral sensors that are used on aircraft. One example is Light
1246 Detection and Ranging (LIDAR), which uses light in the form of a pulsed laser to measure ranges
1247 (variable distances) to the Earth. These light pulses, combined with other data recorded by the airborne
1248 system, generate precise, three-dimensional information about the shape of the Earth and its surface
1249 characteristics. A LIDAR instrument principally consists of a laser, a scanner, and a specialized GPS
1250 receiver. Airplanes and helicopters are the most commonly used platforms for acquiring LIDAR data over
1251 broad areas. Two types of LIDAR are topographic and bathymetric. Topographic LIDAR typically uses a
1252 near-infrared laser to map the land, while bathymetric LIDAR uses water-penetrating green light to also
1253 measure seafloor and riverbed elevations. The CRCP incorporates by reference this activity referenced in
1254 Section 3.1.2 of OCS PEA (2013).

1255 Small drones can also be used to map and photograph coral reefs and other habitats. A drone is an
1256 unmanned aerial vehicle remotely controlled that can have on-board sensors or camera to record and
1257 transmit information/data. All drones used must be in compliance with the Federal Aviation
1258 Administration regulations.

1259 ***Satellite Mapping***

1260 The primary source of data used to date for production of interpreted shallow-water benthic habitat maps
1261 with CRCP funding has been IKONOS imagery. The IKONOS satellite was launched in 1999 and has
1262 panchromatic, blue, green, red and near infrared bands and multiple 11 km (6.83 mi) wide swaths can be
1263 combined to cover thousands of km². The 3.2-4.0 m (10.5-13.1 ft) resolution multispectral imagery has
1264 been used for production of the CRCP shallow-water benthic habitat maps that were not produced using
1265 overflights by aircraft. Remote sensing via satellites is also used for biophysical, geological, and
1266 oceanographic monitoring.

1267 ***2.3.1.5 Common Research Activities***

1268 The CRCP is also engaged in coral reef ecosystem research activities. These activities may involve the
1269 collection of coral fragments or cores for studies associated with coral health and disease; collection of
1270 samples of corals and other organisms for genetic analysis and identification, larval tracking, algal
1271 ecology studies, fish and invertebrate life history studies, assessment of the ornamental trade in reef
1272 organisms, climate change mitigation, and biodiversity studies; testing and development of
1273 mitigation/recovery actions; and research on the effects of sediment, nutrients, or pollution on coral reef
1274 organisms.

1275 ***2.3.1.5.1 Tagging***

1276 ***Fin Fish***

1277 Fish caught for tagging are captured with fish traps, hook and line, or nets, with efforts taken to minimize
1278 deployment time and barotraumas (e.g., injuries caused by pressure changes). In general, traps are set for
1279 a few hours to a maximum of 24-48 hours to prevent fish from starving or preying upon each other, and
1280 nets are deployed for a few hours to minimize entanglement of other non-target species. The captured fish
1281 are measured and tagged with minimal exposure to air, and released, generally within a few minutes to
1282 avoid post-collection mortality. In some cases, an anesthetic may be used and fish may be held in surface
1283 pens up to 60 minutes to allow for recovery and to examine potential negative impacts associated with
1284 tagging. In most cases, divers can measure and tag fish at m of capture to reduce the stress of bringing the
1285 fish out of the water, barotrauma issues, and release mortality. Sharks are often captured using alternate
1286 methods than fin fish, such as drum lines with circle hooks. Depending on the shark species and location,
1287 nets or seines may be used, but the most common gear is a drum line.

1288 Typical tags include coded wire tags (e.g., external spaghetti tags), elastomer T-bar anchor tags, 8.0 cm
1289 (3.1 in) serially numbered plastic (nylon) dart identification tags, visible implanted fluorescent elastomer
1290 tags, and acoustic transmitters. Coded wire, T-bar, and dart tags are external tags that are inserted into the
1291 fish near the dorsal fin. Visible implanted fluorescent elastomer tags are injected between the rays of the
1292 caudal fin, similar to a barcode. Each is comprised of four separate lines in differing colors that can be
1293 read underwater using an ultraviolet light source. Acoustic transmitter tags are implanted inside of the
1294 fish.

1295 Projects tracking fish movement patterns involve the use of underwater acoustic telemetry transmitters
1296 that are of a small size for implanting into fish; the transmitters have a relatively long battery life, an
1297 adequate detection range, and a unique signal to allow differentiation of individuals. One of the most
1298 common approaches involves fitting of fishes with internal coded acoustic tags (e.g., tags are generally 8-
1299 25 mm (0.31-0.98 in) in size, 69 kHz, 144-158 dB with a battery life of 2-24 months). Tags are typically
1300 inserted into a small incision in the abdominal wall, which is closed using a surgical stapler or
1301 biodegradable suture; fish are bathed in aerated MS-222 (tricaine methanesulfonate, see below), an
1302 anesthetic solution to prevent stress during the surgery. These transmitters transmit a train of pings
1303 (pulses) per cycle at a frequency of 51-84 kHz depending on the size and type of transmitter used. Battery
1304 lifespan for transmitters varies with battery size, power output, and ping frequency. The acoustic signal
1305 undergoes rapid loss due to absorption properties of the water, requiring the fish to be within the range of
1306 the receiver to pick up the signal.

1307 In addition to various internal and external tags, researchers may used chemically mark the otoliths of
1308 fishes with inorganic fluorescent substances such as oxytetracycline (OTC, oxytetracycline hydrochloride
1309 at 75 mg/kg fish body weight). OTC belongs to a group of antibiotics used chiefly in treating infections
1310 caused by streptococci, staphylococci, Gram-negative bacilli, rickettsiae, and certain protozoans and
1311 viruses, and is now the preferred chemical because of its high retention in bony structures. OTC is
1312 injected into the coelomic cavity or the fish are bathed in an OTC solution.

1313 MS-222 may be used for the temporary immobilization of fish and is generally used at a concentration of
1314 0.1 g/L. MS-222 is generally used during manual spawning (fish stripping), weighing, measuring,
1315 marking, surgical operations, transport, photography, and research. MS-222 is not used in-situ, but is used
1316 in captive situations, such as in a laboratory. Fish treated with MS-222 is not used in fish intended for
1317 human consumption.

1318 ***Sharks***

1319 The two principal tags in use are a fin tag and a dart tag. One type of fin tag is a two-piece, plastic cattle
1320 ear type tag, which is inserted through the first dorsal fin using seawater resistant nylon cable tie. The
1321 second type is the dart tag, which is easily and safely applied to sharks in the water. The "M" tag is
1322 composed of a stainless steel dart head, monofilament line, and a plexiglass capsule containing a vinyl
1323 plastic legend with return instructions. These dart tags, in use since 1965, are implanted in the back
1324 musculature near the base of the first dorsal fin.

1325 ***Coral***

1326 Corals may be tagged to determine growth rate, spawning potential, or to monitor individual colony
1327 health over time for a study. Corals are generally tagged with aluminum or plastic tags that are attached
1328 with nails, cable ties, or epoxy to the substrate adjacent to the coral colony. Markers that are directly
1329 attached to coral colonies are rarely used and, when used, coral colonies have shown rapid tissue growth
1330 over the marker.

1331 Alizarin Red S, a hydroquinone dye, can be used to stain or tag corals in order to provide a baseline
1332 growth ring and assess calcification rates. The stain is incorporated into the outer skeletal layer of the
1333 coral. Generally, the coral is removed and placed in chemical solution either in the lab or on a boat, but
1334 the coral may also be exposed *in-situ* using a plastic bag to enclose the coral for a given period of time.
1335 Exposure time is limited to eight hours because stress bands form in skeletons of corals that have had

1336 longer exposures (Dodge, 1984). Alizarin Red S in large amounts is toxic to all living creatures. When
1337 applied with running seawater, Alizarin Red S caused mild stress to adult corals, which caused the release
1338 of planulae and/or withdrawal of tentacles. Doses higher than 10 ppm (10 mg/ml) will not be permitted
1339 (Lamberts, 1973). Once the Alizarin Red S exposure is complete, the coral that was removed to be treated
1340 may be placed back on the reef from where it was collected or affixed to a base and secured to the
1341 seafloor (as described in Section 2.3.1.2, Instruments Moored to the Seafloor) for a period of time
1342 (months up to two years) until removed for laboratory analysis.

1343 2.3.1.5.2 Collection of Coral Reef Species

1344 **Coral**

1345 Large cores (e.g., 10-15 cm diameter x 0.5-5.0 m length [4-6 in x 19-197 in] and small cores (2.5 cm
1346 diameter x 0.5-1.0 m length [1 in x 0.2-20 in]) are removed from large massive colonies to assess rates
1347 and patterns of reef accretion, the composition or nature of fossil assemblages, coral growth for species
1348 with annual banding patterns, and generate a long-term record correlating environmental change with
1349 fossil records. Coring requires use of an underwater hydraulic drill, pumps, and coring equipment. A
1350 common practice to minimize potential environmental impacts (and to reduce the potential for colony
1351 mortality) involves the filling of holes left by coring with Portland cement, clay, epoxy or similar
1352 materials, which allows live tissue to grow over the part that was cored (Figures 2-10).

1353 Branches or portions of colonies (e.g., fragments, small cores) are collected for disease and health
1354 research (e.g., genetic studies, physiology and growth studies, infection experiments, and histology), used
1355 in coral nurseries (discussed in Section 2.3.6), and assessed for coral contaminants. Tissue sampling
1356 involves the collection of one polyp (~1 cm² of tissue [0.4 in²]) or larger (~2-10 cm branch tip [~0.8-4 in])
1357 using hand tools such as a syringe, shears, hammer and chisel, or pliers. The collection of small tissue
1358 samples from branching corals generally occurs at the outermost portion of the branch tip (Figure 2-11).

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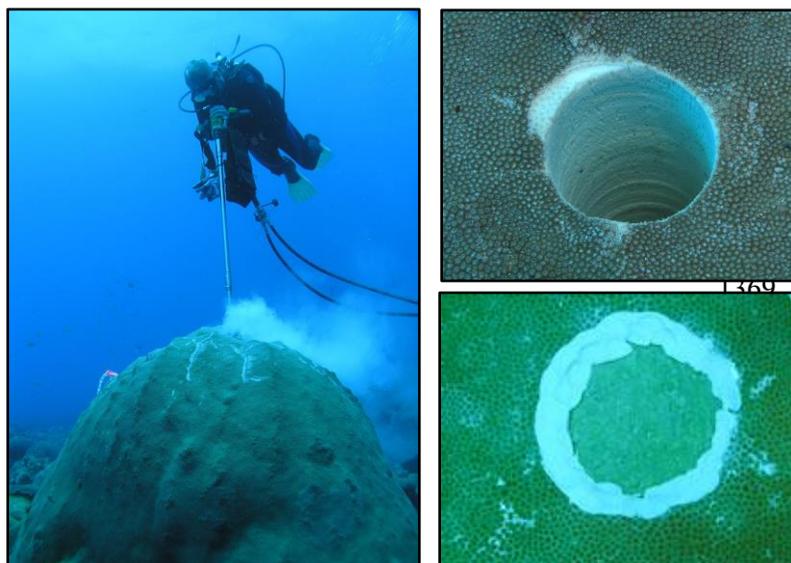


Figure 2-10. Coral coring (large cores). Left: A diver drills into coral; Upper Right: A hole left in a coral after drilling is complete; Lower Right: A cement plug with clay to seal the cored hole. Source: Emma Hickerson/NOAA FGBNMS



Figure 2-11. Divers collect a branch tip.

Source: NOAA CRCP/Coral Disease and Health Consortium

1382 Additionally, researchers may collect naturally available coral fragments (e.g., picking up fragments from
 1383 the seafloor by hand) or corals of opportunity (e.g., coral fragments or colonies that will be lost as a result
 1384 of projects such as port expansions). Naturally available fragments are often reattached during restoration
 1385 and transplantation experiments or cultured in a nursery for restoration and experimental use.

1386 Multiple coral fragments or cores are not typically collected from the same coral colony or the same
 1387 location. Researchers try to distribute the sample load across colonies and areas. In some cases, more than
 1388 one sample may be taken from the same colony; for example; when conducting coral disease research,
 1389 scientists may sample the healthy tissue and the infected tissue from the same colony.

1390 Coral gametes may be collected for culture and used in restoration efforts or for research related to early
 1391 life stages of corals or for cryopreservation. When collecting gametes from broadcast spawning corals,
 1392 such as *Acropora* spp. and *Orbicella* spp., collections are made *in situ* via tent-like nets that are placed
 1393 carefully by divers over individual spawning coral colonies (Figures 2-12 and 2-13). These nets are
 1394 temporarily placed (< 24 hours) over the spawning colonies and can be secured to the seafloor using nails.
 1395 The coral larvae produced from collected gametes can be released to the field after settlement or reaching
 1396 the planktonic stage or they can be used for research. Additionally, divers can use syringes to collect
 1397 sperm and eggs released from gonochoric broadcast spawning corals, such as *Dendrogyra cylindrus*.
 1398 Sperm or eggs are released from individual colonies, and the sperm dilutes immediately if not packaged
 1399 with buoyant eggs. The syringes used to collect sperm or eggs do not directly contact the coral only the
 1400 water surrounding the colonies. To collect gametes from brooding corals, such as *Porites* spp. and
 1401 *Agaricia* spp., researchers “borrow” the whole coral colony from a reef, bring it into a lab tank for a few
 1402 days while the planulae are released, and then epoxy the parent coral back on the reef where it came from.
 1403 In rare cases when field collection is not possible, a limited number of parent colonies may be “borrowed”
 1404 from the reef to facilitate the gathering of gametes in the lab during broadcast spawning events. Parent
 1405 colonies will be brought into the lab up to two weeks prior to spawning and returned to the reef after the
 1406 spawning event. These brooding species are generally smaller and hardier, making this possible to do.



Figure 2-12. A diver collects spawning coral gametes using a tent net. (left) *Source: NOAA*
 Figure 2-13. Collected coral gametes in a tube. (right) *Source: Kelli O'Donnell*

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1410 Settlement plates can be biologically conditioned by placing them on the reef for a short period of time
 1411 (two to three months) to be colonized by coralline algae and bacterial biofilm that serve as settlement cues
 1412 for corals. The plates are primarily secured to the benthos using stainless steel or rebar rods; however,
 1413 other methods have been used such as egg crates cable-tied to the non-living reef framework. Newly
 1414 settled corals can be collected using these settlement plates/tiles. Settlement plates are man-made devices
 1415 that are designed to simulate the natural strata that corals settle on and are generally made up of
 1416 ceramic/limestone tiles (2.5-25 cm x 2.5-25 cm [1-10 in x 1-10 in]) but can also have other shapes (e.g.,
 1417 round, three-dimensional). Conditioned settlement plates can be used in the laboratory to settle larvae
 1418 from collected gametes or they can be placed *in-situ* within coral reefs, using the methods described
 1419 above, for a short period (weeks to months) or a longer period (one to two years) to assess natural coral
 1420 recruitment. At the end of the *in-situ* period, plates are removed and analyzed in a lab.

1421 Additionally, coral mucus samples are collected with a syringe without the needle attached or with swabs
 1422 (Figure 2-14). Mucus samples are typically used for various monitoring purposes (e.g., disease) or for
 1423 coral-bacteria symbiont research.



Figure 2-14. A snorkeler collects mucus for coral disease and health research.
Source: Mote Marine Laboratory

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1427 ***Fish and Other Invertebrates***

1428 In most instances, researchers conduct non-lethal sampling such as fin clips or scales collection for
 1429 genetic analysis, or collect samples from fish previously harvested by fishermen to characterize life

1430 history stage, fecundity, growth rates, and diet. However, limited lethal collection of fish and motile
1431 invertebrates is undertaken to characterize life history stage, fecundity, growth rates, diet, or to understand
1432 corallivore impacts on corals or to assess contaminant exposure. This includes collection of fishes and
1433 invertebrates using hook and line, spearfishing, traps, or nets. Nets and traps are usually placed in areas
1434 near reefs, but not on the corals themselves. Hand collection can be used to collect slow-moving species.
1435 Hand collection includes small hand held nets, brushing off live rock or rubble, hand picking specimens
1436 from substrate, or suctioning of burrowed organisms. Traps are baited and temporarily placed (up to 24
1437 hours) in mud or sand adjacent coral reefs, mangroves, or in seagrass areas. Bottom type is visually
1438 confirmed from the surface or by free divers prior to deployment. Collected organisms are either tagged
1439 and released or killed in the process of doing research.

1440 In addition, Autonomous Reef Monitoring Structures (ARMS) or other structures, which are intended to
1441 mimic the structural complexity of coral reefs, are deployed for a determined amount of time (months to
1442 years) to attract colonizing macroinvertebrates. The ARMS currently used by the CRCP are 36 cm x 46
1443 cm x 20 cm (14 in x 18 in x 8 in) and contain nine layers, which are 23 cm x 23 cm (9 in x 9 in) each, for
1444 colonization. ARMS are made of non-caustic PVC type 1 plastic and consist of layers that alternate
1445 between an open surface that contains triangular-shaped colonization sites. The top layer is a convoluted
1446 filter layer designed to provide a multitude of colonization sites and a large surface to volume ratio.
1447 ARMS are placed by divers on sites identified as uncolonized pavement or sand in proximity to natural
1448 coral reef structures to avoid coral damage. ARMS are anchored using stainless steel stakes and weights
1449 to ensure the ARMS stay in place during the duration of deployment.

1450 *Algae/Seagrass*

1451 For CRCP projects, algae/seagrass are typically collected during photoquadrat surveys. After divers take a
1452 photograph and visually quantify algae/seagrass, they collect representative samples of turf algae,
1453 crustose coralline red algae, and fleshy macroalgae by hand for laboratory identification or quantification
1454 of biomass. Samples collected for identification consist of individual plants, likely including blades, stipe
1455 and holdfast, as applicable.

1456 *2.3.1.5.3 Coral Measurements*

1457 Coral colonies are often measured using hand-placed calipers, rulers, or flexible tapes, which briefly (< 5
1458 min) remain in contact with a portion of the coral colony (Figure 2-15 and 2-16).



1459
1460 Figure 2-15. A diver measures corals in a block style nursery. Source: Kelli O'Donnell



Figure 2-16. A diver inspects corals that were grown in a nursery and outplanted. *Source: Kelli O'Donnell*

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1463 **2.3.2 Coral Restoration and Interventions**

1464 **2.3.2.1 Coral Nursery**

1465 Reared or collected coral fragments are attached to bases and then attached to a growing rack in benthic
1466 or land-based nurseries, or attached to a tree or rope line in mid-water nurseries. *In-situ* nurseries are
1467 generally kept in areas near coral reefs where environmental conditions are appropriate for rearing corals
1468 (high water quality, circulation, presence of herbivores, etc.). Corals can also be grown *ex-situ* in land-
1469 based facilities. Corals grown in all nurseries can be used for coral restoration through transplantation or
1470 outplanting (attaching nursery grown corals back onto coral reefs), fragmentation to grow additional
1471 corals, and as a supply for laboratory research related to restoration and resilience.

1472 ***In-situ* Coral Nursery Development/Expansion**

1473 In order to set up a new nursery, a site-specific nursery operational plan is developed. The CRCP will
1474 work with grantees to identify options for nursery siting. Sites for new nurseries will be based on several
1475 selection factors: (1) avoiding impacts to existing benthic habitats including coral and seagrass; (2) areas
1476 with minimal predators; (3) appropriate water quality and substrate conditions for coral growth; and (4)
1477 logistics such as accessibility from land. Once a site is selected, the grantee will obtain all permits from
1478 applicable federal, state/territorial, and local permitting agencies.

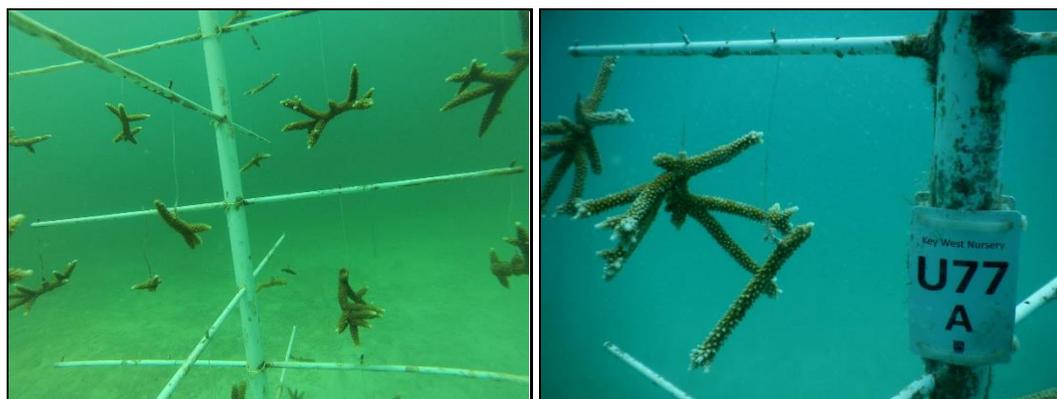
1479 *In-situ* coral nurseries are either floating/midwater nurseries or bottom-placed structures. There are a
1480 variety of structural forms for *in-situ* coral nurseries including lines, trees, and tables for floating
1481 nurseries, and blocks, PVC blocks, wire cages, and A-frames for bottom-placed nurseries. Floating
1482 nurseries, such as lines and trees, have four main components: an anchor, floats, lines, and coral
1483 attachment devices. Structures can be anchored to the bottom using duckbill anchors, helix ground
1484 anchors, rebar, anchor screws, heavy weights, or eye bolts cemented into hard-bottom. Horizontal lines or
1485 frames are held taut with floats. For line-style structures (Figure 2-17), vertical lines run between or
1486 through the middle of the horizontal line or lines may run parallel to the bottom supported by PVC pipes
1487 and floats at the middle and ends. Tree-style structures (Figure 2-17) have a PVC pipe or a fiberglass rod
1488 that runs up the center with branches (usually wooden, PVC, or fiberglass) coming off the center stem.
1489 The branches of tree-style nurseries may also support trays made of PVC and plastic mesh to hold
1490 microfragments. Floating table-style structures (Figure 2-18), have a flat surface typically made of PVC

1491 pipes or a plastic mesh that is floated vertical to the bottom. In some cases, during bleaching events, shade
1492 cloths can be deployed about 0.6 m (2 ft) above the coral table. The shade cloths are held taut with floats
1493 and removed when the bleaching event ends. Corals are attached to the lines or branches using vinyl-
1494 coated wires, cable ties or monofilament fishing line, or may be inserted into the braids of the line itself or
1495 held in place with small pieces of hemp or rope. Bottom-placed structures include block or frame
1496 nurseries that are fixed to the bottom with cinder blocks or anchors and do not include floats. This type of
1497 nursery has three main components: an anchor, a constructed unit, and a coral attachment device. For the
1498 block grow-out structures, cinder blocks are the base of the construction unit and are anchored in place
1499 using rebar (Figure 2-19). Pedestals (usually cut PVC pipes) are attached to the top of the cinder block
1500 using epoxy (Figure 2-20). Corals can be attached to the pedestal on the top of the cinder block via
1501 cement disks, cones, or pyramids using plastic ties, wires, or epoxy. Frame grow-out structures are made
1502 in a variety of shapes: tables, triangles, circles, or domes and are typically metal (stainless steel rebar with
1503 wire mesh) coated with epoxy, fiberglass to reduce fouling, or PVC pipes (Figure 2-20). Novel
1504 biodegradable materials such as bamboo with hemp ties are also being tested. Frames are anchored to the
1505 bottom using cinder blocks, weights, or rebar. Corals are then attached to the frames using wire or plastic
1506 ties.



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Figure 2-17. Examples of floating/midwater coral nurseries: Horizontal line setup (left) and tree style nurseries (right).
Source: Mote Marine Laboratory



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Figure 2-18. Coral trees made from PVC. Monofilament lines dangle Acroporid corals from the trees to allow them to grow.
Source: Kelli O'Donnell



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Figure 2-19. Example of anchor for nursery trees. A short float marking where a duckbill anchor for coral nursery tree with fish nearby. A float is put on a short line to make it easier to find where the duckbill is anchored. *Source: Kelli O'Donnell*



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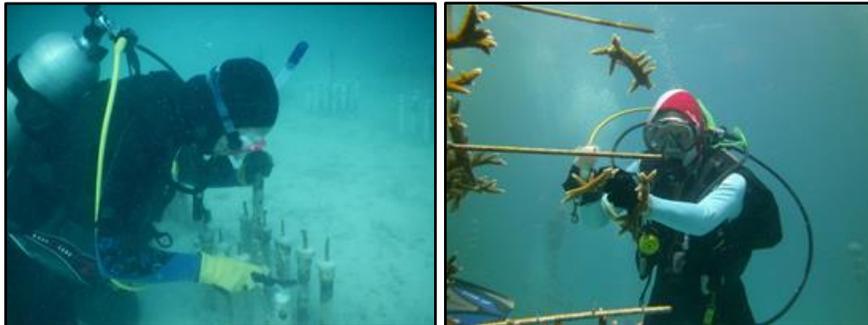
Figure 2-20. Examples of benthic coral nurseries. The left photo shows the block style nursery where Acroporid corals are affixed on top of blocks to grow and the right photo is an example of an A-frame nursery with Acroporid coral attached. *Source: Mote Marine Laboratory (left); University of Miami (right)*

1520 Corals grown in an *in-situ* nursery setting are usually “fragments of opportunity” that have previously
1521 broken from the donor colony during natural events or ship groundings, or have been "rescued" from
1522 areas where construction or other activities would have impacted the corals. However, fragments can also
1523 be collected from large healthy colonies using the method described in Section 2.3.1.5.2, Collection of
1524 Coral Reef Species. Collected fragments are either transported underwater to nearby nurseries or placed
1525 in bins with seawater on a vessel or vehicle if they need to be transported some distance to nursery sites
1526 (Figure 2-20). The seawater is changed regularly, and the bins remain shaded during transit. Typically,
1527 after establishment of a nursery during the first year of operation, no additional coral collection is needed
1528 to expand the nurseries, as the nursery itself will produce enough coral tissue *in-situ* for both expansion
1529 by fragmenting and for outplanting. However, in some cases, additional collections are made to increase
1530 genetic diversity within a nursery or to house corals salvaged from groundings, natural disasters, or
1531 construction projects.

1532 Temporary nurseries can also be set up at the same reef location where transplanting/outplanting would
1533 occur such as following a vessel grounding. Once outplanting to restore the site is complete, the nurseries
1534 are removed from the site. This ensures corals never leave the water, which helps increase daily
1535 outplanting (restoration efforts), and reduces the handling and transport time of corals. Maintaining
1536 temporary nurseries allows corals to acclimate to the outplanting site’s local microbiota and
1537 environmental condition or to remain acclimated to the site.

1538 ***Coral Nursery Maintenance***

1539 Regular maintenance of nurseries is needed to maintain the health of the corals and to ensure the
1540 structures are stable. Typical nursery maintenance is done by divers and includes the removal of fouling
1541 organisms (algae, tunicates, sponges, and hydroids), use of wire or plastic brushes (Figure 2-21), removal
1542 of corallivores (snails, worms, and damselfish) by hand (see Section 2.3.2.3, Nuisance Species Control),
1543 repair of broken nursery components (lines, wires, and anchoring materials), removal or treatment of
1544 diseased corals such as administering a “break” (see Section 2.3.2.3, Coral Disease
1545 Control/Management), monitoring of coral health and growth (length, branch tips, width, condition, and
1546 mortality), and continued propagation (fragmentation) of corals to maintain nursery and
1547 transplanting/outplanting stock.



1548 Figure 2-21. Divers clean the *in-situ* coral nursery structures as part of the maintenance routine.
1549
1550 *Source: Kelli O'Donnell and Dave Seeley*

1551 ***2.3.2.2 Coral Transplantation/Outplanting***

1552 Transplantation of corals can be used to: (1) rehabilitate a degraded reef that has been impacted by an
1553 environmental disturbance such as disease and/or bleaching outbreaks; (2) restore a reef that has been
1554 physically impacted by ship groundings, anchor damage, or storms; (3) increase a reef’s species or
1555 genetic diversity to promote resilience to human-based and natural stressors; and (4) conduct research to
1556 assess the effectiveness of restoration methods, coral resilience to climate change, coral disease, or other
1557 perturbations and their effects on corals.

1558 Transplantation involves stabilizing the substrate, reattaching fragments, and/or attaching nursery-raised
1559 corals to reef or other hard bottom substrate. As with transport to nurseries, colonies are either transported
1560 underwater to nearby outplanting sites or placed in bins with seawater on board a vessel or vehicle if they
1561 need to be transported a further distance (Figure 2-22). Before outplanting corals, the substrate may need
1562 to be cleaned of fouling organisms such as sponges and algae, which can hinder attachment and overgrow
1563 the newly outplanted corals. Larger coral pieces or substrate may be attached or secured using cement,
1564 rebar, nails, epoxy, and/or limestone. The placement, attachment, or stabilization of smaller coral
1565 fragments, individual coral colonies, or nursery-reared corals is typically done using epoxy, cement,
1566 concrete nails, other mechanical devices (e.g., plastic cable ties), or hemp rope, or corals may be attached
1567 directly to a rack or other stabilization structure that remains on site and becomes overgrown by the
1568 transplanted corals (e.g., bamboo rack). Generally, transplanted corals are attached either directly to the
1569 seafloor or to a base (e.g., a concrete disk or limestone), which is then affixed to the seafloor (Figure 2-
1570 23).



Figure 2-22. Transporting corals from nursery to outplanting site. Left: A diver transports coral underwater to the outplanting site; Right: Corals are transported out of water. Source: Mote Marine Laboratory (left); David Gross (right)

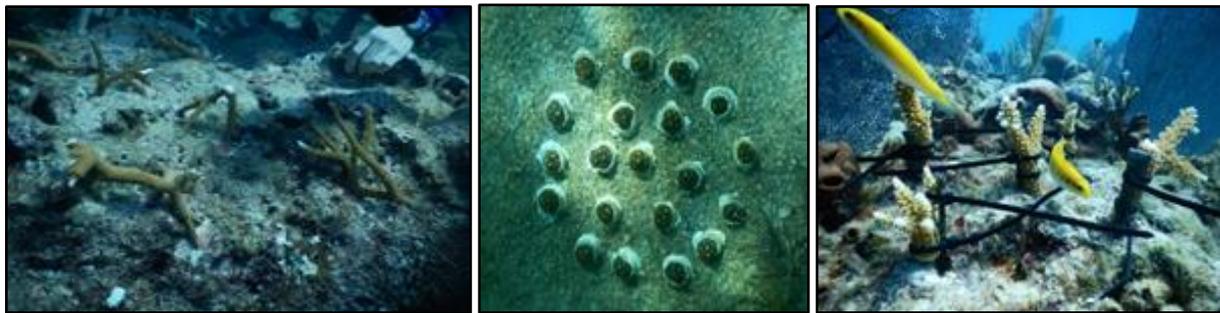


Figure 2-23. Left: Nursery reared corals outplanted on a reef using epoxy. Center: Outplanted coral micro fragments using epoxy. Right: Nursery reared corals using nails and cable ties. Source: Kelli O'Donnell

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1578 New and innovative coral restoration techniques include ways to increase the outplanting efficiency,
1579 increase survivorship of outplanted corals, enhance natural coral recruitment, and/or increase use of
1580 biodegradable materials. Activities may include the use of novel structures (bamboo, hemp rope, and
1581 natural limestone) to grow corals in nurseries and directly outplant onto the reef on a pilot scale. For
1582 example, one of the newer outplanting techniques uses hemp ropes containing nursery grown corals that
1583 are nailed to the substrate. Corals are attached to the rope by looping around the bases of large coral
1584 colonies, zip tying, or putting smaller corals into the twist of the rope. When ready for outplanting, the
1585 rope is laid across the substrate and nailed into place. Once the corals begin to grow and attach to
1586 substrate, the hemp rope will eventually biodegrade. Additionally, an example to increase coral
1587 recruitment using “flypaper” techniques or settlement tents attract coral larvae to settle on suitable
1588 restored substrate, thereby enhancing recruitment to the restoration site. Another method involves the
1589 collection of coral gametes *in-situ* followed by *ex-situ* fertilization and settlement on plates or other
1590 structures that can be transplanted on the reef.

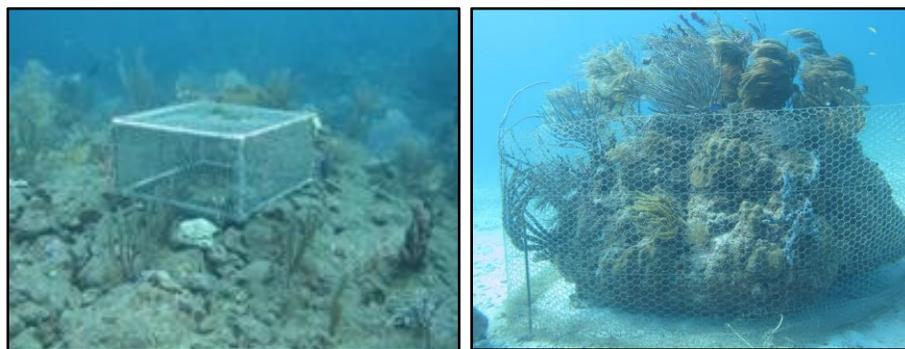
1591 2.3.2.3 Other Interventions

1592 **Urchin Propagation and Outplanting**

1593 In order to increase herbivory on reefs and increase coral recruitment habitat (i.e., hard substrate free of
1594 high macroalgal cover), efforts are underway to collect, culture, and outplant sea urchins, such as
1595 *Diadema antillarum* and *Tripneustes gratilla*. There are two methods for collecting urchins to rear in
1596 captivity. The first method involves the collection of adult urchins and coaxing the urchins to spawn and
1597 release gametes into containers in the lab. The gametes are then mixed together to produce zygotes

1598 (larvae) and urchin larvae are kept suspended until their settlement stage. Urchins that settle are then
1599 reared in a lab nursery setting until they reach a suitable size for outplanting. The second method involves
1600 the collection of juvenile urchins on the seafloor or newly settled urchins using settlement plates. For
1601 settlement plates, mooring lines are attached to cement anchor blocks in a sand channel in a coral reef for
1602 up to 6 months. Settlement plates, which are artificial turf squares, are attached along the mooring lines.
1603 The plates are collected monthly and brought to the laboratory for analysis. Settled urchins are picked off
1604 the plates and moved to a nursery culture tank. Juvenile urchins can also be collected and moved to a
1605 nursery tank to be grown to a certain size.

1606 Divers outplant urchins either by placing them directly on the reef or by placing them in temporary
1607 corrals or cages that consists of galvanized chicken wire, nylon, or plastic mesh that is typically one-inch
1608 diameter or less (Figure 2-24). The plastic chicken wire, nylon, or plastic mesh is attached to the bottom
1609 of the corral so that it can be molded to the reef and fully enclose the corrals. The cages/corrals are held in
1610 place using PVC or rebar and are placed around the reef or around isolated coral colonies for about one
1611 month for urchin acclimation and to help facilitate herbivory. Urchin outplanting may be done in
1612 conjunction with coral outplanting.



1613
1614 Figure 2-24. Left: *Diadema* outplanting cage; Right: Chicken wire mesh around coral to contain outplanted urchins.
1615 Source: NOAA (left); Coastal Survey Solutions, LLC (right)

1616 ***Invasive Species Removal***

1617 To help restore the condition of coral reefs and coral reef ecosystems, management efforts have been
1618 implemented to remove invasive species such as algae, seagrass, and fish (e.g., lionfish in the Atlantic and
1619 Caribbean). Invasive algae and seagrass can be removed by hand or by using a suction pump that
1620 transports the invasive algae or seagrass to a boat for sorting and disposal on land. The removed algae can
1621 also be used as fertilizer on land. Biological controls can also be used to control invasive algae. The use
1622 of biological controls relies on predation, parasitism, herbivory, and other natural mechanisms through the
1623 release of native organisms (e.g., parrotfish and urchins) that control invasive organism or organisms in
1624 areas that have large invasive populations. Lionfish are removed by divers using hand nets, slurp guns,
1625 spears, or traps (Figure 2-25). Captured specimens are used in research, disposed of on-land, or if the
1626 appropriate licenses are held, sold to fish markets.



Figure 2-25. Diver removes an invasive lionfish using a spear. *Source: Alex Fogg*

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1629 ***Nuisance Species Control***

1630 Crown-of-thorns starfish (*Acanthaster planci*) infestation on coral reefs in the Pacific/Indo-Pacific are
1631 controlled by injecting ox bile and bile derivatives, acetic acid (vinegar), sodium bisulfite, or physical
1632 removal. Ox-bile is a natural substance that kills the creature but does no harm to the reef (Figure 2-26).
1633 For this method, divers inject the ox bile near the central disk of each starfish using an ox bile injector, a
1634 46 cm (18-in) metal tube that houses a syringe with a needle and contains ox bile. Acetic acid is injected
1635 on the central disk of each starfish using a similar injector. The sodium bisulfite method requires multiple
1636 injections on the central disk of each starfish. After a crown-of-thorns is injected and dies, it is left on the
1637 reef. If injectors are not available, the starfish can be physically removed from the water and transferred
1638 to land for disposal.



Figure 2-26. Crown-of-thorns starfish injected with ox bile in American Samoa.
Source: National Marine Sanctuary of American Samoa

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1642 Divers can remove other corallivores, such as the gastropods, *Coralliophila abbreviata* and *Drupella* spp.,
1643 fireworms, and butterflyfish by hand or with a bar, pick, tongs, or hand net. Those removed specimens are
1644 either brought back to a lab for analysis or disposed of on land. Additionally, other nuisance species such
1645 as octocorals, may be removed by hand to prepare sites for coral restoration activities.

1646 ***Coral Disease Control/Management***

1647 Corals are affected by a variety of diseases caused by bacteria, fungi, viruses, or environmental stressors
1648 such as temperature, nutrients, ultraviolet radiation, or toxins. The physical manifestation of diseases on
1649 corals include discoloration in the form of bands or spots, lesions, tissue sloughing that exposes the
1650 skeleton, and growth anomalies. While the exact causes of many coral diseases are not entirely known,
1651 researchers have used management strategies to try to control coral disease. These strategies include the
1652 surgical removal of diseased tissue, removing diseased portions of coral colonies or entire diseased
1653 colonies (or sacrificing corals in place), removing the area between the diseased tissue and the healthy

1654 tissue (forming a break between the healthy/unhealthy tissue areas), application of clay or underwater
1655 epoxy putty directly over the diseased tissue or in the break line made between the healthy and unhealthy
1656 tissue, aspirating the diseased tissue with large syringes or pumps to remove cyanobacteria or other
1657 microorganisms (Figure 2-27), or a combination of these activities. In extreme situations, healthy corals
1658 may be removed from the water and cared for at ex situ facilities until the disease event has subsided or
1659 ended, to preserve genetic diversity and ensure that highly susceptible species are not locally extirpated
1660 by disease. Corals are cultured on land with the intention of returning them to their home reefs once
1661 conditions would support their survival.



1662
1663 Figure 2-27. An example of an epoxy to form a break between healthy and diseased tissue to prevent further spread of the
1664 disease. Source: NOAA

1665 Diseased coral may also be treated *in-situ* with antibiotics or powdered chlorine. In severe cases, diseased
1666 corals might be treated with a white petrolatum mixture or similar non-toxic compound (e.g., epoxy, clay)
1667 mixed with amoxicillin (60 mg/mL of petrolatum mixture; usually one application) or chlorine powder
1668 (calcium hypochlorite at ~15 mL/50 mL epoxy). The amount of the mixture applied to individual corals
1669 depends on coral size; larger infected colonies may require up to five grams of antibiotic to treat the
1670 disease. Future activities may include the administration of additional antibiotics or other drugs *in-situ* to
1671 address the causal agents of the coral disease once they have been tested in research laboratories. In
1672 addition, diseased and healthy coral specimens will continue to be used to support laboratory research on
1673 the causative agents of disease outbreaks. Healthy corals raised in *in-situ* or *ex-situ* coral nurseries may be
1674 used to repopulate reef areas that have been degraded by disease outbreaks, (see Section 2.3.6 and 2.3.7).
1675 However, effects of antibiotic application in the field on coral reef ecosystem species are unknown at this
1676 time (see Section 4.4.3.1). Site-specific NEPA analysis would be required before use of this technique in
1677 the field.

1678 ***Coral Genomics, Stress Hardening and Survival Analysis***

1679 Coral samples can be analyzed in the laboratory for genotype sequencing that includes DNA isolations,
1680 genotype sequencing, and data preparation using standard and routine procedures to help understand the
1681 genetic makeup of resilient corals. This information can be used to support selective or managed breeding
1682 of corals by mixing gametes from different populations or individuals that have certain traits (e.g., heat or
1683 disease resistance) and by hybridizing species to select for certain traits expressed by corals that would
1684 then be grown in nurseries and outplanted if permits allow.

1685 Studies can be conducted in the laboratory or *in-situ* to assess how corals respond to warmer waters,
1686 bleaching, pollution, and coral disease and understand why or how some corals appear to be more
1687 resistant or resilient to stressors than others. *In-situ* activities can involve temporarily transferring or

1688 transplanting corals from areas of high stress (pollution, high temperatures) to less stressed areas to
1689 determine how well they survive or maintain resistance to stressors, or transplanting healthy corals from
1690 less stressed areas to higher-stress areas to see if the corals acclimate and remain acclimated to the
1691 adverse conditions. Coral can also be taken into a laboratory setting and exposed to warmer temperatures
1692 or other stressors and placed back on the reefs. Generally, these types of studies are small-scale pilot
1693 studies may involve attaching corals using zip ties to gridded crates or structures that are temporarily
1694 placed in the sites using the mooring methods described in Section 2.3.1.2, Instruments Moored to the
1695 Seafloor. Resilient and resistant corals identified through these types of studies may be grown in nurseries
1696 and outplanted if permits allow.

1697 The collection of coral gametes from wild corals or nursery-reared corals (see Section 2.3.1.5.2, Coral)
1698 can be cross fertilized with other coral gametes to create new genotypes, and rearing of those corals in *ex-*
1699 *situ*. These new genotype corals may be used for laboratory studies or outplanted if permits allow.

1700 To help understand resistance to coral diseases, diseases can be transferred to healthy fragments by
1701 grafting (cable tying) a small piece of diseased tissue to the healthy tissues (Williams & Miller, 2005;
1702 Vollmer & Kline, 2008; Brant et. al, 2013). This can be done *in-situ* or *ex-situ*. In *ex-situ* situations,
1703 diseases can also be transferred using filtered homogenates (Vollmer & Kline, 2011), or via other means
1704 such as through water exchange or direct tissue contact.

1705 ***Potential Future Coral Intervention Activities***

1706 Future work to assist with the restoration of coral reefs may include outplanting of corals with modified
1707 symbionts, movement of corals to non-native areas to enhance diversity (assisted migration), shading of
1708 corals/coral reefs, water cooling, and other methods to treat diseases, such as probiotics. At this point in
1709 time, there is not enough information to describe the methods that would be used to describe these
1710 activities, but CRCP may consider implementing pilot studies in the future. Site-specific NEPA analysis
1711 would be required before implementing these techniques in the field.

1712 ***2.3.3 Watershed Management and Restoration***

1713 The CRCP's efforts to protect coral reef ecosystems from land-based sources of pollution focus on the
1714 implementation of watershed management through technical support for Watershed Management Plans
1715 (WMPs) and/or Conservation Action Plans (CAPs) and on-the-ground restoration activities to reduce
1716 rates of erosion and the quantities of transported sediment and other pollutants impacting coral reef
1717 ecosystems. The projects vary in size (acreage) and combination of management or restoration techniques
1718 implemented, but for an example of previous projects, see
1719 <https://www.coris.noaa.gov/activities/projects/watershed/>.

1720 ***2.3.3.1 Technical Support for Watershed Management Plans***

1721 The CRCP provides technical assistance toward the development and implementation of WMPs and/or
1722 CAPs in watersheds that have been identified as priority areas by the jurisdictions. The primary purpose
1723 of a WMP or CAP is to outline a comprehensive set of actions and an overall management strategy for
1724 improving and protecting the watershed from nonpoint and point sources of pollution associated with
1725 changes in land use, and residential, commercial, and agricultural activities. A WMP/CAP identifies a set
1726 of key recommendations, specific partners, and next steps towards implementation of land-based
1727 pollution control strategies. WMP/CAP recommendations typically include BMPs and/or management
1728 activities that target the reduction and movement of sediment, nutrients, and contaminants within

1729 watersheds. Examples include re-vegetation and stabilization of land, stream-banks, and dirt-roads/trails;
1730 changes in stormwater and wastewater treatment practices; and improvements to site design practices.
1731 Implementation of BMPs and management activities are essential to maintaining hydrologic functions
1732 including streamflow and groundwater recharge to limit land-based sources of pollution inputs and
1733 impacts to nearshore marine environments, particularly coral reef ecosystems.

1734 The CRCP supports data collection for WMP/CAP development. This includes *in situ* monitoring of the
1735 nearshore reefs, remote sensing data, and field assessments of the watershed. Nearshore reef *in situ*
1736 monitoring collects information on water quality, sedimentation rates and assessments of benthic habitats,
1737 fish, and invertebrates. Field assessments are conducted to identify areas of concern that contribute to
1738 land-based sources of pollution. Areas of concern can include places where there are stormwater drainage
1739 areas, septic systems, streams/ghuts (ephemeral streams), unpaved roads, impervious surfaces,
1740 conveyances, detention areas, point sources of pollution (including commercial, industrial, and
1741 municipal), and/or intermittent streams and wetlands. The types of activities involved in field assessments
1742 include the collection of sediment samples via plugs or grabs; the collection of water samples; and
1743 walking through wetlands and along streams and shorelines to look for potential problem areas and
1744 ground truth remote sensing data, identify ghuts, and release tracer dyes to locate point source pollution
1745 hotspots. Tracer dyes are released at a known point and monitored for discharge at another known point.
1746 Data generated from remote sensing are used to determine land use, land cover, benthic habitats, and
1747 turbidity.

1748 2.3.3.2 Vegetative Plantings

1749 Bare soil is stabilized through the establishment of vegetative cover (Figure 2-28). On highly erodible
1750 sites, grass seeds, mulch, fertilizer, and water can be combined and sprayed onto the hillside as hydroseed
1751 for quick and effective erosion control (Figure 2-30). While various plants can be used to revegetate bare
1752 soils, the CRCP uses native or non-weedy/non-invasive plants (e.g., vetiver grass) for this purpose
1753 (Figure 2-29). Plantings may also be used with existing or dormant crops as conservation cover (i.e.,
1754 shade grown coffee). When plantings necessitate fertilizer, efforts are taken to minimize potential
1755 leaching of nutrients to water bodies including by adhering to minimum application rates, understanding
1756 near-term climate predictions to prevent storm conveyance of nutrients, and assuring a sufficient buffer
1757 between fertilizer application points and any nearby stream.



1758
1759 Figure 2-28. Volunteers plant vetiver grass to stabilize soil in the Talakahaya watershed in Rota, Commonwealth of the Northern
1760 Mariana Islands. Source: NOAA

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Figure 2-29. West Maui erosion control in watershed using vetiver grass to catch sedimentation. Planting vetiver rows (left); finished vetiver rows (right). *Source: West Maui Ridge to Reef*

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Figure 2-30. Hillside hydroseeding in Puerto Rico. *Source: Protectores de Cuencas*

1766 **2.3.3.3 Unpaved Road/Trail Stabilization**

1767 Unpaved roads and trails can be significant sources of erosion and sedimentation. Construction of broad-
1768 based dips, at the lowest point where the road grade curves, and water bars, which are small ditches
1769 constructed at low points, are two erosion control measures used to direct runoff from unpaved roads
1770 before it has a chance to erode the roadway through the formation of gullies and channels in the road.
1771 Designs incorporating these or similar elements allow runoff to be directed along various portions of the
1772 road to low points within the road that are then sloped to the downstream side of the road, where a
1773 stabilized outlet receives the flow and directs it downstream. Additionally, roads can be paved to prevent
1774 further erosion and sedimentation (Figure 2-31; Figure 2-32; Figure 2-33).

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Figure 2-31. Gerda Marsh road stabilization on St. Johns, USVI. *Source: Coral Bay Community Council*



Figure 2-32. Freeman's Ground, St. Johns, USVI retaining wall for road stabilization. *Source: Coral Bay Community Council*



Figure 2-33. Dirt road stabilization in Puerto Rico. *Source: Protectores de Cuencas*

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1781 **2.3.3.4 Stormwater Best Management Practices**

1782 Surface runoff from storm events or stormwater is a significant source of sporadic, erosive flows, erosion,
 1783 and sedimentation. Stormwater BMPs are designed to reduce the velocity of stormwater flows and trap
 1784 and remove sediments and other contaminants that may be transported in the stormwater. There are
 1785 several types of BMPs designed for these purposes, including for treating various sizes of drainage areas.
 1786 The implementation of these BMPs is site specific. BMPs include bioretention cells, baffle boxes, culvert
 1787 repair or replacement, curb inlet grate filters, grass swales, stormwater or sediment basins, constructed
 1788 wetlands, low impact development, stream bank or gut stabilization, and fencing.

1789 ***Bioretention Cell (Rain Gardens)***

1790 A bioretention cell, or a rain garden, is a low-impact development measure placed along the flow path of
 1791 stormwater runoff to capture and treat stormwater containing pollutants in order to reduce runoff volume,
 1792 peak flow, and pollutant loadings to natural water bodies. Bioretention cells help to break up extensive
 1793 impervious areas (e.g., resorts, shopping plazas, industrial areas, and roadways). A bioretention cell is
 1794 comprised of a shallow depression excavated and backfilled with media used to promote infiltration and
 1795 supporting plants that both physically trap and bioremediate pollutants (i.e., heavy metals and nutrients).
 1796 This system detains the volume of stormwater runoff known as the “first flush,” which is the initial
 1797 surface runoff generated on impervious or semi-impervious areas during a rain event. The “first flush”
 1798 portion of rainfall typically contains the highest concentration of pollutants and is treated within the
 1799 bioretention cell through natural chemical processes that include plant root uptake and soil retention.
 1800 Bioretention cells have soft design features incorporating vegetative areas and can be installed alone or as
 1801 part of a series of stormwater management measures (Figure 2-34; Figure 2-35).



1802
1803 Figure 2-34. Constructing (left) and finished (right) bioretention area in West Maui. *Source: West Maui Ridge to Reefs*



1804
1805 Figure 2-35. Constructing a rain garden in West Maui. *Source: West Maui Ridge to Reefs*

1806 ***Baffle Box***

1807 A baffle box is a multi-chambered concrete box that contains a series of sediment settling chambers
1808 separated by baffles. The baffle box is tied into an existing stormwater drainage system, or at a drainage
1809 outfall, to decrease stormwater velocities to allow settling of sediment, suspended particles, and
1810 associated pollutants in the boxes. Baffle boxes can also be outfitted with trash screens to capture trash
1811 and debris or can be outfitted with absorbent membranes to trap floating pollutants (e.g., hydrocarbons) to
1812 further minimize transport of contaminants to water bodies.

1813 ***Culvert Repair or Replacement***

1814 Undersized or collapsed culverts can impede natural flows and concentrate flows, which may increase the
1815 velocity of flows, flooding, and channel bank erosion. Standard culverts can be removed, repaired, or
1816 replaced with structures such as bottomless culverts to increase the area of flow and decrease the velocity
1817 of flow resulting in decreased channel bank erosion and sediment transport to downstream habitats.

1818 ***Curb/Grate Inlet Basket (with filter)***

1819 Curb or grate inlet baskets are manufactured frames that can be fitted with filters or fabric and placed in a
1820 curb opening to remove trash, sediment, or debris. Baskets trap items larger than sediment and can
1821 remove large quantities of hydrocarbons, including oils and grease, when fitted with an optional absorbent
1822 polymer.

1823 ***Swale***

1824 A grass swale is a shallow excavation, constructed on a gradually sloped grade, lined with grass along a
1825 waterway or roadway (Figure 2-36). The vegetated conveyance channel slows stormwater flows,
1826 temporarily impounds a portion of the flow, filters a portion of the pollutants contained in stormwater

1827 flow, settles out sediment, encourages infiltration into the underlying soils, and reduces the potential for
1828 bank erosion caused by runoff velocity within the channel. Grass swales can be installed when runoff
1829 needs to be conveyed to a natural drainage channel from another stormwater treatment structure or from a
1830 land use that has incorporated preventative treatment measures. Grass swales can be especially effective
1831 when constructed at grades approaching level because they slow water flow to the maximum extent
1832 possible while still maintaining a positive grade. Ponding may occur in swales, which will aid in
1833 additional settling and treatment of stormwater runoff.



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Figure 2-36. An example of swale construction in Puerto Rico. *Source: Protectores de Cuencas*

1836 ***Stormwater Ponds or Sediment Basins***

1837 Stormwater ponds or sediment basins are a stormwater drainage feature designed to retain stormwater,
1838 reduce flow velocities, and retain sediment (Figure 2-37). The ponds or basins can be designed to store a
1839 permanent or intermittent pool of water, based on the design of the outlet. The outlets can be designed as
1840 a pipe or an overflow structure, or they can link into another stormwater BMP like a constructed wetland.
1841 The design of the pond or basin is site specific and dependent on the intended purpose and the size of the
1842 drainage area.



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Figure 2-37. Examples of constructed stormwater ponds in Puerto Rico. *Source: Protectores de Cuencas*

1845 ***Check Dams***

1846 Erosion in small rills or gullies in the upper reaches of watersheds may be slowed with the use of check
1847 dams or fiber rolls. Check dams are small structures that slow the flow of water in small erosion features.
1848 They are often made of natural materials (e.g., wattles, dead branches, or fiber rolls) or stones. These are
1849 designed to slow the velocity of water and reduce runoff in the areas below.

1850 ***Fiber Mats and Rolls or Filter Socks***

1851 Bare soils may be stabilized with fiber mats made of natural materials like woven jute or coconut (coir)
1852 fiber mats. These mats are a good option for soils affected by wildfire or construction and temporarily
1853 hold soil in place until vegetation can take root and hold the soil in place. They allow water to percolate
1854 and can provide a stable foundation for native plant growth or be sown with seed. These mats can also be

1855 rolled and secured with short wooden stakes to create a barrier to slow overland flow on bare soils. In
1856 some cases, a filter sock filled with mulch, compost, or other filter material, can be used in a similar
1857 fashion.

1858 2.3.3.5 Constructed Wetland

1859 A constructed wetland is an artificial wetland that may be a marsh, mangrove area, or swamp created for
1860 pollutant retention and removal (Figure 2-38; Figure 2-39). Constructed wetlands have characteristics
1861 similar to natural wetlands and use the same natural processes (e.g., microbial activity) to remove
1862 pollutants from stormwater, wastewater, or sewage effluent and also allow sediments to settle. The
1863 constructed wetland can also provide habitat for native and migratory wildlife.



1864
1865 Figure 2-38. Example of an under construction (left) and finished floating wetland (right). Source: West Maui Ridge to Reef



1866
1867 Figure 2-39. Building constructed wetland (left) and finished wetland (right). Source: Protectores de Cuencas

1868 2.3.3.6 Low Impact Development

1869 Low Impact Development (LID) strategies integrate the use of site planning and stormwater management
1870 to promote the infiltration and retention of stormwater and associated pollutants at their source. The
1871 overall goal of LID is to maintain a site's pre-development hydrologic condition to the greatest degree
1872 practicable. The stormwater BMPs associated with LID, subsequently referred to as LID practices, utilize
1873 natural processes (e.g., infiltration, temporary detention, and groundwater recharge) to disperse
1874 stormwater throughout the site and retain stormwater volume and associated pollutants on-site, rather than
1875 conveying stormwater and associated pollutants directly to receiving waters. In general, LID practices
1876 focus on reducing impervious cover (e.g., using pervious pavers, pervious concrete [Figure 2-40]),
1877 retaining stormwater (e.g., cisterns, rain barrels), and/or slowing the velocity of stormwater runoff to

1878 allow for stormwater infiltration and retention of pollutants on site (e.g., bioretention swales, vegetated
1879 buffers, green roofs, and infiltration wells/trenches).

1880



1881
1882 Figure 2-40. Examples of low impact development practices and permeable parking areas that allow for filtration of rain/run off.
1883 *Source: Protectores de Cuencas*

1884 2.3.3.7 Stream Bank or Ghut Stabilization

1885 Stream bank stabilization is defined as the stabilization of an eroding stream bank using practices that
1886 consist primarily of a mixture of “soft” or “hard” engineering practices. “Soft” engineering practices
1887 include, but are not limited to, regrading with natural materials like coconut (coir) fiber mats, grasses, and
1888 various shrubs and trees to reduce erosive slopes and stabilizing those slopes via vegetation and their root
1889 structure. “Hard” stabilization practices include, but are not limited to, installation of turf reinforcement
1890 matting, riprap or other rock, and gabions to reduce velocities of storm flows and stabilize erosive stream
1891 banks. The use of “hard” engineering techniques is not considered a restoration or enhancement strategy,
1892 but may be necessary in certain locations where erosion threatens adjacent properties and the probability
1893 of success using soft engineering practices is low. Other sections along the channel banks can be treated
1894 with bioengineering and soft engineering practices, which can be expected to reduce bank erosion,
1895 increase site aesthetics, enhance in-stream habitat, and be less costly compared to hardened structures.

1896 Turf reinforcement mats are made of synthetic fabric and are used to line bare soil areas along channel
1897 banks to protect the channel bed and bank from erosion. These mats may also be used in landscaping in
1898 areas with bare soils. They provide a long-term solution for erosion control and maintain intimate contact
1899 with the subgrade, resulting in rapid seedling emergence and minimal soil loss. Turf mats allow water to
1900 infiltrate into the substrate and provide for hydraulic connectivity to groundwater. Turf mats are made of
1901 non-biodegradable fabric to ensure long-term stabilization of soils.

1902 Riprap is angular rock used for stabilizing steep soil slopes on which a healthy stand of vegetation cannot
1903 be established or within concentrated channels that would otherwise be susceptible to erosion from
1904 rainfall and concentrated runoff. The size of the rock used is based on the expected shear stress induced
1905 by flowing water. Depending on the site conditions (e.g., waterflow, velocity), rocks may be reinforced or
1906 held together with rebar and mortar or placed in wire baskets (gabions). Non-reinforced riprap structures
1907 are usually anchored into the ground to increase their resistance to movement. A geotextile fabric is
1908 typically installed prior to riprap placement to prevent undermining of soils and different sizes of rock are
1909 installed under and within the larger boulders to further stabilize the riprap.

1910 **2.3.3.8 Fencing**
1911 A fence is installed to prevent livestock (e.g., cattle or horses) or feral animals from accessing a stream or
1912 other sensitive area. The goal is to reduce erosion caused by trampling as well as abate nutrient or bacteria
1913 input.

1914 **2.3.3.9 Elevated Boardwalks and Delimitation of Ecologically Sensitive Vegetative Areas**
1915 Measures to reduce impacts to sensitive vegetated areas include the installation of treated wooden posts or
1916 other markers to identify sensitive areas (Figure 2-41). Treated posts or boulders can also be used to
1917 prevent vehicular access to these areas. Posts are generally installed by digging holes about a foot and a
1918 half deep and securing the post with cement. To provide public access across sensitive areas, raised
1919 boardwalks may be built using treated wood anchored on piles.



1920
1921 Figure 2-41. Examples of elevated boardwalks and delimitation of sensitive vegetation areas while allowing public access to
1922 beaches. *Source: Protectores de Cuencas*

1923 **2.3.3.10 Removal of Terrestrial Invasive or Nuisance Species**
1924 In some situations, invasive or nuisance species, such as bamboo (*Bambusa vulgaris*) and feral goats and
1925 hogs, may impair watershed health and impair native habitat restoration. In such cases, invasive or
1926 nuisance species may be removed using appropriate methods (e.g., humane capture and relocation, trained
1927 herding animals, and culling of herd). All restoration sites should be restored using BMPs for stormwater
1928 control and appropriate native vegetation. For bamboo, this may include the cut stump method where
1929 bamboo stems are cut low to the ground and then spot treated with direct, limited application of an
1930 appropriate pesticide. Pesticide use should be limited to the minimum amount necessary to control the
1931 problem species.

1932 **2.3.4 Reduction of Physical Impacts to Coral Reef Ecosystem**

1933 The CRCP supports activities such as community-based involvement in coastal cleanup activities, the
1934 removal of derelict fishing gear and other marine debris from coral reef ecosystems, and the installation
1935 of mooring buoys and other buoys to mark access to protected areas or limited access zones to reduce
1936 physical impacts.

1937 **2.3.4.1 Buoy Installation**

1938 **Recreational Boat/Day Moorings**

1939 Anchor damage is a common disturbance to coral reefs and seagrass beds (Davis, 1977; Jameson et al.,
1940 1999; Rogers et al., 1988) and permanent boat mooring systems are a widely accepted means to lessen the
1941 harmful effects of recreational boat anchoring and aid in coral ecosystem conservation (Halas, 1985;
1942 Halas, 1997; Rogers et al., 1988). All mooring buoy systems consist of the following three elements: an
1943 anchor on the sea bottom, a buoy floating on the water surface, and a line connecting the two (Figure 2-

1944 42). CRCP only funds embedment anchors, which are embedded into either solid bedrock or soft
1945 substrate and held in place by the weight of the sand, rubble, or hard substrate.



Figure 2-42. A boater secures the buoy mooring line to anchor his vessel. *Source: NOAA*

1946
1947

1948 A common mooring buoy system used in areas with flat, solid bedrock is the Halas system (Halas, 1985;
1949 Halas, 1997). The system consists of a stainless steel eye bolt cemented into a small hole 50 mm wide x
1950 609 mm deep (2 in wide x 24 in deep) drilled into hard substrate. A floating line shackled to the eye bolt
1951 extends to the surface and through a polyethylene buoy to a pickup line, which attaches to a boat. The
1952 hole for the eye bolt is typically drilled in flat, solid, uncolonized bedrock using an underwater hydraulic
1953 drill. The hole is located away from branching coral formations that could catch or abrade the slack down
1954 line. Installation takes about 30 minutes to drill the hole and about another five minutes to set the steel rod
1955 with previously mixed hydraulic cement or epoxy. Installation does not produce significant amounts of
1956 sediments or destroy living coral colonies. The Halas system eliminates the need for the heavy chain used
1957 for conventional mooring systems, which can often damage the surrounding sea bottom (Project AWARE
1958 & PADI International Resort Association, 1996).

1959 Embedment anchors suitable for soft bottom, such as sand, rubble, and seagrass beds, include systems
1960 such as the Manta Ray® and the Helix (Project AWARE & PADI International Resort Association,
1961 1996). The Manta Ray® system consists of a utility anchor attached to an eight-foot anchor rod that is
1962 hammered under the soft bottom using a hydraulic underwater jackhammer and gad (Figure 2-43). The
1963 anchor is set using a load locker or by tying a line from the anchor to a workboat and driving the boat
1964 either forward or in reverse to apply pressure along the line and cause the anchor to open. A thimble eye
1965 at the upper end of the anchor rod is used for the attachment of the floating line, which extends to the
1966 surface through a buoy to a pick up line. Installation of a Manta Ray® System produces only minimal
1967 short-term impacts in the form of a small sediment plume during drilling. Installation time varies with sea
1968 bottom characteristics, but usually can be installed in less than 30 minutes.

1969 Screwing mooring anchors, such as the Helix system, which uses circular shaft (disk dimensions: 10-25.4
1970 cm [4-10 in], shaft 1.9-3.2 cm [0.75-1.25 in] x 114-168 cm [45-66 in]) are anchored by screwing the shaft
1971 into soil by hand using a steel rod to turn it. The termination end or exposed end of the shaft has an eye
1972 bolt to which a floating line is attached and extends to the surface through a polyethylene buoy to a
1973 pickup line.

1974 For the installation of these systems, a vessel is necessary to access the area and serve as a work platform.
1975 Two diving teams usually perform buoy installation. Each diving team consists of a pair of divers. A
1976 support team in charge of boating safety, equipment, and material handling is also present on the vessel.

1977 The installation of each mooring anchoring system may take between 35 and 45 minutes, depending on
1978 the depth and the type of substrate and system to be installed. If needed, hydraulic tools will be lowered to
1979 the sea bottom to divers. Air bags should be used to ease and control both the descent and ascent of the
1980 submerged tools to avoid dragging them on the seafloor. Dive teams assist in ensuring the vessel is
1981 anchored over the working site in an area and manner that does not impact marine habitat.



1982
1983 Figure 2-43. A diver installs a mooring buoy on the seafloor. *Source: NOAA*

1984 ***Storm Moorings***

1985 Storm moorings in the form of designated mooring fields are used to secure watercraft during storms.
1986 Mooring fields for storm moorings consist of open link mooring chain laid out in parallel rows and
1987 secured to the seabed with hydraulically installed helical embedment anchors. Installation of embedment
1988 anchors is done using the same methods as described for the installation of recreational boat moorings.
1989 Individual mooring lines are attached to the ground chain between the installed helical embedment
1990 anchors, thereby spreading the load between the anchors. Marker buoys delineate where fore and aft
1991 secure shackle attachment points are connected to the ground chains in order for each boat to attach its
1992 individual down lines. Storm mooring fields are designed to allow sufficient room between boats and
1993 clear passageways for transiting boats.

1994 ***Marker Buoys***

1995 Marker buoys are used to designate particular areas for use/nonuse by recreational boats and jet skis,
1996 swimmers, divers and snorkelers; to demarcate boundaries of preservation areas, zones in protected areas;
1997 and to identify shallow seagrass and reef areas, among other things. Buoys consist of a floating buoy or
1998 cylindrical floating pipe that can carry an informational message and are secured in a fashion similar to
1999 that used for mooring buoys based on the substrate (Figure 2-44). Where possible, marker buoys
2000 generally use round shaft anchors or weighted anchors and are placed in sand to avoid the expense and
2001 complication of drilling in bedrock.



Figure 2-44. Examples of marker buoys. Left: Yellow marker buoys are used denote zones with special regulations in the Florida Keys National Marine Sanctuary. Right: Spar buoys for Wildlife Management Areas and sites on the Shipwreck Trail in the Florida Keys National Marine Sanctuary. *Source: NOAA*

2002
2003
2004
2005

2006 **2.3.4.2 Debris Removal**

2007 Debris removal projects include coastal/beach clean-ups and in-water removal of debris (e.g., plastics,
2008 glass, metal and rubber, and derelict fishing gear). The purpose of debris removal is to eliminate
2009 immediate physical, biological, or chemical threats to the survival of living coastal and marine resources
2010 and their habitats. For in-water removal of debris caught/entangled on coral, SCUBA divers or snorkelers
2011 employ methods to reduce further negative impacts to coral (i.e., cutting nets and fishing line instead of
2012 pulling on the objects and breaking coral). SCUBA divers and snorkelers will also be trained how to
2013 safely remove debris to ensure it is not entangled and to avoid interactions with ESA-listed species.

2014 For in-water marine debris removal efforts, a vessel may be necessary to access the area and serve as a
2015 work platform. A support team in charge of boating safety, equipment, and material handling should also
2016 present on the vessel. Air bags should be used to ease and control of ascent of any larger or heavy debris
2017 to avoid dragging items along the seafloor. Dive teams assist in ensuring the vessel is anchored over the
2018 working site in an area and manner that does not impact marine habitat.

2019 For examples of previously funded marine removal projects, see
2020 [https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/other/grants/NFWF/NA10NOS4630103_Final_Re](https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/other/grants/NFWF/NA10NOS4630103_Final_Reports/23649_forweb.pdf)
2021 [ports/23649_forweb.pdf](https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/other/other_crcp_publications/SEFCRI/FDOU_Project/FDOU_Project_29_30_32_Year3.pdf) and
2022 [https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/other/other_crcp_publications/SEFCRI/FDOU_Pro](https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/other/other_crcp_publications/SEFCRI/FDOU_Project/FDOU_Project_29_30_32_Year3.pdf)
2023 [ject/FDOU_Project_29_30_32_Year3.pdf](https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/other/other_crcp_publications/SEFCRI/FDOU_Project/FDOU_Project_29_30_32_Year3.pdf).

2024 **2.3.5 Outreach/Education and Program Operations**

2025 **2.3.5.1 Education and Outreach**

2026 The CRCP also conducts several education and outreach activities including affixing signs within
2027 formation about conserving and protecting resources, involving the public and stakeholders in hands-on
2028 coral preservation and conservation activities, and outreach to members of the user community often
2029 using educational materials.

2030 **Signage**

2031 Informational and educational signs are placed in strategic locations to alert and educate the public about
2032 important conservation and preservation messages. Land-based educational signs are placed near streams,
2033 in coastal areas at sites determined to be highly visible by the public. Signboards are firmly fastened to a

2034 metal post or wood pole, which is secured in concrete in the ground or driven with a hammer into soft
2035 bottom substrate.

2036 Educational signs may also be placed in the water as part of an underwater trail (Figure 2-45). Tail signs
2037 may either be signs posted on stone markers on the seafloor that may or may not include a floating buoy
2038 for easy identification or the marker is the floating buoy, which contains educational information on the
2039 buoy. The stone markers are placed on the seafloor and are held in place using stainless steel pins as
2040 described in 2.3.1.2, Instruments Moored to the Seafloor. Buoy markers are installed using the methods
2041 described in Section 2.3.4.1, Buoy Installation. Vessels and SCUBA divers will be necessary for the
2042 installation and maintenance of the markers. Air bags should be used to ease and control of ascent of any
2043 larger or heavy debris to avoid dragging items along the seafloor. If anchoring, the dive teams assist in
2044 ensuring the vessel is anchored over the working site in an area and in a way that does not impact marine
2045 habitat. The markers are maintained/cleaned by hand periodically by divers using plastic brushes.



2046
2047 Figure 2-45. A diver maintains an underwater stone marker trail sign at Buck Island National Monument, USVI.
2048 *Source: National Park Service*

2049 ***Hands-on Educational Activities***

2050 Some outreach activities involve bringing stakeholders into the field to experience and learn about coral
2051 reef resources first hand. These activities include training citizens to conduct biological assessments (e.g.,
2052 fish and/or coral identification and measurements) or participate in on-the ground/in-water restoration.
2053 Trainings include not only the techniques needed to conduct the work and minimize impacts to corals and
2054 habitats, but also considerations regarding health and safety precautions need to conduct the various
2055 activities (Figure 2-46). In-water activities may involve diving/snorkeling from land or boat and kayaking
2056 along the coastline. Inexperienced snorkelers and swimmers are required to wear a floatation device. All
2057 divers participating must be certified for diving and have had proper training in diving and be capable of
2058 exhibiting responsible dive practices (e.g., proper buoyancy). Land-based activities may include walking
2059 in or near vegetative areas adjacent to the coastline and/or along beaches in order to conduct the
2060 restoration activities.



Figure 2-46. Left: An education event on coral reefs and snorkeling in the Manell-Geus watershed in Guam; Right: Snorkelers after orientation learn about Guam's coral reefs. *Source: NOAA, Valerie Brown*

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2062
2063

2064 ***Other Outreach Activities***

2065 The CRCP is engaged in national, international, and local outreach initiatives to build awareness of and
2066 support for coral reef conservation efforts. Associated activities include the development of posters,
2067 booklets, videos, and training materials for various audiences; and outreach to fishermen, local schools,
2068 and other user groups through community meetings. The CRCP also supports and maintains the Coral
2069 Reef Information System, which provides access to NOAA coral reef information and data products with
2070 emphasis on the U.S. states, territories, and remote island areas.

2071 ***2.3.5.2 Data Analysis and Modeling***

2072 Computer-based analysis of data collected through mapping, monitoring, and research or that has been
2073 collected by other agencies or scientist. The data can be used to create a variety of models to help improve
2074 management and guide the implementation of projects.

2075 ***2.3.5.3 Program and Interagency Coordination/Management***

2076 The CRCP oversees U.S. coordination efforts through the USCRTF by serving as its co-chair and steering
2077 committee secretariat. The CRCP reviews plans, policies, and regulations related to coral reef
2078 conservation and management; supports meetings; manages CRCP data; implements and manages
2079 external funding opportunities; and supports program staff and travel to implement the program activities
2080 and coordination. The CRCP also provides support for international conferences such as the International
2081 Coral Reef Symposium.

2082 ***2.3.5.4 Operational Activities***

2083 To support its mapping, monitoring, research, and restoration activities, the CRCP uses NOAA ships,
2084 charter boats, and small vessels.

2085 NOAA operates a wide assortment of hydrographic survey, oceanographic research, and fisheries survey
2086 vessels, which play a critical role in the collection of data to support CRCP's goals and objectives. All
2087 vessels are operated by NOAA's Office of Marine and Aviation Operations (OMAO), an office composed
2088 of civilians and officers of the NOAA Commissioned Corps. OMAO also manages the NOAA Diving
2089 Program and NOAA Small Boat Program.

2090 Research and monitoring activities funded by the CRCP occurring in the Atlantic and Caribbean has
2091 typically been conducted on the NOAA research vessel (*R/V Nancy Foster*) and work in the Pacific Island
2092 used to use *R/V Hi'ialakai*. Future work in the Pacific will be conducted on other NOAA vessels due to
2093 the planned decommissioning of the *R/V Hi'ialakai*. The *R/V Nancy Foster* is one of the most
2094 operationally diverse platforms in the NOAA fleet. CRCP operations conducted on the *R/V Nancy Foster*

2095 include the characterization of habitats and fauna, bathymetric surveys, physical and chemical
2096 oceanography studies, and pollution assessments. This vessel employs state of the art navigation,
2097 propulsion, and mission systems resulting in high quality and efficient data collection with cutting edge
2098 technology including high-resolution multibeam echosounders, split-beam echosounders, and a vast array
2099 of oceanographic and atmospheric sensors. Additional capabilities include water and sediment sampling,
2100 net towing, sub-bottom profiling, diving with air and nitrox (Nitrogen/Oxygen mix that has more Oxygen
2101 than 21% and less Nitrogen than 79%), AUV and ROV support with dynamic positioning, small boat
2102 operations, and buoy servicing.

2103 In some instances, it is not possible or appropriate to use NOAA vessels for CRCP funded activities;
2104 therefore, the principal investigators charter ships or small boats. All vessels chartered by NOAA shall
2105 meet applicable international, federal, state, and local pollution control laws and regulations. Vessels shall
2106 be outfitted and operated in accordance with applicable U.S. Coast Guard and International Maritime
2107 Organization regulations for the control of pollution by air emissions, sewage, oil, trash and garbage.

2108 This document does not consider the following:

- 2109 ● Vessel operations that are not related to CRCP activities, such as transits to a new homeport or to
2110 a dry dock, to a non-CRCP funded activity, or from a non-CRCP funded activity to a port;
- 2111 ● Vessel construction and acquisition, repairs, maintenance, or upgrades, such as the installation or
2112 testing of new scientific equipment; and
- 2113 ● Any chartered vessel operations that are not undertaken as part of a CRCP-funded activity.

2114 **2.4 Alternatives**

2115 NEPA and the CEQ regulations require all EISs to include alternatives to the proposed action and require
2116 Federal agencies to “study, develop, and describe appropriate alternatives to recommended courses of
2117 action in any proposal which involves unresolved conflicts concerning alternative uses of available
2118 resources” 42 U.S.C. § 4332(C) & (E). CEQ considers the alternatives requirement so critical to informed
2119 decision-making that it refers to the alternatives analysis as the “heart of the [EIS].” 40 C.F.R. § 1502.14.
2120 Agencies must “rigorously explore and objectively evaluate all reasonable alternatives, and for
2121 alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been
2122 eliminated.” 40 C.F.R. § 1502.14(a). The analysis must “[d]evote substantial treatment to each alternative
2123 considered in detail including the proposed action so that reviewers may evaluate their comparative
2124 merits” 40 C.F.R. § 1502.14(b). It is well accepted that an agency must only consider “reasonable
2125 alternatives” bounded by the agency’s purpose and need for acting and need not speculate or consider
2126 alternatives that are not viable.

2127 ***2.4.1 Approach to Alternatives Analysis***

2128 Based on environmental issues identified through scoping and the objectives described above in the
2129 purpose and need statement, the CRCP developed and evaluated a reasonable range of alternatives for
2130 implementing the program in accordance with NEPA, CEQ’s implementing regulations, and NOAA’s
2131 internal implementing procedures set forth in the Companion Manual to NOAA Administrative Order
2132 216-6A. Our approach to developing a reasonable range of alternatives follows:

- 2133 ● NOAA has set forth a basic statement of its purpose and need for taking action that will provide
2134 reasonable bounds for identifying viable courses of action;

- 2135 ● NOAA then developed screening criteria (2.4.1.1) based on objectives designed to achieve the
2136 stated purpose and need;
- 2137 ● Based on scoping to identify important issues of environmental concern and the criteria described
2138 below in Section 2.4.2.3, NOAA identified a range of alternatives potentially capable of meeting
2139 the agency’s purpose and need;
- 2140 ● Each alternative was evaluated using the screening criteria described below in Section 2.4.1.1 to
2141 determine whether each alternative is viable. Viable alternatives were carried forward for full
2142 evaluation, and those determined not to meet the CRCP’s purpose and need were not carried
2143 forward but NOAA provides an explanation supporting their exclusion;
- 2144 ● A No Action Alternative reflecting the “status quo” (i.e., current management of the CRCP), will
2145 be carried forward for detailed evaluation as it will establish an important baseline against which
2146 to compare and contrast one or more reasonable action alternatives.

2147 *2.4.1.1 Screening Criteria for Developing Reasonable Alternatives*

2148 Based on the purpose and need for action stated in Sections 1.4.1 and 1.4.2, an alternative for
2149 implementation of the CRCP must meet the following criteria to be considered a reasonable alternative
2150 carried forward for detailed consideration. The alternatives must:

- 2151 A. Seeks to meet NOAA’s duties and obligations and be consistent with the authorities specified by
2152 Congress in the CRCA;
- 2153 B. Seeks to meet one or more goals established by the CRCP Strategic Plan Section 2.2;
- 2154 C. Be implemented in a manner that ensures compliance with applicable statutory requirements
2155 protecting natural and cultural resources Section 1.10.3; and
- 2156 D. Be implemented in a manner that is practicable from economic, technological, and policy
2157 standpoints.

2158 ***2.4.2 Alternatives Carried Forward for Detailed Analysis***

2159 *2.4.2.1 No Action Alternative*

2160 The No Action Alternative maintains the status quo of continued operation of the CRCP based on
2161 addressing the three primary threats (i.e., fishing impacts, land-based sources of pollution, and climate
2162 change), supporting research and possible application of coral restoration and intervention techniques to
2163 restore viable coral populations in response to to imminent threats, such as increased bleaching and
2164 disease, and addressing physical impacts to coral reefs. CRCP operations include the implementation of
2165 monitoring, mapping, research activities, watershed and coral reef restoration, reduction of physical
2166 impacts to coral reef ecosystems, outreach and education, and program operations as described above in
2167 Section 2.3. The CRCP would continue to be implemented using available appropriations, across four
2168 NOAA line offices, using a mix of internal and external funding, across existing geographic areas, and in
2169 collaboration with similar partners. The CRCP would continue to conduct program activities under the No
2170 Action Alternative in compliance with mandatory mitigation measures developed in compliance with
2171 applicable environmental laws such as the ESA as well as mitigation measures set forth in Appendix A.
2172 The CRCP does not currently require implementation of the Discretionary Conservation and Mitigation
2173 Measures (DCCMs) proposed in Appendix B. Some mitigation measures listed in Appendix B may be
2174 implemented on a project-by-project basis. For the purposes of this DPEIS, it is assumed that the
2175 activities would be conducted in the same manner as they currently are.

2176 *2.4.2.2 Alternative 1*
2177 Alternative 1 reflects the operation of the CRCP to address the three primary threats (i.e., fishing impacts,
2178 land-based sources of pollution, and climate change) but would not include the in-water activities that
2179 restore viable coral populations (i.e., in-water coral restoration and intervention techniques) and the
2180 activities that reduce physical impacts to coral reefs (i.e., marine debris removal and installation of
2181 buoys). This alternative would refocus CRCP’s resources and efforts on and prioritize the three primary
2182 threats, which include monitoring and research to support coral reef fisheries and ecosystem management
2183 and conservation, on-the-ground watershed restoration to reduce land-based sedimentation and pollution,
2184 and outreach and education. The CRCP would continue to be implemented using available appropriations,
2185 across four NOAA line offices, using a mix of internal and external funding, across existing geographic
2186 areas, and using similar partners. The CRCP would continue to conduct program activities in compliance
2187 with mandatory mitigation measures listed in Appendix A and developed in compliance with applicable
2188 environmental laws such as the ESA.

2189 *2.4.2.3 Alternative 2*
2190 Alternative 2 is continued operation of CRCP including the in-water coral restoration and intervention
2191 activities and reduction of physical impacts to coral reef ecosystems that support restoring viable coral
2192 populations (i.e., the No Action Alternative) plus requiring the implementation of DCMMs (Appendix B).

2193 *2.4.2.4 Summary Comparison of Alternatives*
2194 The fundamental distinctions between the alternatives are listed in Table 2-2. The distinction between
2195 Alternative 1 and the No Action Alternative is that No Action Alternative includes restoration and
2196 intervention activities that support viable coral populations and activities that reduce physical impacts to
2197 coral reefs. Alternative 1 would therefore focus the CRCP’s resources on addressing the three primary
2198 threats set forth in the CRCP Strategic Plan. The fundamental difference between Alternative 2 and the
2199 No Action Alternative is that Alternative 2 includes a suite of standard, DCMMs that would supplement
2200 the conservation and mitigation measures that are currently implemented. These mitigation measures
2201 would then be implemented across the program as mandatory. While some of the measures listed in
2202 Appendix B may be implemented on a project-by-project basis, there is no existing CRCP requirement
2203 mandating their implementation. All alternatives would require the CRCP to continue to be implemented
2204 in accordance with applicable law and mandatory mitigation and conservation measures developed
2205 through statutory compliance (e.g., terms and conditions set forth in the Incidental Take Statement of a
2206 Biological Opinion issued under Section 7 of the ESA). Discretionary measures developed through
2207 statutory compliance (e.g., conservation recommendations provided by NMFS Office of Habitat
2208 Conservation through an EFH consultation under the MSA) would be required to be implemented under
2209 Alternative 2, but would remain discretionary under the No Action Alternative. The lack of required
2210 discretionary mitigation measures is the primary distinction between the No Action Alternative and
2211 Alternative 2, and the impacts analysis in Chapter 4 therefore evaluates the distinction between the CRCP
2212 with (Alternative 2) and without (No Action Alternative) mandatory implementation of the measures
2213 listed in Appendix B. The summary of activities within each alternative is listed in Table 2-3.

2214

2215

2216 Table 2-2. The implementation of the CRCP under each of the alternatives.

	No Action Alternative	Alternative 1	Alternative 2
Monitoring, mapping, and research	X	X	X
Coral restoration and interventions	X	--	X
Watershed management and restoration	X	X	X
Reduction of physical impacts to coral reef ecosystems	X	--	X
Outreach/education and program operations	X	X	X
Continued compliance with mandatory mitigation measures (Appendix A)	X	X	X
Requirement of discretionary conservation and mitigation measures(Appendix B)	--	--	X

2217
2218
2219

Table 2-3. Summary of the on-the-ground and in-the-water activities anticipated under the proposed alternatives.

Activities	No Action Alternative: Continued implementation of the CRCP Strategic Plan, which addresses land-based sources of pollution, improve fisheries sustainability, address climate impacts, and coral restoration.	Alternative 1: Implementation of activities to address the three primary threats - land-based sources of pollution, fishing impacts, and climate change.	Alternative 2: Implementation of the No Action Alternative supplemented with discretionary conservation and mitigation measures.
Monitoring, Mapping, and Research Activities			
Biological Monitoring			
SCUBA and/or Snorkel Surveys	X	X	X
Stationary Cameras	X	X	X

SCUBA/Snorkel Mandatory Mitigation Measure	X	X	X
SCUBA/Snorkel Discretionary Mitigation Measure	--	--	X
Geological and Oceanographic Monitoring			
In-water Instruments (Moored and Moving)	X	X	X
Instruments Moored Discretionary Mitigation Measure	--	--	X
ROV Discretionary Mitigation Measures	--	--	X
Fish Monitoring and Detection Using Echosounder	X	X	X
Water Quality/Sediment Monitoring	X	X	X
Socioeconomic Monitoring	X	X	X
Mapping (in-water, aerial, and satellite)	X	X	X
Acoustic Mapping Discretionary Mitigation Measure	--	--	X
Research			
Tagging	X	X	X
Collection of Fish (Lethal/non-lethal and coral samples), Invertebrates, and Seagrass	X	X	X
Coral Fragments, Cores. Settlement Plates, Gamete collection, and measurements	X	X	X
Coral Collection Discretionary mitigation Measures	--	--	X

Invasive Species Discretionary Mitigation Measures	--	--	X
Coral restoration and interventions			
Coral Nursery			
<i>In-situ</i> Nursery Development/Enhancement	X	--	X
Nursery Maintenance	X	--	X
Coral Transplantation	X	--	X
Coral Restoration Mitigation Measures	--	--	X
Other Interventions	X		X
Watershed Management and Restoration			
Technical Support for Watershed Management Plans	X	X	X
On-the-ground Watershed Restoration Activities	X	X	X
Watershed Restoration Discretionary Mitigation Measures	--	--	X
Projects that Might Temporarily Increase Sedimentation Mitigation Measures	--	--	X
Reducing physical impacts to coral reef ecosystems			
Buoy Installation	X		X
Marine Debris Removal	X		X
Buoy Installation Discretionary Mitigation Measures	--	--	X
Outreach/Education and Program Operations			

Outreach/Education	X	X	X
Data Analysis and Modeling	X	X	X
Program and Interagency Coordination/Administration	X	X	X
Operational Activities (Vessels)	X	X	X
Discretionary Mitigation Measures - Other	--	--	X

2220

2221 **2.4.3 Alternatives Initially Considered but not Carried Forward**

2222 *2.4.3.1 Functional Alternative*

2223 NOAA considered the functional alternative of shifting management and conservation of coral reefs to
 2224 non-NOAA organizations. Under this alternative, coral management and conservation would shift
 2225 primarily to other Federal agencies, states, territories, and local governments. NOAA did not carry this
 2226 alternative forward as it did not meet screening criteria A and B (see Section 2.4.1.1). Shifting
 2227 management in this manner would not meet NOAA’s obligations under the CRCA. NOAA did not
 2228 identify any other functional alternatives to consider.

2229 *2.4.3.2 Operational Alternatives*

2230 The primary operational alternatives considered altering the mechanism and distribution of funding and
 2231 effort (e.g., assistance awards, internal implementation, etc.) and modifying program priorities. NOAA
 2232 did not carry these operational alternatives forward as they did not meet screening criteria B and D. These
 2233 operational alternatives were thoroughly considered and addressed in the planning process that
 2234 culminated with the CRCP Strategic Plan. The CRCP Strategic Plan has been finalized and sets forth
 2235 program objectives, priorities, and guidance. That plan was adopted after substantial outreach to and
 2236 coordination with a wide array of stakeholders and affected parties and reflects their input. Reinitiating
 2237 the planning process to consider these alternatives again would be inefficient, waste limited
 2238 administrative resources, and disrupt program implementation. Other operational alternatives focused on
 2239 achieving efficiencies in managing the program. Alternative means of implementing mitigation measures
 2240 would meet all four screening criteria and thus meet the purpose and need for the proposed action. These
 2241 operational alternatives have been carried forward for detailed analysis in this DPEIS. Public comments
 2242 submitted in response to our publication of the NOI to prepare a PEIS suggested expanding the range of
 2243 alternatives to include an expansive set of intervention techniques to respond to threats to coral reefs
 2244 through spatial management, restoration, pollution control, and providing resources to repair reefs.
 2245 Measures to combat the adverse effects of fishing and land-based pollution are already included in the
 2246 CRCP and will continue to be refined and implemented over time. In addition, researching and
 2247 implementing novel intervention techniques related to coral restoration, as suggested, is already included
 2248 in the No Action Alternative and Alternative 2. Adding additional measures such as regulation of
 2249 fisheries, establishment of marine protected areas, and development of an insurance program to repair
 2250 reefs in the event of a disaster, while laudable objectives, are beyond the scope of the CRCP’s authority

2251 and existing policy for the program and thus inconsistent with screening criterion D. The CRCP considers
2252 these suggestions to be alternatives for additional program elements rather than mitigation for program
2253 activities. The focus of mitigation efforts will be on avoiding or minimizing adverse impacts to marine
2254 resources as the CRCP is implemented through project-specific activities over time.

2255 **3. AFFECTED ENVIRONMENT**

2256 **3.1 Introduction**

2257 The Affected Environment section of this DPEIS describes the existing areas and resources likely to be
2258 affected by the CRCP, in compliance with the CEQ regulations 40 C.F.R. § 1502.15 and 1980, the
2259 NOAA's 216-6A Companion Manual, which states:

2260 “The environmental impact statement shall succinctly describe the environment of the area(s) to
2261 be affected or created by the alternatives under consideration. The descriptions shall be no longer
2262 than is necessary to understand the effects of the alternatives. Data and analyses in a statement
2263 shall be commensurate with the importance of the impact, with less important material
2264 summarized, consolidated, or simply referenced. Agencies shall avoid useless bulk in statements
2265 and shall concentrate effort and attention on important issues. Verbose descriptions of the
2266 affected environment are themselves no measure of the adequacy of an environmental impact
2267 statement.”

2268 This chapter describes resources likely to be affected directly, indirectly, or cumulatively by the No
2269 Action Alternative and two Action Alternatives. If other resources present within the area of potential
2270 effect are unlikely to be affected, they will receive only brief evaluations in the following Environmental
2271 Consequences chapter. Chapter three is organized by resource categories that are common across all
2272 CRCP areas of influence, followed by details regarding applicable CRCP jurisdictions. Past and ongoing
2273 factors that influence the current condition of resources discussed is guided by internal and external
2274 scoping, including public comment in response to NOAA's publication of a Notice of Intent to prepare an
2275 EIS (Note- provide a hyperlink here for this NOI). Where appropriate, information from relevant existing
2276 documentation is incorporated by reference, in compliance with 40 C.F.R. § 1502.21.

2277 The affected environment for the CRCP covers the areas with tropical coral reef ecosystems within the
2278 U.S., U.S. territories, and within the Coral Triangle (formed by the Philippines, Malaysia, and Solomon
2279 Islands) and Caribbean Sea. Affected resources include coral reef, mangrove, and seagrass habitats, the
2280 surrounding water column, as well as the living coastal and marine resources that use these habitats such
2281 as algae, plankton, and diverse invertebrate and vertebrate species. The U.S. has jurisdiction over an
2282 estimated 19,702 km² of shallow-water coral reefs. Thus, the extent of the potentially affected
2283 environment associated with the proposed action is substantial and includes all tropical coral reef habitats
2284 in state and territorial waters, plus offshore habitats and coastal areas that influence or affect coral reef
2285 ecosystems within the U.S. Exclusive Economic Zone (Figures 1-1 and 1-2).

2286 Approach to use of Chapter 3:

- 2287 ● This is a programmatic document and description of the affected environment will only focus on
2288 primary environmental resources likely to be impacted by CRCP activities;

- 2289 ● The description of the affected environment is presented at two levels--first, a general description
2290 of common resources that occur in all geographic areas within the action area, and second, a more
2291 specific description focuses on resources within each jurisdiction;
- 2292 ● The vast majority of data and information necessary to describe the affected environment at a
2293 programmatic or planning level exists; and
- 2294 ● Historical natural and anthropogenic trends are directly related to the current condition of
2295 resources described in the affected environment and are discussed in Chapter 3 to provide an
2296 understanding of the conditions and causes leading to the “snapshot” of the current condition of
2297 resources and therefore discussed in this chapter and, where appropriate, cross referenced in
2298 Chapter 4’s evaluation of cumulative impacts.

2299 ***3.1.1 The context in which Action Occurs***

2300 Global coral health in the context of time is an important and overarching consideration for understanding
2301 the Affected Environment descriptions below. A snapshot of coral reef ecosystems does not effectively
2302 describe the conditions that CRCP activities are impacting. Global environmental trends discussed below
2303 are already having significant negative impacts on coral reef ecosystems.

2304 Corals have already survived multiple major extinction events, which can be attributed to changes in
2305 global temperatures and ocean circulation patterns (Hallock, 1997; Kiessling, 2001; Pandolfi et al., 2011).
2306 In the Modern era, global mean greenhouse gases have increased since the advent of the Industrial Era,
2307 leading to an increase in atmospheric and ocean temperatures, sea level, and ocean acidification (Pachauri
2308 et al., 2014).

2309 These increasing trends for temperature, sea level, and ocean acidification have only accelerated in recent
2310 years and with them so have the frequency and severity of coral bleaching events (Glynn, 1993; Gattuso
2311 et al., 2014; Hoegh-Guldberg et al., 2014; Hughes et al., 2018), resulting in significant mortality
2312 worldwide. Earth’s current climate is comparable to the Paleocene/Eocene Thermal Maximum, which
2313 was also characterized by a rapid rise in atmospheric greenhouse gas concentrations, increased
2314 temperatures, sea level height, and ocean acidification, resulting in a global reduction of coral (Pandolfi et
2315 al., 2011). This impact of this acceleration is most visible for ocean temperatures, which triggered a three-
2316 year, global bleaching event from 2014-2017 that was without precedent in recorded history (Eakin et al.,
2317 2018). This 36-month event brought bleaching-level thermal stress to 75% and mortality-level stress to
2318 30% of the world’s shallow-water coral reefs, with much more severe levels locally (Eakin et al., 2018).

2319 Ocean temperatures have a substantial impact on coral health. During periods of thermal stress, the corals
2320 expel their symbiotic zooxanthellae (known as “coral bleaching”), which removes a primary energy and
2321 oxygen source for the coral. Although coral can recover from a bleaching episode, bleaching leaves corals
2322 vulnerable to disease and other stressors and can also lead to mortality (Brandt & Mcmanus, 2009; Brandt
2323 et al., 2013). As outlined in Section 3.1.1, thermally-induced global bleaching events are occurring with
2324 greater frequency and intensity due to climate change.

2325 Kennedy et al. (2002), Link et al. (2015), and Osgood (2008) suggest global climate change could affect
2326 temperature changes in coastal and marine ecosystems. These changes can influence organisms’
2327 metabolisms and alter ecological processes such as productivity and species’ interactions; changes
2328 precipitation patterns and lead to a rise in sea level which could change the water balance of coastal

2329 ecosystems; alter patterns of wind and water circulation in the ocean environment; and influence the
2330 productivity of critical coastal ecosystems such as wetlands, estuaries, and coral reefs. The distribution of
2331 native and exotic species, the prevalence of disease in keystone animals such as corals and the occurrence
2332 and intensity of toxic algal blooms may also change with increased water temperature.

2333 Ocean acidification, or the decline in ocean pH due to an increase in CO₂ molecules caused by rising
2334 atmospheric CO₂ (Sabine et al., 2004), is another hazard to coral reef health (Anthony et al., 2011;
2335 Pandolfi, 2011). This acidification makes it difficult for corals to build their skeletons and requires them
2336 to use more energy (Pandolfi, 2011). This additional stress makes corals more prone to disease and
2337 bleaching.

2338 Global sea level changes are of particular concern for corals. Decreases in sea level may lead to increased
2339 exposure at low tides and potentially high rates of coral mortality. Because corals grow slowly, they may
2340 be able to survive and continue building reefs with very gradual rises in sea level. However, rapid sea-
2341 level rise that outpaces the growth rate of coral also poses a threat to corals if they become less exposed to
2342 the sunlight required for survival in deeper waters (Hoegh-Guldberg et al., 2007).

2343 Coral threats are not limited to climate change-related stressors. Land-based sources of pollution and
2344 overfishing are also factors that have and continue to contribute to the decline of coral reef systems. Land-
2345 based sources of pollution include the human-produced plastics and chemicals that are harmful to corals
2346 and the excessive nutrient loading caused by changing land use upstream and shoreline erosion (Hall et
2347 al., 2015; Zaneveld et al., 2016). These factors increase coral susceptibility to disease and mortality and
2348 increase the vulnerability of other related ecosystem components, such as seagrasses and mangroves, to
2349 environmental effects.

2350 **3.2 Physical Environment**

2351 ***3.2.1 Action Area***

2352 While deepwater corals exist in many regions throughout the world, the primary focus of the CRCP has
2353 been on the shallow (<30 m [<90 ft] depth) and mesophotic (30-150 m [90-500 ft] depth) coral reefs and
2354 associated life forms found between 30°N latitude and 30°S latitude. The majority of the CRCP funding
2355 supports activities within U.S. waters nestled within the 200 nm exclusive economic zone (EEZ) in seven
2356 jurisdictions: USVI, Puerto Rico, Florida, Hawaii, American Samoa, the CNMI, and Guam. In addition,
2357 the CRCP also occasionally supports activities within Pacific Remote Islands Marine National Monument
2358 (PRIMNM) (i.e., Baker, Howland, Jarvis, Johnston, Kingman, Palmyra, and Wake); deeper reefs in the
2359 northern Gulf of Mexico (including the Flower Garden Banks); the western Atlantic and the Caribbean
2360 Basin (Figure 3-1). Although the CRCP supports coral reef conservation activities in some international
2361 areas, such activities are primarily administrative, such as workshops, in the Freely Associated States (i.e.,
2362 Federated States of Micronesia, Palau, and the Republic of the Marshall Islands); Western Samoa; and the
2363 Coral Triangle Region (i.e., Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands
2364 and Timor-Leste). In addition, some small monitoring efforts occur in the Freely Associated States.

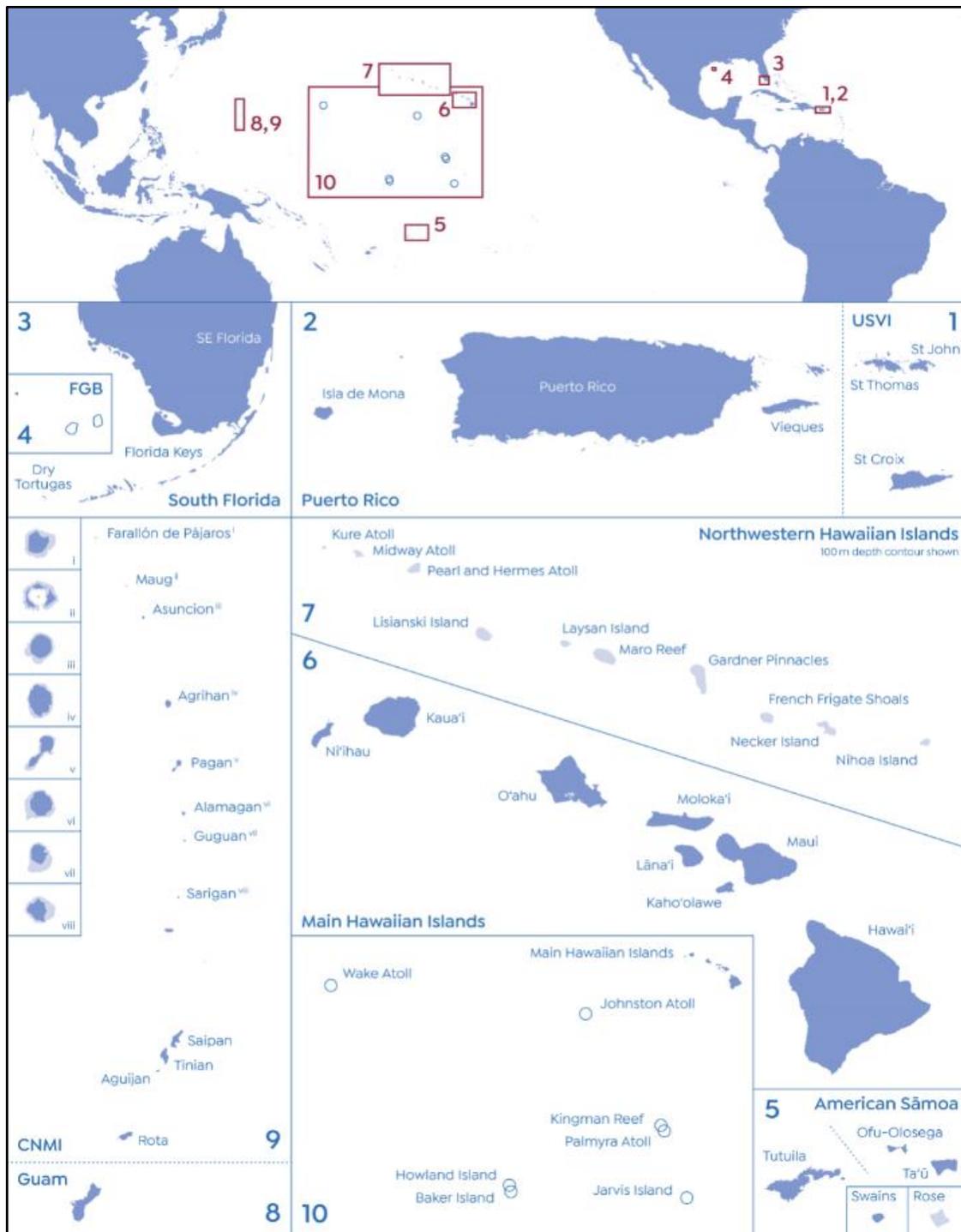


Figure 3-1. Map of U.S. areas with coral reefs. *Source: NOAA*

2365
2366

2367 CRCP activities are not restricted to coral reefs. Coral reef health can be linked to conditions upstream,
 2368 whereby land-based sources of pollution and land use practices that generate sediment and other
 2369 pollutants across those watersheds drain into coral reef areas. CRCP research activities related to coral
 2370 health, fisheries, and restoration also utilize terrestrial and marine spaces for indoor and outdoor
 2371 laboratories and coral nurseries.

2372 **3.2.2 Existing Natural Hazards**

2373 The status and health of coral reef ecosystems are heavily influenced by their oceanographic setting and
2374 natural disasters. This includes ocean temperatures, ocean pH, relative sea level, coastal erosion, tropical
2375 storms, earthquakes, tsunamis, and volcanic activity. This section discusses how these natural hazards
2376 affect coral health.

2377 *3.2.2.1 Coastal erosion, transport, and deposition*

2378 Erosion and changes in sediment transport and deposition may be affected by coastal development, ocean
2379 energy, and strong weather events. Coastal development can reduce vegetation that retains sediments and
2380 increase coastline hardness via construction of seawalls or other similar structures. Energy from ocean
2381 currents and waves affect coral reefs and coastlines through erosion and breaking corals and other hard
2382 structures. Nearshore ocean currents transport and deposit eroded and other loose sediments. Sediment
2383 deposition on coral reefs can suffocate corals or reduce light available for photosynthesis of
2384 zooxanthellae, thus affecting coral health.

2385 Common coastal habitats include maritime forests, scrub thickets, freshwater swamps, freshwater
2386 marshes, mangrove swamps, saltwater and brackish marshes and swamps, and grassy or forested dunes
2387 (Morton et al., 2004). Each type of coastal vegetation has unique features that can retard land loss. For
2388 example, dense stands of salt marsh and mangroves trap sediment or offer resistance to waves and
2389 currents so that land loss is prevented or mitigated. Dune grasses also help stabilize blowing sand and can
2390 assist in dune enlargement. However, the roots of grasses and trees are generally too shallow to reduce
2391 erosion from large storm waves that lower the back beach and undercut the dunes or uplands (Morton et
2392 al., 2004). The density and type of vegetative cover also influence land loss by dissipating the wave
2393 energy reaching sheltered shores, encouraging the accumulation of organic and inorganic sediment, and
2394 acting as a sediment binder that resists erosion.

2395 *3.2.2.2 Tropical Storms*

2396 In contrast to the chronic effects of routine ocean currents and wave energy, U.S. coral reefs are also
2397 subject to acute and extreme impacts of storms. Importantly, in coastal areas with healthy coral reefs, the
2398 reefs are valuable natural infrastructure that provide the ecosystem service of storm protection by
2399 attenuating waves, which reduces damage from storm surges and wave action. In the Atlantic, storms
2400 form off the West African coast and move toward the Caribbean. Most recently, Hurricanes Irma (2017)
2401 and Maria (2017) damaged coral reefs in the USVI, Puerto Rico, and Florida. More storms hit Florida
2402 than any other U.S. state, and since 1851 only eighteen hurricane seasons have passed without a known
2403 storm impacting the state, with a cumulative impact from the storms totaling over \$191 billion in damage
2404 (2017 USD) (Pasch et al., 2019).

2405 Coral jurisdictions in the Pacific are also subject to tropical storm system impacts. In American Samoa,
2406 these systems usually form when sea surface temperatures are at their highest, during the months of
2407 November through May. The CNMI is centrally located in the most prolific tropical cyclone basin.
2408 Coastal flooding, inundation, and inland flooding from tropical typhoons and monsoon surges pose the
2409 greatest acute threat to the CNMI's communities, watersheds, and reef ecosystems. Similarly, Guam has
2410 been hit by four typhoons with sustained winds greater than 150 mph since 1994. Although Guam has
2411 been spared a direct hit by a typhoon-strength storm since Super Typhoon Pongsona in December 2002,
2412 storm systems regularly pass close to the island (U.S. Naval Oceanography Command Center, 1990).

2413 The impacts of tropical storms on coral reefs vary. Storm surges can result in the grounding of vessels and
2414 loss of fishing gear, which physically damages coral reefs. High wave energy, coupled with storm surges,
2415 may cause coral to break or overturn. Although such physical damage can be bad for corals,
2416 fragmentation of certain types of corals, such as branching corals, facilitates asexual reproductive success.
2417 Furthermore, severe storms can also transport marine debris that could physically damage corals. Storms
2418 may also increase suspension of sediments, erosion, and transport of inland sediments and debris via
2419 rivers swollen from large precipitation events, all of which negatively affect coral directly, via
2420 smothering, and indirectly, through reduced water clarity and salinity. The heavy precipitation can be
2421 exacerbated by urban runoff, failing sewage systems, unpaved roads, farms, land clearing and
2422 development, increasing the consequences for culturally significant fishing activities, marine-related
2423 tourism, and overall reef resilience (World Bank Organization, 2017). However, during periods of high
2424 water temperature, heavy precipitation from storms can cool temperatures, thus reducing the extent of
2425 coral bleaching and enabling conditions that allow for recovery from bleaching.

2426 3.2.2.3 Disease

2427 Corals are affected by an array of diseases, which can cause mortality on an ocean-basin scale. In the
2428 Caribbean, coral diseases include white plague-II, yellow band disease, white band, black band, white
2429 pox, red band, Caribbean ciliate infection, dark spots disease, fungal aspergillosis, and tumors. These
2430 diseases are especially prevalent during times of stress (e.g., bleaching), as demonstrated in 2005 when a
2431 bleaching event coincided with a 2,530% increase in disease lesions, a 770% increase in denuded
2432 skeletons, and a loss of 51.5% live coral cover in the USVI (Miller et al., 2006) and intense outbreaks of
2433 white plague-II and yellow band disease mainly affecting *Montastraea*, *Diploria*, and *Colpophyllia*
2434 species in Puerto Rico (Garcia-Sais et al., 2008).

2435 Numerous diseases have been documented with increasing frequency since the first reports of coral
2436 disease in the Florida Keys emerged in the 1970's (e.g., Porter et al., 2001). The Florida Reef Tract is
2437 currently experiencing one of the most widespread and virulent disease outbreaks on record: stony coral
2438 tissue loss disease (Sharp & Maxwell, 2018). This disease is one previously unknown and its outbreak has
2439 resulted in the mortality of thousands of colonies of at least 20 species of scleractinians, including
2440 primary reef builders and ESA-listed species (Sharp & Maxwell, 2018). The disease was first reported
2441 near Key Biscayne in 2014 (Precht et al., 2016) and progressed southward along the Florida Reef Tract,
2442 reaching Key West by December 2017 (Sharp & Maxwell, 2018). The disease has since spread to St.
2443 Thomas in USVI, Bahamas, Jamaica, Mexico, and likely other locations throughout the Caribbean. A
2444 limited understanding of the disease outbreak, due to limited diagnostic capacity, and its mode and rate of
2445 transmission, has greatly hindered management efforts to control or prevent the spread of the disease
2446 (Sharp & Maxwell, 2018).

2447 In the Pacific, coral populations continue to be spared from epidemic disease outbreaks. However, a 2003
2448 survey (N=73) of the Northwestern Hawaiian Islands found ten types of coral diseases (Aeby, 2006). The
2449 coral diseases were found at most of the survey sites (68.5%) but at low levels of occurrence with an
2450 average of 0.5 % colonies showing signs of infection (Aeby, 2006). Additional surveys in 2004 and 2005
2451 identified 12 coral diseases across the Hawaiian Archipelago (Aeby, 2011). These diseases included
2452 *Porites* growth anomalies, *Porites* trematodiasis, *Porites* multi-focal tissue loss, *Porites* discolored tissue
2453 thinning syndrome, *Porites* brown necrotizing disease, *Porites* bleaching with tissue loss, *Montipora*
2454 multifoci tissue loss syndrome, *Montipora* white syndrome, *Montipora* patchy tissue loss, *Montipora*

2455 growth anomaly, *Acropora* white syndrome, and *Acropora* growth anomaly (Aeby, 2006; Aeby, 2011).
2456 Later, a 2004 disease outbreak around Kauai was determined to be black band disease (Aeby et al., 2015).
2457 *Montipora* white syndrome, which causes acute tissue loss, has been documented throughout the main
2458 Hawaiian Islands; however, prevalence of this disease is approximately four times higher in Kaneohe
2459 Bay, Oahu (average prevalence=0.27 + 0.08% SE) than in the other main islands (Friedlander et al.,
2460 2008).

2461 Coral diseases in American Samoa are widespread and present on regularly monitored coral reefs, though
2462 only a very small proportion (0.14%) are affected, with the most common disease being the white
2463 syndrome, similar to that found on the Great Barrier Reef (Fenner, 2019). Likewise, white syndrome
2464 appears to be the most prevalent disease in Guam (observed in nine out of 10 sites) and the source of
2465 greatest tissue mortality, though black band disease, brown band disease, ulcerative white spots, and
2466 multiple growth anomalies are also present on Guam reefs (Burdick et al., 2008; Cheney, 1977;
2467 Raymundo et al., 2003).

2468 **3.2.3 Ridge to Reef Habitats**

2469 CRCP-supported activities occur in some inland habitats affecting marine or estuarine waters. They may
2470 also affect adjacent or continuous habitats that support living coastal and marine resources. Habitats and
2471 their geological and soil resources that may be impacted vary among and within jurisdictions and include
2472 sandy beaches, cays/keys, rocky coastlines, mud bottoms, and many other types of substrates and source
2473 materials. Geologic features and soils depend on location, local physical geography, climate, geologic
2474 activity level, and a number of other attributes. A general description of the types of habitats in the
2475 affected areas follows.

2476 **3.2.3.1 Riparian and Upland Habitat**

2477 The riparian zone is defined by the area within the floodplain or a zone hydrologically influenced by a
2478 stream or river (Hunt, 1988). Riparian environments are maintained by high water tables and experience
2479 seasonal or periodic flooding. The characteristics of the riparian zone vary between regions, river and
2480 watershed size, and stream order. Riparian habitat may also contain or adjoin riverine wetlands and share
2481 with them functions including water storage, sediment retention, nutrient and contaminant removal, and
2482 maintenance of habitat for plants and animals. These ecosystems have distinctive vegetation and soils,
2483 and are characterized by the combination of species diversity, density, and productivity. There are
2484 continuous interactions between riparian, aquatic, and upland ecosystems via the transfer or exchange of
2485 energy, nutrients, and species (National Research Council, 1995).

2486 **3.2.3.2 Beaches and Dunes**

2487 Sandy beaches include sandy bluffs, embayments, barrier islands, and dunes consisting of fine to coarse
2488 (diameters from 0.5 mm to 2 mm) sediments and may contain substantial amounts of shell fragments.
2489 They are naturally unstable due to constant action of waves, currents, and winds, with sand seasonally
2490 moving offshore and onshore. These beaches exhibit low species diversity, but high densities of those
2491 tolerant species, like some invertebrates, that can withstand the high-energy conditions.

2492 Sand dunes form when wind and waves push sand above the mean high water level where it is trapped by
2493 coarser sediments or vegetation. Dunes mature via plant succession, with small, salt-tolerant pioneer
2494 species overtaken by woodier species to form maritime forests, if given a stable environment. Dunes
2495 provide habitat for organisms including seabirds and sea turtles that rely on beaches for nesting habitat.

2496 3.2.3.3 *Mudflats*

2497 Mudflats are level and unvegetated areas adjacent to shorelines or islands, often backed by sandy beaches
2498 or marshes and occur in areas where general circulation results in sediment deposition (Thayer et al.,
2499 2003). Composed of fine-grained sediments and covered with shallow-water at low-water tidal areas
2500 where exposure to the air is temporary, they provide both burrowing habitat for invertebrates and feeding
2501 grounds for birds and fish (Mitsch & Gosselink, 2000). Mudflats provide key substrata for biofilms, or
2502 communities of microorganisms (collectively called microphytobenthos) embedded in a matrix of
2503 polymeric compounds, which are dominated by photosynthetic microalgae, mostly diatoms (De Brouwer
2504 & Stal, 2001). These biofilms provide food source for snails and other invertebrates, a few species of
2505 fish, and shorebirds. Disruptive events, can have a major impact on these microscopic communities and
2506 impact the mudflat ecosystem as a whole.

2507 3.2.3.4 *Subtidal Bottom*

2508 Subtidal bottoms below the low tide line can be either hard or soft substrates. They are composed of
2509 unconsolidated fine- to coarse-grained sediments. Located adjacent to beaches or other sediment sources
2510 (Thayer et al., 2003), they can support a diversity of fauna, depending on factors including the type of
2511 substrate (i.e., sand or mud), content of organic matter, and depth. Many subtidal bottoms are dominated
2512 by infaunal invertebrates, including polychaete worms, crustaceans, echinoderms, and mollusks.

2513 Subtidal bottom ecology is sensitive to pollution, such as wastewater discharge, that alters levels of
2514 organic and small particulate material. The often vague physical distinction between sand and mud
2515 habitats creates overlap in species distributions. The species assemblages of the subtidal soft bottom are
2516 divided into offshore eelgrass bed, subtidal mud, and subtidal sand ecotypes (Ricketts et al., 1985).

2517 3.2.3.5 *Soft-Bottom Habitat*

2518 Soft-bottom habitat is formed by unconsolidated sediments that lack vascular plants (i.e., seagrasses).
2519 Although soft-bottom habitat lacks visible structural features, many microscopic plants occur at the
2520 sediment surface and burrowing invertebrates, such as polychaetes and crustaceans, commonly occur
2521 below the surface (Peterson, 1979; Alongi, 1990). Soft-bottom habitats provide ecological services to
2522 coastal ecosystems, such as biogeochemical processing and recycling of watershed-derived nutrients and
2523 toxic substances (Peterson & Lubchenco, 1997) in addition to foraging habitat for many fishery species
2524 and their prey. The high availability of food and refuge for predators make soft-bottom habitats,
2525 especially those in shallow-waters and close to mangroves, seagrass, live/hard bottom, or inlets, important
2526 nursery areas for many species of juvenile fish (Ross & Epperly, 1985). Flatfishes, rays, and small cryptic
2527 species, such as shrimp and crabs, can bury in the sediment, camouflaging themselves from predators
2528 whereas predators in shallow-water also bury themselves, relying upon ambush tactics for feeding.
2529 Consequently, many fishes, crabs, and shrimp in subtidal, soft bottom habitats forage nocturnally
2530 (Summerson & Peterson, 1984).

2531 3.2.3.6 *Hard-Bottom Habitat*

2532 Hard-bottom constitutes a group of communities characterized by a thin veneer of corals or other sessile,
2533 benthic organisms that secrete a skeleton or shell (alive or dead) and other biota overlying assorted
2534 sediment types. Hard bottom usually has low relief and is on the continental shelf (Bright et al., 1991) and
2535 many are associated with relic reefs where the coral veneer is supported by coquina, limestone, or relic
2536 coral, molluscan, and annelid reefs. Diverse biotic zonation patterns have evolved in many of these

2537 communities because of their geologic structure and geographic location. Species compositions may vary
2538 dependent upon water depth and associated parameters (light, temperature, etc.) (NOAA, 1998).

2539 3.2.3.7 Coral Reefs

2540 The U.S. has jurisdiction over an estimated 19,700 km² of coral reefs, not including the Freely Associated
2541 States (Turgeon et al., 2002). Twenty-two coral species from the Caribbean and Indo-Pacific regions are
2542 listed under the ESA (Appendix E). Coral reefs provide habitat for thousands of species of fish and
2543 shellfish and hundreds of species of corals, algae, sponges, echinoderms, mollusks, bryozoans,
2544 crustaceans, and many other groups of organisms (Reaka-Kudla, 1997). Therefore, the health of coral
2545 reefs has profound implications on these species and on the marine ecosystem as a whole. Some of the
2546 functional roles of coral reefs and associated habitats include:

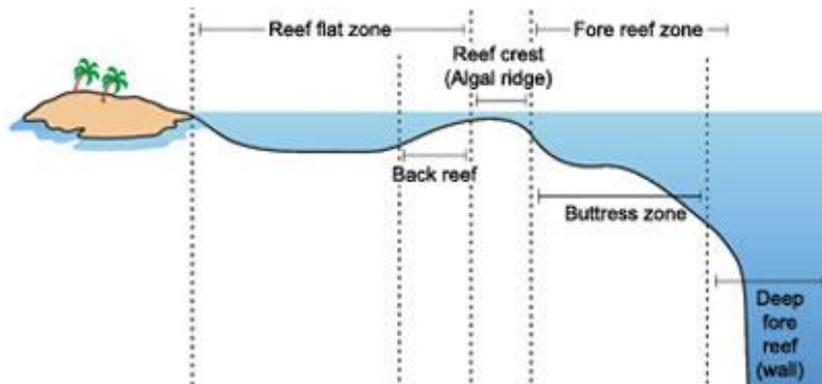
- 2547 ● Complex, high-relief habitat that serves as refuge for motile fish and invertebrates and
2548 microhabitats for cryptic fauna and flora;
- 2549 ● Breeding, feeding, and nursery habitats for a variety of marine species;
- 2550 ● Hard substrate for settlement and growth of sessile organisms;
- 2551 ● Enhancement of global biogeochemical cycles including a storehouse of carbon dioxide;
- 2552 ● High productivity based on sunlight and coral/zooxanthellae symbiosis that supports a complex
2553 food web;
- 2554 ● Repository of marine biodiversity with potential medicinal use substances;
- 2555 ● Recreational opportunities, such as diving and snorkeling;
- 2556 ● Protection for coastal areas from strong wave action and full impacts of storms, of which they
2557 absorb 97% (Ferrario et al., 2014); and
- 2558 ● Natural recorders of past climate and environmental variation.

2559 The CRCP focuses on shallow-water coral reefs, whose location makes them especially vulnerable to the
2560 constant oceanographic forcing of currents, waves, and tides whose energy is greatest in shallow depths.
2561 These corals require proximity to the ocean surface for exposure to sunlight, which drives photosynthesis
2562 within their dinoflagellate symbionts, providing nutrients essential for coral growth and reproductive
2563 processes (Muscatine et al., 1977). Generally, shallow-water corals require fully marine waters, stable and
2564 warm temperatures, low wave energy and turbidity, ample sunlight, and the presence of suitable
2565 substratum. Coral reef systems are often strongly linked to upstream freshwater and terrestrial systems
2566 and, therefore, cannot be treated as completely independent from separate from these watersheds and
2567 shorelines (Virginia Institute of Marine Science, 1975). These associated catchments' health is influential
2568 to that of coral reefs.

2569 Shallow-water reef-building corals are tiny individual polyps that cluster together to form larger coral
2570 colonies. A typical coral reef is composed of complexes of coral colonies and other organisms that
2571 construct a calcium carbonate (limestone) structure. Living corals and other benthic organisms form a thin
2572 veneer that overlies this limestone framework that has been deposited over thousands of years by previous
2573 reef-building individuals. This structure is solidified by the combined processes of cementing crustose
2574 coralline algae, mechanical action of waves, bioerosion from boring sponges and other organisms, and the
2575 chemical action of rainwater. Reef-building stony corals are the predominant organisms responsible for
2576 most of the reef's framework growth, followed by crustose coralline algae on wave exposed reef slopes,
2577 and green algae (e.g., *Halimeda* spp.) in back reef and lagoonal depositional zones (Zundelevich et al.,
2578 2007).

2579 Coral reefs can be broadly classified into four types (Darwin, 1889): fringing reefs, which grow close to
2580 shorelines and generally have a high degree of non-carbonate sediment; barrier reefs, which are offshore
2581 and have a high degree of consolidated limestone sediments; atolls, which are a wall of reefs that encloses
2582 a central lagoon; and those which do not fall into any of these classifications, such as platform, pinnacle,
2583 and patch reefs. Coral reefs may be further described by their geomorphology and predominant biotic
2584 communities. Eleven geform types of shallow-water and mesophotic coral reefs include aggregate coral
2585 reef, shallow/mesophotic coral carbonate mound, coral head/bomme, coral pinnacle, fragile mesophotic
2586 coral reef, fringing coral reef, halo, linear coral reef, patch coral reef, and spur and groove coral reef
2587 (FGDC, 2012).

2588 For most coral reef types, there are distinct zones, defined by differences in depth, wave energy, currents,
2589 light, temperature, and sediment (Figure 3-2). The zone closest to shore is broadly called the reef flat,
2590 comprised of the lagoon and back reef areas. Shallow-waters in the reef flat are protected from waves
2591 behind the reef crest and experience a large range in temperature and salinity and accumulate sediments.
2592 Coral growth in this zone is limited by these extreme conditions. Despite low coral cover and extreme
2593 swings in environmental conditions, this reef flat is a haven for marine species (NOAA, 2017a).



2594 Figure 3-2. A diagram showing the different zones of a coral reef system.
2595 Source: *Cayman Islands Twilight Zone 2007 Exploration*, Kyle Carothers, NOAA-OE
2596

2597 The reef crest protects the lagoon and is the highest point of the reef and absorbs the constant wave action
2598 from the open sea. Encrusting algae are prevalent, constantly repairing the wave damage to strong,
2599 closely-knit corals, which brace against the waves. This structure provides shelter to marine species
2600 seeking refuge.

2601 Beyond the reef crest is the fore reef, comprised of the buttress zone and reef wall. Corals protrude
2602 seaward and create wave-reflecting vertical channels that help to drain sediments. As the buttress drops
2603 off to the reef wall, light and wave energy diminish and sediments increase with depth.

2604 While most of the reef environment is depositional, the seaward growing portion of the reef is essential
2605 for the survival and maintenance of the rest of the reef system (Hoegh-Guldberg, 1999). Coral reefs
2606 predominate in many tropical benthic environments because of their ability to grow or maintain structures
2607 in the face of heavy or prevailing wave action. Coral may predominate a habitat (coral reefs), be a
2608 component of a habitat (hardbottom), or exist as individuals within a community characterized by other
2609 fauna (solitary corals) (GMFMC, 1998; NOAA, 2011).

2610 Two of the main outputs of reefs are organic and inorganic carbon production. Reef organisms fix carbon
2611 for the production of their skeletons. The resulting skeletal structure provides a substrate for the
2612 settlement and attachment of other sessile organisms, as well as topographical relief that serves as habitat
2613 for motile fishes and invertebrates. Coral and algal skeletal materials are also broken down into sediments
2614 that form beaches and soft bottom habitats, are incorporated into the reef structure, and form an important
2615 part of the inorganic carbon pathway. Primary production of organic carbon by symbiotic zooxanthellae,
2616 turf algae, macroalgae, and coralline algae supports the diverse organisms and complex food webs found
2617 on coral reefs. Through herbivore grazing and dislodgement, turf algae and frondose algae are maintained
2618 in an early stage of growth and ecological succession where rates of photosynthesis and growth are
2619 highest. Secondary consumers (predators of herbivorous fishes and invertebrates) further enhance reef
2620 productivity by maintaining their prey in high growth phases and by supplying concentrated nutrients to
2621 their prey (McClanahan et al., 2002).

2622 ***3.2.4 Environmental Quality***

2623 *3.2.4.1 Water Resources and Quality*

2624 Water quality is a generic term that describes the relationship between concentrations of various chemical
2625 and physical contaminants or pollutants and the ability of water resources to support their ecosystems
2626 adequately. Water quality is a function of many factors, including nitrogen, phosphorus, chlorophyll a,
2627 dissolved oxygen content, and water clarity.

2628 Water resources in the areas that could be affected by CRCP-supported projects include surface waters
2629 and groundwater. Surface waters include marine waters (oceanic), which support tidally influenced water
2630 bodies (such as estuaries), coastal wetlands, coral reefs, mangrove forests, and upwelling areas, among
2631 others. Nontidal freshwater resources include those inland rivers, streams, and their corresponding
2632 floodplains, in addition to lakes and ponds. Water resources also are affected by or associated stormwater
2633 runoff (point and nonpoint releases), which can directly and indirectly affect water quality.

2634 The ocean waters (Pacific and Atlantic, including the Gulf of Mexico and Caribbean Sea) that border the
2635 U.S. coral jurisdictions are saline (marine) to varying degrees. These marine waters are the primary
2636 medium for living coastal and marine resources and comprise the bulk of essential fish habitat (Section
2637 3.4.2 - Regulatory Environment). Marine water quality is altered by point and nonpoint source pollution
2638 from agricultural and stormwater runoff and wastewater discharge. Pollution, including eutrophication
2639 and sedimentation associated with land-based activities, has been associated with the degradation of water
2640 quality and coral reef health and diversity (LaPointe et al., 2010). Some of the sources of land-based
2641 pollution include: improper coastal development, road construction, dredging and beach renourishment,
2642 land clearing for agriculture, golf course irrigation, discharge of untreated sewage, industrial waste,
2643 agrochemicals, and pharmaceuticals, and chemical and oil spills. Pollution not only affects the physical
2644 environment and the numbers of species and individuals that live in these waters, but also impacts human
2645 welfare through the exposure to contaminants, through possible consumption of exposed fish/shellfish
2646 and swimming, and the loss of recreational and commercial opportunities (EPA, 2004).

2647 While excess nutrients are generally a problem for coral reefs, a continuous supply of inorganic nutrients
2648 is essential for maintenance of metabolic processes, the proper functioning of reef ecosystems, and the
2649 persistence of coral- and coralline algae-predominated communities. Many coral reefs occur in regions
2650 subjected to seasonal upwelling or other natural events that contribute temporary pulses of nutrients.

2651 Nutrient fluxes associated with upwelling events, currents, tides and other sources can play an important
2652 role in overall productivity of coral reefs. Furthermore, reefs can persist in areas affected by nutrient
2653 loading, provided that the herbivores are sufficiently abundant and diverse to control the proliferation of
2654 macroalgae and cyanobacteria (Holbrook et al., 2016).

2655 Estuaries are generally enclosed in part by the coastline, marshes, and wetlands; the seaward border may
2656 be barrier islands, reefs, and sand flats or mud flats. These areas of transition between the land and the sea
2657 are tidally driven, but, like rivers, they are sheltered from the full force of ocean wind and waves.
2658 Estuaries are biologically productive and directly support many species of plants, animals, birds, and fish,
2659 while also sequestering and storing substantial amounts of carbon from the atmosphere, particularly in
2660 their vegetated coastal wetlands. Bodies of water that may be estuaries include bays, harbors, sounds, and
2661 inlets. Nontidal surface waters include any lakes, ponds, rivers and streams that support diadromous fish
2662 or are hydrologically connected to coastal, marine, estuarine resources, or wetlands.

2663 Groundwater is water beneath the land surface. It interfaces with surface waters and supplies streamflow
2664 during periods between rain events. Groundwater discharge is a large source of input to many tidal and
2665 nontidal water resources (including rivers, streams, and estuaries) and influences the overall water quality
2666 in these areas. Groundwater quality can be compromised in many ways, including spills and seepage from
2667 buried disposal areas (e.g., landfills) and from failing septic systems.

2668 Floodplains are adjacent to stream channels that may be inundated during periods of high water (Linsley
2669 et al., 1982) and are composed of sediments deposited by these streams. Floodplains include a floodway
2670 (the width of the river that must be reserved to discharge the 100-year flood without increasing the water
2671 surface by more than 1 ft) and a flood fringe (the area of the floodplain outside the floodway that is
2672 susceptible to flooding). A 100-year flood is the flood elevation with a one percent chance of being
2673 equaled or exceeded in any one year (FEMA, 2004). Development and agricultural activities within
2674 floodplains may alter the water flow and may increase flooding and runoff. Agricultural inputs to coastal
2675 waters reportedly affect approximately 25% of the total global reef area around the globe (Kroon et al.,
2676 2014). Floodwaters can transport sediment, pollution, nutrients, pathogens, and debris from the floodplain
2677 to coastal areas, which can decrease water quality, increase turbulence, block waterways, and may also
2678 put human life and property at risk.

2679 Stormwater refers to water flows caused by heavy precipitation rates or volumes that exceed the ability of
2680 the ground to absorb it, with excess flowing downslope. In many locations across the U.S., stormwater
2681 has been diverted into marine, estuary, and freshwater bodies. The results could lead to an overall loss of
2682 ecological value due to declining water quality associated with constituents in the runoff. Chemical
2683 contamination (including metals and organic substances from urban, agricultural, and industrial sources)
2684 of water bodies and sediments has also resulted in declining water quality, affecting marine, estuarine,
2685 and freshwater resources (EPA, 2004).

2686 Domestic and industrial wastewater discharges (sewage) are reportedly the largest component of coastal
2687 pollution due to poorly or untreated discharge or stormwater runoff (Wear & Thurber, 2015). Stressors
2688 from domestic and industrial wastewater and associated responses increased bleaching, reduction in coral
2689 growth rates, disease, reduced photosynthesis of coral symbionts, reduced coral species richness, lethal
2690 and sublethal impacts to corals (Wear & Thurber, 2015). Although the amount of domestic and industrial
2691 wastewater discharged into tropical oceans is difficult to quantify, 104 of 112 coral reef areas, including

2692 territories, states, and countries, have documented sewage contamination and most occur as direct ocean
2693 discharge (only three of the 112 geographies are uninhabited and therefore have no potential for direct
2694 sewage contamination) (Wear & Thurber, 2015). While other stressors can increase susceptibility to
2695 infection, sewage provides a mechanism for rapid delivery and disease progression (Wear & Thurber,
2696 2015).

2697 3.2.4.2 Air Quality

2698 In the U.S., National Ambient Air Quality Standards have been developed to evaluate the acceptable
2699 levels of sulfur dioxide, carbon monoxide, ozone, nitrogen oxides, lead, and inhalable particulate matter.
2700 Local air quality can be assessed through carbon monoxide and inhalable particulate matter, while the
2701 remaining pollutants are associated with regional air quality stemming from widely dispersed sources of
2702 pollution. Air quality can be altered by anthropogenic and natural sources such as African dust, volcanic
2703 dust, wildfires, aerosols, and fossil fuels.

2704 Also, hundreds of millions of tons of eroded mineral soils (dust) are carried in the atmosphere from the
2705 Sahara Desert and Sahel in Africa to the western Atlantic and Caribbean Sea (Rothenberger et al., 2008).
2706 Over the past 40 years, the quantity of dust has increased, and the composition of the dust cloud has been
2707 altered due to pesticide use, changes in land use, and burning of synthetic materials and biomass (fuel) in
2708 the dust source regions and in the areas over which they pass (Garrison et al., 2003; 2005). An
2709 international team of scientists led by the U.S. Geological Survey is examining the contaminants carried
2710 with African dust and the role they may play in the degradation of Caribbean coral reefs and other
2711 downwind ecosystems (Shinn et al., 2000; Garrison et al., 2003; 2005). Thus far, African dust has been
2712 found to carry viable microorganisms, including pathogens, nutrients such as iron, persistent organic
2713 pollutants and heavy metals (Rothenberger et al., 2008). A coral disease pathogen, the fungus *Aspergillus*
2714 *sydowii*, has been identified in dust (Weir-Brush et al., 2004). Pesticides, polycyclic aromatic
2715 hydrocarbons, and polychlorinated biphenyls have been identified in African dust air masses in the
2716 Caribbean (USVI and Trinidad) and in Africa (Garrison et al., 2005). These contaminants are known to be
2717 toxic at very low concentrations, to persist in the environment, to bioaccumulate in organisms, and to
2718 interfere with reproduction and immune function. Some of these contaminants are known to shut down
2719 phytoplankton photosynthesis (Wurster, 1968).

2720 Motorized vessels are also a source of air pollutants around coral reefs through the release of combustion
2721 products into the atmosphere. Anthropogenic sources of aerosols can reduce the growth rate of corals by
2722 enhancing reflective conditions through scattering sunlight and increasing clouds (Kwiatkowski et al.,
2723 2013).

2724 3.2.4.3 Acoustic Environment

2725 Healthy coral reef ecosystems are noisy environments. Many coral reef inhabitants produce an array of
2726 sounds for defense or territorial displays, feeding, schooling, courtship, or spawning, which can vary
2727 based on the time of day, lunar cycle, and seasonally (Lammers et al., 2008, Tricas & Boyle, 2014;
2728 Staaterman, 2014). Natural coral reef sounds, including wind, rain, and waves, may provide cues for
2729 larval settlement (Montgomery et al., 2006; Vermeij et al., 2010; Radford et al., 2011) and nocturnal
2730 movement (Montgomery et al., 2006; Simpson et al., 2008). Anthropogenic sounds, such as motor boats,
2731 hammer use, hydrographic surveys, and shipping, can interfere with the natural cues and the behavior reef
2732 inhabitants (Weilgart, 2018). Motor boats sounds have been shown to disrupt orientation behavior of
2733 settling fish larvae (Holles et al., 2013), increase metabolic rate (oxygen intake), and increase fish

2734 mortality by predation (Simpson et al., 2016). However, there is recent evidence that has shown that
2735 juvenile reef fish can become tolerant to repeated exposure to motor boat sound (Nedelec et al., 2016).
2736 More substantial acoustic stressors, such as seismic surveys, pile driving, and military testing and
2737 training, could lead to behavioral and injurious impacts of marine biota (U.S. Department of the Navy,
2738 2018; 83 FR 36773).

2739 **3.3 Biological Environment**

2740 This section describes, generally, the organisms that may inhabit areas affected by CRCP activities. These
2741 areas stretch from the ridges of riparian habitat to the coral reefs and coral reef-associated ecosystems.
2742 Corals reefs ecosystems are known for their high species diversity. This section is organized by functional
2743 groups to provide the necessary context for how CRCP activities may impact them.

2744 **3.3.1 Primary Producers**

2745 Primary producers are those organisms that are able to fix carbon via chemosynthetic or, more commonly,
2746 photosynthetic processes. This group is dominated by phytoplankton, cyanobacteria, macroalgae (e.g.,
2747 kelps and seaweeds), coralline algae (which are important for suitable habitat for coral recruitment),
2748 seagrasses, and mangroves. Corals, which leverage a symbiotic relationship with photosynthesizing
2749 dinoflagellates (unicellular algae) called zooxanthellae, can also be included within this group. Primary
2750 producers not only provide the food source necessary to sustain the ecosystem, but also contribute to
2751 habitat structure that provides shelter and favorably alters oceanographic processes to promote the
2752 settlement of many organisms on coral reefs. Left unchecked by herbivory, some primary producers may
2753 negatively affect the surrounding environment (Burkepile & Hay, 2010; McManus & Polsenberg, 2004).
2754 For example, certain algal species may outcompete corals, smothering them and causing a paradigm shift
2755 in the nature of the ecosystem (Done, 1992; Hughes, 1994; Hughes et al., 2007). Nutrient-enriched waters
2756 can lead to massive blooms of algae and cyanobacteria in the water column, which reduce light
2757 penetration and whose death and decay may create oxygen-depleted areas.

2758 *3.3.1.1 Phytoplankton and Algae*

2759 Microscopic marine plants (phytoplankton), bacteria (e.g., cyanobacteria), and other organisms form the
2760 base of the pelagic food web. Many species of phytoplankton inhabit coral reef systems, and marine life is
2761 highly dependent on their growth and productivity. Their numbers, biomass, and production vary greatly
2762 both spatially and temporally.

2763 Algae in coral reef systems include zooxanthellae, microalgae, and macroalgae, which include coralline
2764 algae (both crustose and branching forms). The coral polyp provides habitat, carbon dioxide, and nutrients
2765 for zooxanthellae, while the algae provide the polyps with oxygen and carbohydrates, among other mutual
2766 benefits. Coralline algae are important in reef formation, cementing rubble together to form stable
2767 substrate (Skelton, 2003), and some species release chemicals prompting larval coral settlement (Tebben,
2768 2015). These macroalgae are the primary spatial competitor to coral reefs.

2769 *3.3.1.2 Seagrasses*

2770 Submerged grasses or seagrasses differ from most other wetland plants in that they are evolved from
2771 terrestrial plants and adapted to living in almost exclusively subtidal areas, reside mainly in marine
2772 salinities, and use the water column for support although they may be exposed to the air during very low
2773 tides. Seagrasses occur across a wide depth range, from rocky intertidal habitats to depths of 40 meters,

2774 and across broad latitudinal ranges (Spalding et al., 2003; Orth et al., 2006). Distribution patterns are
2775 influenced by physical (waves, currents, tides), geological (sediment grain size), and geochemical factors
2776 (Koch, 2001). Waters with good light penetration facilitate seagrass colonization.

2777 Seagrass roots and leaves dampen waves and slow currents, enhancing sediment stability and increases
2778 the accumulation of organic and inorganic material, and provide horizontal and vertical complexity to
2779 habitat, which, together with abundant and varied food sources, support densities of fauna generally
2780 exceeding those in un-vegetated habitats (Wood et al., 1969; Thayer et al., 1984).

2781 Seagrass beds are nurseries for reef-associated fishes and invertebrates and harbor a wide range of
2782 benthic, demersal and pelagic organisms. This includes permanent residents, which spawn and spend
2783 most of their lives in seagrass beds, as well as transient species. Transient species either leave seagrass
2784 beds only to spawn or move between habitats on a daily basis, using seagrass beds for food or shelter.
2785 Additional transient species seek food and shelter in seagrass beds during their juvenile stage, and move
2786 to other habitats as sub-adults or adults (Parsons et al., 2015).

2787 Seagrasses are very productive ecosystems that store and sequester substantial amounts of carbon
2788 belowground in soils at very high rates, commonly known as ‘blue carbon’ (Duarte et al., 2010; Donato et
2789 al., 2011; McLeod et al., 2011; Fourqurean et al., 2012). Such carbon sequestration makes these
2790 ecosystems approximately equivalent to terrestrial forests in their ability to serve as carbon sinks, despite
2791 having a much smaller geographic footprint (McLeod et al., 2011).

2792 Since 1980, seagrass loss has been at a rate of 110 km² yr⁻¹, which is comparable to other important
2793 ecosystems, such as coral reefs and rainforests (Waycott et al., 2009). Factors contributing to the loss of
2794 seagrass include a broad spectrum of natural and anthropogenic causes, such as the direct effects of
2795 disease outbreaks, destructive fishing practices, boat propellers, coastal constructions, cyclones and other
2796 storms, and tsunamis; and the indirect effects from land-based sources of pollution, aquaculture, invasive
2797 species introductions, and trophic cascades caused by overfishing of predators (Waycott et al., 2009).

2798 There are seven native species of seagrass in the Caribbean: turtle grass (*Thalassia testudinum*), manatee
2799 grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), widgeon grass (*Ruppia maritima*),
2800 *Halophila baillonii*, *H. engelmanni*, and paddle grass (*H. decipiens*) (Seagrass Watch, 2019). Turtle grass,
2801 manatee grass, shoal grass, widgeon grass, and paddle grass are all found throughout the Caribbean, with
2802 turtle grass being the most predominant. Manatee grass is often intermixed with turtle grass; shoal grass
2803 typically grows on sand and mud from the intertidal zone to five m (16 ft) deep; widgeon grass is in the
2804 brackish waters from 0-2.5 m (0-8.2 ft); and paddle grass is found 1-58 m (3-190 ft). *H. engelmanni* is
2805 found in the Bahamas, Florida, the Greater Antilles, and the western Caribbean down to 5 m (16 ft), and
2806 *H. baillonii* is only in the Lesser Antilles (Seagrass Watch, 2019). Johnson’s seagrass (*Halophila*
2807 *johnsonii*), listed as threatened under the ESA, is found in lagoonal water along southeastern Florida from
2808 Sabastian Inlet to northern Biscayne Bay (NMFS, 2002). *H. stipulacea* is an invasive species found in the
2809 Caribbean but is native to the Red Sea and parts of the Indian Ocean (Willette & Ambrose, 2012). *H.*
2810 *stipulacea* forms monoculture beds in addition to interspersing with native populations of seagrasses and
2811 covers more than 100,000 m² of seafloor, ranging from the low tide line to 50 m (164 ft) depth (Willette
2812 & Ambrose, 2012).

2813 Seagrass populations are more discrete in the U.S. Pacific jurisdictions. In American Samoa, surveys of
2814 the splash zone to 20 m (66 ft) depth, found two species of paddle weed (*Halophila ovalis* and *H. minor*),

2815 which differ only by the number of veins morphologically (Skelton, 2003). Guam and CNMI have three
2816 species of seagrasses: *H. uninervis*, *Enhalus acoroides*, and *H. minor* (Lobban & Tsuda, 2003). Hawaii
2817 has two native species of seagrasses *H. hawaiiiana*, which is endemic to Hawaii, and *H. decipiens*.

2818 3.3.1.3 Mangroves

2819 Of tremendous importance to the function of coral reefs is their proximity to other associated
2820 communities, such as seagrass beds and mangroves (Mumby et al., 2004; Nagelkerken et al., 2000).
2821 Mangrove trees inhabit saltwater or brackish water in the coastal intertidal zone in the tropics and
2822 subtropics along protected coastlines, away from the direct action of waves (Kathiresan & Bingham,
2823 2001). They have developed special adaptations to survive the variable flooding and salinity conditions
2824 imposed by the coastal environment and act as a buffer between the land and sea, trapping much of the
2825 soil and nutrients that runoff from land (Kathiresan & Bingham, 2001). In addition, mangroves store and
2826 sequester substantial amounts of “blue” carbon (Donato et al. 2011; McLeod et al. 2011), both in
2827 aboveground biomass and belowground in soils at high rates.

2828 Mangrove ecosystems are often coupled to other systems, such as seagrass beds and coral reefs, and
2829 support fish, invertebrates, and birds. Mangroves provide important nursery habitat for reef fish, such as
2830 the rainbow parrotfish (*Scarus guacamaia*) and goliath grouper (*Epinephelus itajara*) (Koeing et al.,
2831 2007; Dorenbosch et al., 2006). Most of the production in mangroves is associated with the microbial
2832 community in the sediments, which breaks down the organic matter from land and leaves that fall off the
2833 trees, and is largely exported to reef communities where it is utilized as a nutrient source. Mangrove
2834 communities may also support large resident and migratory populations of mammals, reptiles, and other
2835 animals (Alongi, 2002).

2836 A trend analysis indicated that mangrove losses across the U.S. have ranged between 14-57% from 1980-
2837 2005 compared to a worldwide reduction of 3.6 million ha, or 20% over the same 25 year period (FAO,
2838 2007). Previous mangrove degradation and loss in the USVI was due to unsustainable development of
2839 tourism industries and related infrastructure; this trend has been reversed in favor of mangrove protection
2840 (FAO, 2007). Puerto Rico, with increased legal protection, colonization of new areas, and restoration of
2841 agricultural land back to mangroves, has actually experienced a net increase of 18% in mangrove area
2842 since 1980 (FAO, 2007). In Florida, mangrove ecosystems have been negated via drainage for agriculture,
2843 reclamation for urban development, and canalization, though large mangrove areas are protected in
2844 southern Florida, most notably within Everglades National Park, and laws have been enacted for the
2845 protection and sustainable utilization of mangroves (FAO, 2007). Mangroves in Guam been lost to
2846 dredging of wetlands; American Samoa has lost mangroves due to coastal development (filling, seawall
2847 construction, pollution, and dumping of waste and oil); and mangrove areas in the CNMI have been
2848 converted to agriculture (FAO, 2007). All three of these Pacific island jurisdictions have moved to
2849 conserve mangroves via reforestation and afforestation, led by the CNMI’s creation of natural reserves
2850 and parks (FAO, 2007). Hawaiian mangroves stand in stark contrast with the other coral jurisdictions, as
2851 there are no native mangrove species, and introduced species have become invasive (Allen, 1998). There
2852 have been multiple efforts to control and remove these invasive mangroves from Hawaii to promote
2853 reclamation by native species (Allen, 1998).

2854 3.3.2 Primary Consumers

2855 Primary consumers are the species that eat primary producers. Some of these organisms, such as corals,
2856 sponges, and crinoids, feed on microalgae and plankton and contribute to coral reef habitat.

2857 3.3.2.1 *Corals*

2858 Corals as defined by the CRCA refers to the “species of the phylum Cnidaria, including:

- 2859 1. All species of the orders Antipatharia (black corals), Scleractinia (stony corals), Gorgonacea
2860 (horny corals), Stolonifera (organpipe corals and others), Alcyonacea (soft corals), and
2861 Coenothecalia (blue coral), of the class Anthozoa; and
2862 2. All species of the order Hydrocorallina (fire corals and hydrocorals) of the class Hydrozoa.”

2863 Coral taxonomy has changed slightly since CRCA was enacted. The current coral classifications are used
2864 throughout this DPEIS.

2865 Stony coral organisms (i.e., scleractinians) are soft body polyps with a hard limestone (calcium carbonate)
2866 base (Barnes, 1987; Lalli & Parsons, 1995). For most species of stony corals, the polyps bud or divide
2867 and form connecting tissue between each polyp. These budding polyps form coral colonies. Coral
2868 colonies of various species can collectively form massive coral reefs (reefs or shoals composed primarily
2869 of corals). These reef-building corals are commonly referred to as hermatypic corals, which are the
2870 primary focus of CRCP. Globally, there are 794 reef-building corals, which are mainly distributed within
2871 the wider Caribbean and from East Africa and the Red Sea to Indo-Pacific (Spalding, 2001). Coral
2872 diversity is greater in the Indo-Pacific than in the Caribbean; for example, the Caribbean has 62 stony
2873 coral species and 719 stony coral species are found the Indo-Pacific (Spalding, 2001). Many stony corals
2874 have different growth forms, including branching, columnar, massive/lobate, plate-like, foliaceous
2875 (horizontal plates), encrusting, and free-living. These growth forms are influenced by environmental
2876 factors such as water motion, light, and biological factors such as genetics and coral symbionts. Coral
2877 growth rates range between 0.3-2 cm (0.1 - 0.77 in) per year for massive corals, and up to 10 (3.9 in)
2878 per year for branching corals; formation of a coral reef can take up to 10,000 years (Barnes, 1987).

2879 Stony corals host symbiotic algae called zooxanthellae that provides the corals with energy, oxygen, and
2880 other photosynthetic byproducts, which corals use to make the calcium carbonate necessary to build their
2881 skeletons (Hoegh-Guldberg et al., 2007). Zooxanthellae are also the basis for the coral’s color; a stressed
2882 coral can expel its zooxanthellae, which leaves the coral colorless and is considered bleached. In return,
2883 the zooxanthellae gain protection from predators and strong wave activity by residing within a coral
2884 polyp, and the algae use the carbon dioxide and water produced by the coral to photosynthesize. Their use
2885 of carbon dioxide and water also serves as waste removal, which contributes to efficient coral respiration.
2886 In addition to using energy from zooxanthellae, corals actively feed on plankton or benthos using
2887 nematocysts (Muscatine & Porter, 1977; Sebens, 1987), or stinging cells, and cilia with a mucus trap
2888 (Yonge, 1968; Goreau et al., 1971; Lewis & Price, 1975).

2889 Shallow-water stony corals use asexual and sexual reproductive strategies to build large colonies that
2890 support coral reef ecosystems (Weiblen et al., 2000). Asexual reproduction takes place through budding,
2891 when a new polyp forms directly from parent polyps to expand the size of the colony or begins a new
2892 colony (Sumich, 1996). This occurs when the parent polyp reaches a certain size and divides. This
2893 process continues throughout the animal’s life (Barnes & Hughes, 1999). Asexual reproduction also
2894 occurs when broken fragments (e.g., from hurricane damage) result in a new colony in a different location
2895 where the fragment landed. Regarding sexual reproduction, individual corals can be hermaphrodites,
2896 producing eggs and sperm within a single polyp or colony in one breeding cycle (Rinkevich & Loya,
2897 1979); protandrous, performing male functions at small sizes before performing female functions at larger

2898 sizes to accommodate for the most energy-intensive egg production (Charnov, 1982); or gonochoric,
2899 where individual colonies are either male or female. Sexual reproduction in corals occurs via brooding or
2900 broadcast (or synchronous) spawning of gametes. Brooding coral species fertilize the egg within a polyp
2901 and releases planula larvae; this type of sexual reproduction allows quick settlement after the larvae are
2902 released into the water column. The other type of sexual reproduction, broadcast spawning, requires
2903 external fertilization, and the timing of reproduction is important to ensure that the gametes (eggs and
2904 sperm) can mix in the water column to produce zygotes (fertilized eggs). The spawning of coral gametes
2905 is generally driven by the lunar cycle, water temperature, and day length. The zygotes drift in the currents
2906 and divide to eventually form planula; the coral larvae then settle on suitable hard-bottom habitat. Both
2907 abiotic (e.g., light, hard substrate, and water quality) and biotic (e.g., the presence of crustose coralline
2908 algae and biofilm [i.e., bacteria and microorganisms], and the presence of competitors) factors may
2909 influence coral settlement (Ritson-Williams et al., 2009).

2910 Coral health, reproduction, and recruitment can be altered by anthropogenic derived stressors.
2911 Sedimentation caused by runoff from land or dredging can affect corals by blocking light needed by the
2912 zooxanthellae, by suffocating polyps causing the tissue to die, by increasing suspended bacteria, and by
2913 covering settlement substrate (Erftemeijer et al., 2012; Fabricius, 2005). Sediment effects on corals can
2914 range from sublethal (changes in polyp activity, mucus production, respiration, photosynthesis, nutrient
2915 uptake and calcification) to mortality (Erftemeijer et al., 2012). The extent of impact varies by coral
2916 species and morphology, duration of the sedimentation event (days, weeks, or months), and the size of
2917 sediment grains (fine vs. coarse) (Erftemeijer et al., 2012). Increased nutrients, nitrogen and phosphorus,
2918 has also been shown to increase coral susceptibility to disease and bleaching (Vega Thurber et al., 2013;
2919 Wiedenmann et al., 2013; Voss & Richardson, 2006).

2920 3.3.2.2 Other Primary Consumers

2921 Zooplankton are microscopic animals that feed upon those primary producers suspended in the water
2922 column. Zooplankton include the larvae of numerous marine species, including the majority of coral reef
2923 invertebrates, which are dispersed into the pelagic environment to feed on the various types of plankton.

2924 Some invertebrates are affixed to the seafloor and feed passively or actively on algae and plankton. Such
2925 sessile invertebrates are especially vulnerable to local threats and disturbances. These organisms also
2926 augment habitat area and complexity, further enhancing species diversity on coral reefs.

2927 Other invertebrates, such as echinoderms, arthropods, and gastropods, are motile. Urchin species, which
2928 consume algae, have had profound effects upon coral reef ecosystems. The die-off of the Caribbean sea
2929 urchin (*Diadema antillarum*) from a disease epidemic in 1983-1984 was a critical event that contributed
2930 to phase shifts from coral-dominated ecosystems to fleshy macroalgae-dominated systems in many
2931 Caribbean locations, including Florida, Puerto Rico, and the USVI (Hughes et al., 2010).

2932 Herbivorous fish feed by filtering plankton as they swim or actively grazing or scraping algae from the
2933 benthic substrate. Herbivorous families consist mostly of 75 species of surgeonfishes (*Acanthuridae*), all
2934 27 species of rabbitfishes (*Siganidae*), all 79 species of parrotfishes (Subfamily *Scarinae* of the Family
2935 *Labridae*), majority of the 320 species of damselfishes (*Pomacentridae*), and smaller fishes, which
2936 include combtooth blennies (*Blenniidae*) and batfish (*Platax pinnatus*) (Hixon, 2015). These fish help
2937 control algal growth on coral reefs (Hughes et al., 2007; Paddock et al., 2006), and expose preferred
2938 substrate for the coral planular settlement. Other herbivores near coral reef ecosystems include manatees,

2939 dugongs, and sea turtles, which forage on the algae and seagrasses in or near coral reef ecosystems.
2940 Grazing behavior helps to sustain these systems (Lefebvre et al., 2017).

2941 **3.3.3 Secondary, Tertiary, and Apex Consumers**

2942 Secondary consumers feed upon primary consumers, tertiary consumers feed upon primary and secondary
2943 consumers, and apex consumers prey upon any consumer. Such functional roles keep the ecosystem in
2944 balance. This group of consumers includes predatory crustaceans, gastropods, cephalopods, sea snakes,
2945 fish (i.e., groupers, jacks, and sharks), seabirds, and marine mammals. Unsustainable fishing practices and
2946 other adverse effects on consumer species has caused a decline in these populations and affected coral
2947 reef ecosystems.

2948 **3.3.4 Invasive and Nuisance Species**

2949 Invasive species are those non-native species that are introduced to a system and colonize it using a
2950 competitive advantage. The most well-known example on coral reefs is the lionfish (*Pterois volitans* and
2951 *P. miles*) that were introduced to the Caribbean from the Indo-Pacific/Pacific via the aquarium trade (Hare
2952 & Whitfield, 2003). Venomous spines and a lack of natural predators enabled a population explosion of
2953 these fish. Lionfish mainly prey on small bodied and juvenile fishes and, therefore, are associated with a
2954 decline of native reef fish exemplified by reductions in species richness and community structure (Munoz
2955 et al., 2011; Green et al., 2012; Benkwitt, 2014). Invasive plant species that have altered the local
2956 ecosystems include the seagrass *Halophila stipulacea* in the Caribbean, marine algae, such as
2957 *Kappaphycus alvarezii* and *Gracilaria salicornia* in Hawaii, and red mangroves (*Rhizophora mangle*) in
2958 Hawaii (Christianen et al., 2018; Olinger et al., 2017; Allen, 1998). *Halophila stipulacea* has been
2959 reported throughout the Caribbean (Willette et al., 2014; Vera et al., 2014) and has been found to displace
2960 native seagrasses and alter juvenile fish assemblages (Willette & Ambrose, 2012; Olinger et al., 2017).

2961 Native species that cause harm to ecosystems are considered nuisance species. A notable nuisance species
2962 in coral reef ecosystems in the Pacific is the crown-of-thorns starfish (*Acanthaster planci*), which prey
2963 upon certain coral species and kill colonies. Declines in Indo-Pacific coral cover caused by population
2964 explosions of the pandemic crown-of-thorns starfish have been widely documented for the past 40 years
2965 (Hughes et al., 2010; Kayal et al., 2012). Guam has experienced outbreaks of the *Chaetomorpha*
2966 macroalgae, which forms huge mats that can smother/shade corals, impede fishing, and tangle boat
2967 propellers (NOAA, 2015a).

2968 **3.3.5 Terrestrial and Freshwater Organisms**

2969 In addition to marine organisms, CRCP activities may affect terrestrial and freshwater organisms within
2970 streams, riparian zones, and coastal areas. Such areas provide habitat for invertebrates, freshwater fish,
2971 reptiles, birds, and mammals. Organisms of particular concern can be found in the Endangered Species
2972 (Section 3.4.2). In addition, a general description of terrestrial and freshwater habitats likely to be affected
2973 by CRCP activities is included in various sections above in Chapter 3, in the jurisdictional sections below
2974 in Section 3.6, and below in Chapter 4 preceding the impacts analysis. Those descriptions are not repeated
2975 here.

2976 **3.4 Regulatory Environment**

2977 This section describes some of the federal environmental regulations that are likely to apply to CRCP
2978 activities. Other federal regulations may apply, particularly on a project-specific basis, and NOAA and its

2979 partners consider and comply with all other applicable regulations for specific projects as well. This
2980 section includes, among other things, a table of ESA-listed species under NMFS's jurisdiction associated
2981 with coral reef ecosystems.

2982 **3.4.1 Essential Fish Habitat**

2983 Essential fish habitat (EFH) is defined in the Magnuson-Stevens Fisheries Conservation and Management
2984 Act (MSA) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to
2985 maturity." Essential fish habitat includes all types of aquatic habitat—wetlands, coral reefs, seagrasses,
2986 rivers—where fish and invertebrates spawn, breed, feed, or grow to maturity. The NMFS works with the
2987 regional fishery management councils to identify the EFH for every life stage of each federally managed
2988 species using the best available scientific information. The four regional fishery management councils
2989 that have authority within geographic range of the CRCP have designated EFH for their regions as
2990 follows. The CRCP is conducting a programmatic EFH consultation for the proposed action in
2991 coordination with NMFS (See Appendix C for full list of EFH).

2992 ***EFH under the Western Pacific Regional Fishery Management Council (WPRFMC)***

2993 The CRCP implements activities in the Western Pacific off Hawaii, the Northwestern Hawaiian Islands,
2994 American Samoa, Guam, the CNMI, and the U.S. Pacific Island possessions that may be located within
2995 areas identified as EFH for species managed by the WPRFMC. The WPRFMC has classified shallow-
2996 water fish and invertebrates as ecosystem component species, and EFH is not designated for these
2997 species. The WPRFMC has EFH designations for bottomfish and seamount groundfish, crustaceans,
2998 pelagic and precious corals, which may overlap with shallow coral ecosystems. An example is the
2999 juvenile/adult habitat for Kona crab (*Ranina ranina*) that includes bottom habitat from the shoreline to a
3000 depth of 100 m (300 ft).

3001 ***EFH under the Gulf of Mexico Fishery Management Council***

3002 The CRCP implements activities in the Gulf of Mexico that may be located within areas identified as
3003 EFH, including Habitat Areas of Particular Concern (HAPC) such as Madison-Swanson Marine Reserve,
3004 Tortugas North, Tortugas South, Florida Middle Grounds, Pulley Ridge, West Flower Garden Banks, and
3005 East Flower Garden Banks, (70 FR 76216). The HAPCs are closed to fishing entirely or closed during
3006 certain times of the year to specific gear types to provide protection for various managed species. The
3007 entire Gulf of Mexico is considered EFH for the following fishery management plans (FMPs): red drum
3008 (*Sciaenops ocellatus*) under the Red Drum FMP (GMFMC, 2019a); 11 species and life stages of reef fish,
3009 including grouper, snapper, and triggerfish, under the Reef Fish FMP (GMFMC, 2019b); coral and coral
3010 reefs under the Coral and Coral Reefs FMP (GMFMC, 2019c); spiny lobster (*Panulirus argus*) under the
3011 Spiny Lobster FMP (GMFMC, 2019d); king mackerel (*Scomberomorus cavalla*), Spanish (*S. maculatus*)
3012 mackerel, and cobia (*Rachycentron canadum*) under the Coastal Migratory Pelagic FMP (GMFMC,
3013 2019e); and brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*F. duorarum*), white shrimp
3014 (*Litopenaeus setiferus*), rock shrimp (*Sicyonia brevirostris*), and royal red shrimp (*Pleoticus roustus*)
3015 under the Shrimp FMP (GMFMC, 2019f).

3016 ***EFH under the South Atlantic Fishery Management Council***

3017 The CRCP implements activities off the coasts of east Florida and the Florida Keys that may be located
3018 within areas identified as EFH (GMFMC, 2005; SAFMC, 1998). The CRCP project areas may coincide
3019 with EFH for spiny lobster under the Spiny Lobster FMP (SAFMC, 2019a); with brown shrimp, pink
3020 shrimp, white shrimp, rock shrimp, and royal red shrimp under the Shrimp FMP (SAFMC, 2019b);

3021 approximately 55 species in the snapper-grouper complex, including triggerfishes, grunts, snappers, sea
3022 basses, and groupers, under the Snapper-Grouper FMP (SAFMC, 2019c); king mackerel and Spanish
3023 mackerel, and cobia under the Coastal Migratory Pelagic FMP (SAFMC, 2019d); and coral and coral
3024 reefs under the Coral, Coral Reefs, and Live/Hard Bottom Habitat FMP (SAFMC, 2019e). This also
3025 includes supporting activities within designated EFH-HAPC such as coastal inlets for shrimp
3026 overwintering areas and red drum nursery habitat, documented sites of spawning aggregations, mangrove
3027 and seagrass habitat that provide nursery habitat for snappers and groupers, and spiny lobster habitat
3028 (Florida Bay, Biscayne Bay, Card Sound, and coral/hard bottom habitat from Jupiter Inlet, Florida
3029 through the Dry Tortugas, Florida).

3030 ***EFH under Caribbean Fishery Management Council***

3031 The CRCP implements activities in Puerto Rico and the USVI that may be located within areas identified
3032 as EFH for species managed by the Caribbean FMC under a Generic Amendment to four FMPs (CFMC,
3033 1998). The Reef Fish FMP (CFMC, 2019) identifies 13 species of reef fish, including grouper, snapper,
3034 grunt, triggerfish, and red hind (*Epinephelus guttatus*), and their life stages that may exist in CRCP
3035 project areas. Other species that may inhabit areas that coincide with CRCP project locations include over
3036 100 species of coral and life stages, including stony corals, sea fans, and other gorgonians, and over 60
3037 species of plants, including seagrasses, and invertebrates, under the Coral and Reef-Associated Plants and
3038 Invertebrates FMP (CFMC, 2019); spiny lobster under the Spiny Lobster FMP (CFMC, 2019); and queen
3039 conch (*Strombus gigas*) under the Queen Conch FMP (CFMC, 2019). EFH for these FMPs includes all
3040 water from either mean high tide or mean low tide to the outer boundary of the economic exclusive zone
3041 surrounding these territories. The CRCP may also support activities within designated HAPCs including
3042 areas such as Luís Peña Channel, Culebra; La Cordillera, Fajardo; Tourmaline Reefs, Mayagüez, Puerto
3043 Rico; Buck Island Reef National Park, St. Croix; Hind Bank Marine Conservation District, St. Thomas;
3044 and Alton Lagoon, St. Croix.

3045 ***EFH under the Secretarial Atlantic Highly Migratory Species (HMS) Fishery Management Plan***

3046 The CRCP implements activities in the Atlantic/Caribbean and Gulf of Mexico that may be located within
3047 areas identified as EFH, including within HAPCs (82 FR 42329), for certain life stages of species
3048 managed by NOAA Fisheries HMS. The CRCP project areas may coincide with EFH for five species of
3049 tuna, six species of billfish, and 42 species of shark covered under this FMP.

3050 ***3.4.2 Endangered Species Act***

3051 The ESA provides for the conservation of species that are in danger of extinction throughout all or a
3052 significant portion of their range or likely to become so within the foreseeable future and therefore are
3053 threatened with extinction. The ESA also provides authority to designate critical habitat for these species
3054 and protect the ecosystems on which they depend (16 U.S.C. § 1531). Table 3-1 lists the ESA-listed
3055 species and associated critical habitat within NMFS's jurisdiction; ESA-listed species and associated
3056 critical habitat within USFWS's jurisdiction can be found in Appendix E. The CRCP is conducting
3057 programmatic ESA Section 7 consultations for the proposed action in coordination with NMFS and
3058 USFWS. Consistent with existing CRCP practice, individual Section 7 consultations would be initiated
3059 during the planning process for site-specific projects if there is an ESA-listed species that may be affected
3060 by the proposed activity. Project proponents would adhere to any project modifications or other
3061 mandatory minimization and avoidance measures, such as terms and conditions for incidental take,
3062 resulting from formal consultations.

3063 Table 3-1. Endangered Species Act List of NMFS-listed Endangered or Threatened Species Associated with Coral Reef
 3064 Ecosystems (E=endangered, T=threatened). *Some populations are considered threatened and others are considered
 3065 endangered.

Status	Species	Florida	Gulf of Mexico	Puerto Rico	Virgin Islands	American Samoa	CNMI	Guam	Hawaii	Foreign	Critical Habitat
Corals											
T	<i>Acropora Cervicornis</i> , Staghorn Coral	X	X	X	X	--	--	--	--	--	Coastal waters of Florida, Puerto Rico, and the USVI
T	<i>Acropora globiceps</i> , Coral	--	--	--	--	--	X	X	--	--	None designated
T	<i>Acropora jacquelineae</i> , Coral	--	--	--	--	X	--	--	--	X	None designated
T	<i>Acropora lokani</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
T	<i>Acropora palmata</i> , Elkhorn Coral	X	X	X	X	--	--	--	--	--	Coastal waters of Florida, Puerto Rico, and the USVI
T	<i>Acropora pharaonis</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
T	<i>Acropora retusa</i> , Coral	--	--	--	--	--	X	X	--	--	None designated
T	<i>Acropora rudis</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
T	<i>Acropora speciosa</i> , Coral	--	--	--	--	X	--	--	--	--	None designated
T	<i>Anacropora spinosa</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
T	<i>Acropora tenella</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
E	<i>Cantharellus noumeae</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
T	<i>Dendrogyra cylindrus</i> , Pillar Coral	X	X	X	X	--	--	--	--	--	None designated
T	<i>Euphyllia paradivisa</i> , Coral	--	--	--	--	--	X	X	--	--	None designated
T	<i>Isopora crateriformis</i> , Coral	--	--	--	--	--	X	X	--	--	None designated

T	<i>Orbicella annularis</i> , Lobed Star Coral	X	X	X	X	--	--	--	--	--	None designated
T	<i>Orbicella faveolata</i> , Mountainous Star Coral	X	X	X	X	--	--	--	--	--	None designated
T	<i>Orbicella franksi</i> , Boulder Star Coral	X	X	X	X	--	--	--	--	--	None designated
T	<i>Montipora australiensis</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
T	<i>Mycetophyllia ferox</i> , Rough Cactus Coral	X	X	X	X	--	--	--	--	--	None designated
T	<i>Pavona diffluens</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
T	<i>Porites napopora</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
T	<i>Seriatopora aculeata</i> , Coral	--	--	--	--	--	X	X	--	--	None designated
E	<i>Siderastrea glynni</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
E	<i>Tubastraea floreana</i> , Coral	--	--	--	--	--	--	--	--	X	None designated
Other Invertebrates											
T	<i>Nautilus pompilius</i> , Chambered Nautilus	--	--	--	--	X	--	--	--	X	None designated
Marine Mammals											
E	<i>Balaenoptera borealis</i> , Sei Whale	X	X	X	X	X	X	X	X	X	None designated
E	<i>Balaenoptera edeni</i> , Gulf of Mexico Bryde's Whale	X	X	--	--	--	--	--	--	--	None designated
E	<i>Balaenoptera musculus</i> , Blue Whale	X	--	X	X	X	X	X	X	X	None designated
E	<i>Balaenoptera physalus</i> , Fin Whale	X	X	X	X	X	X	X	X	X	None designated
E	<i>Eubalaena glacialis</i> , North Atlantic Right Whale	X	--	--	--	--	--	--	--	--	Outside of CRCP's action area (Gulf of Maine and Georges Bank region and off the Southeast U.S. coast [Cape Fear, North Carolina, southward to approximately

											27 nm below Cape Canaveral, Florida])
E	<i>Monachus schauinslandi</i> , Hawaiian Monk Seal	--	--	--	--	--	--	--	X	--	Waters out 10-20 fathoms in Kure Atoll; Midway Islands (except Sand Island), Pearl and Hermes Reef, Lisianski Island, Laysan Island, Gardner Pinnacles, French Frigate Shoals, Mokumanamana, and Nihoa Island.
E	<i>Physeter Microcephalus</i> , Sperm Whale	X	X	X	X	X	X	X	X	X	None designated
E	<i>Psuedorca crassidens</i> , Hawaiian Insular False Killer Whale	--	--	--	--	--	--	--	X	--	Waters from 45-3,200 meters (49-3,500 yards) around the Main Hawaiian Islands
Sea Turtles											
E	<i>Caretta caretta</i> , Loggerhead Sea Turtle, North Pacific Distinct Population Segment, South Pacific Distinct Population Segment	--	--	--	--	X	X	X	X	--	None designated
T	<i>Caretta caretta</i> , Loggerhead Sea Turtle, Northwest Atlantic Distinct Population Segment	X	X	X	X	--	--	--	--	--	None designated
E	<i>Chelonia mydas</i> , Green Turtle, Central West Pacific Distinct Population Segment	--	--	--	--	X	X	X	X	--	None designated
T	<i>Chelonia mydas</i> , Green turtle, South Atlantic Distinct Population Segment	X	X	X	X	--	--	--	--	--	NMFS - Puerto Rico - Waters around Culebra Island

E	<i>Dermochelys coriacea</i> , Leatherback Sea Turtle	X	X	X	X	X	X	X	X	--	Outside of CRCP's action area (California coast from Point Arena to Point Arguello east of the 3,000 meter depth contour; and 64,760 km ² stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meter depth contour.)
E	<i>Eretmochelys imbricata</i> , Hawksbill Turtle	X	X	X	X	X	X	X	X	--	NMFS Coastal waters surrounding Mona and Monito Islands, Puerto Rico
E	<i>Lepidochelys kempii</i> Kemp's Ridley Turtle	X	X	--	--	--	--	--	--	--	None designated
T	<i>Lepidochelys oliveacea</i> , Olive Ridley Sea Turtle	--	--	--	--	X	X	X	X	--	None designated
Fish											
T	<i>Carcharhinus longimanus</i> , Oceanic Whitetip Shark	X	X	X	X	X	X	X	X	--	None designated
T	<i>Epinephelus striatus</i> , Nassau Grouper	X	X	X	X	--	--	--	--	--	None designated
T	<i>Manta birostris</i> , Giant Manta Ray	--	--	--	--	X	X	X	X	--	None designated
E	<i>Pristis pectinata</i> , Smalltooth Sawfish	X	X	--	--	--	--	--	--	--	Charlotte Harbor and in the Ten Thousand Islands/Everglades, Florida
T	<i>Sphyrna lewini</i> , Scalloped Hammerhead Shark, Indo-West Pacific Distinct Population Segment and Central and Southwest Atlantic Distinct Population Segment	--	--	X	X	X	X	X	--	--	None designated
Plants											

T	<i>Halophila johnsonii</i> , Johnson's Seagrass	X	--	--	--	--	--	--	--	--	East Coast of FL from Sebastian Inlet to Central Biscayne Bay
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3066 Source: NMFS, 2019

3067

3068 **3.4.3 Marine Mammal Protection Act**

3069 All marine mammals are protected under the MMPA regardless of whether they are also listed
3070 under the ESA. In the South Atlantic and Caribbean, including the Gulf of Mexico, there are 27
3071 species of marine mammals, which include the West Indian manatee (*Trichechus manatus*) and
3072 26 cetacean species (dolphins and whales). In the Pacific Ocean, there are 29 species of marine
3073 mammals, which include the Hawaiian monk seal, dugong (*Dugong dugong*), and 27 species of
3074 whales and dolphins. Dugongs and manatees primarily inhabit rivers, bays, canals, estuaries,
3075 mangroves, and coastal waters rich in seagrass and other vegetation. The Hawaiian monk seal is
3076 primarily found within the Hawaiian Islands and uses waters surrounding atolls, islands, and
3077 areas farther offshore on reefs and submerged banks. See Appendix F for full list of marine
3078 mammals in CRCP's action area. Most of the cetacean species reside in the oceanic habitat
3079 (depth ≥ 200 m [656 ft]), although some dolphins can be found in waters from oceanic to shallow
3080 coastal areas including bays and estuaries. The proposed action and alternatives incorporate
3081 avoidance and minimization measures that limit potential effects to marine mammals. CRCP
3082 determined that further coordination under MMPA was not required at this time. Future project-
3083 specific environmental analyses, if necessary, will assess any potential effects to marine mammal
3084 of each project or activity not fully addressed within this DPEIS to determine if permits or
3085 authorizations are needed to comply with MMPA. The CRCP activities include hydrographic
3086 surveys using active acoustic devices (e.g., side-scan echosounder, echosounders). Based on the
3087 analysis in Chapter 4, NOAA has determined that an incidental take authorization under the
3088 MMPA is not warranted for CRCP programmatic activities.
3089

3090 **3.4.4 Clean Water Act**

3091 Surface water quality in states, territories, and authorized tribal lands are required to be reported to EPA
3092 every two years under the CWA Sections 305(b) and 303(d) for waters that have been assessed and
3093 indicate water quality that does not support healthy aquatic life. Section 404 of the U.S. CWA also
3094 provides a statutory definition of wetlands and assigns jurisdiction over protection of wetlands to the U.S.
3095 Army Corps of Engineers. Under Section 404 of the CWA, the U.S. Army Corps of Engineers requires
3096 that an interested party obtain a permit before filling, constructing on, or altering a jurisdictional wetland
3097 (33 U.S.C § 1344). Given the significant impacts that stormwater and land-based sources of pollution
3098 have had on coral reef ecosystems, the protections are critical to ensuring wetlands continue to provide
3099 mitigating ecosystem services.

3100 **3.4.5 Coastal Zone Management Act**

3101 The Coastal Zone Management Act (CZMA, 16 U.S.C. § 1451) was enacted in 1972 to encourage coastal
3102 states, Great Lake states, and U.S. Territories and Commonwealths (collectively referred to as "coastal

3103 states” or “states”) to preserve, protect, develop, and where possible, to restore or enhance the resources
3104 of the nation’s coastal zone. The CZMA is a voluntary program, and all seven states and territories in the
3105 CRCP’s action area have coastal management programs. The federal consistency provision, Section 307,
3106 requires federal actions (inside or outside a coastal zone) that affect any coastal zone resource, to be
3107 consistent with the enforceable policies of the state/territorial approved coastal management program. The
3108 CRCP is coordinating with each jurisdiction to develop an approach for consistency determinations with
3109 their enforceable policies for activities covered by DPEIS.

3110 ***3.4.6 National Historic Preservation Act***

3111 Section 106 of the National Historic Preservation Act of 1966 (NHPA) (54 U.S.C. § 300101 et seq.)
3112 requires federal agencies to take into account the effects of their undertakings on historic properties in
3113 accordance with regulations issued by the Advisory Council on Historic Preservation at 36 C.F.R. Part
3114 800. The regulations require that federal agencies consult with the Advisory Council on Historic
3115 Preservation, states, tribes, and other interested parties (consulting parties) when establishing an area of
3116 potential effects, identifying properties within the area of potential effects and determining their eligibility
3117 for inclusion in the National Register of Historic Properties (NRHP), making effects determinations to
3118 historic properties, and resolving adverse effects. The NRHP is an official Federal Government list of
3119 significant historical properties in architecture, engineering, archeology, history, and culture in general.
3120 Authorized by the NHPA, the NRHP is part of a national program to coordinate and support public and
3121 private efforts to identify, evaluate, and protect America's historic and archeological resources. The
3122 CRCP is coordinating with the Advisory Council on Historic Preservation to develop potential
3123 approaches for addressing programmatic activities. Furthermore, any CRCP activities that may affect
3124 historic properties would undergo individual consultations on a project-specific basis as appropriate. Any
3125 programmatic approach developed in coordination and consultation with the Advisory Council on
3126 Historic Preservation would guide project-specific compliance.

3127 ***3.4.7 National Marine Sanctuaries Act***

3128 The National Marine Sanctuaries Act (16 U.S.C. § 1431 et seq.; NMSA) authorizes the Secretary of
3129 Commerce to designate and manage areas of the marine environment with special national significance
3130 due to their conservation, recreational, ecological, historical, scientific, cultural, archeological,
3131 educational, or esthetic qualities as national marine sanctuaries. Section 304(d) of the National Marine
3132 Sanctuaries Act requires interagency consultation between NOAA and federal agencies taking actions,
3133 including authorization of private activities, “likely to destroy, cause the loss of, or injure a sanctuary
3134 resource.” In addition to consultation, a permit or other approval is required from the Office of National
3135 Marine Sanctuaries (ONMS) when any person wishes to conduct an activity within a sanctuary that is
3136 otherwise prohibited. Prohibitions are sanctuary specific, but commonly include disturbance of
3137 submerged lands, discharges, or injury to historic or cultural resources. The CRCP is coordinating with
3138 ONMS to explore the feasibility of conducting a programmatic NMSA 304(d) consultation. Any NMSA
3139 permits required for CRCP activities would be issued on a project-specific basis.

3140 **3.5 Socioeconomic Environment**

3141 This section outlines some of the human elements associated with U.S. coral reef jurisdictions. The CRCP
3142 recognizes that people and society are part of the coral reef ecosystem and incorporates related data into
3143 coral reef management strategies. The CRCP coordinates a variety of activities including the systematic

3144 collection of socioeconomic variables, including demographics in coral reef areas, human use of coral
3145 reef resources, as well as knowledge, attitudes, and perceptions of coral reefs and coral reef management.
3146 More details on some of the sections outlined below can be found in documents produced as part of the
3147 National Coral Reef Socioeconomic Monitoring Program (NOAA, 2018b).

3148 ***3.5.1 Social Environment***

3149 *3.5.1.1 Population*

3150 Human populations, both as total and density, and their ethnic compositions vary among the jurisdictions.
3151 For example, Atlantic jurisdictions have greater representation among white, black, and Hispanic
3152 communities, and Pacific jurisdictions tend to have more people of Asian and Pacific Islander descent.
3153 However, notions of race and ethnicity will vary based on the cultural and historical contexts of these
3154 places. For example, Hawaii is diverse, with 24% of the population identifying as two or more races, the
3155 highest reported level of multi-ethnicity of all U.S. states (U.S. Census Bureau, 2010). The Chamorro
3156 people of Guam and other indigenous persons of Micronesian heritage are broadly classified as Pacific
3157 Islander within census data.

3158 *3.5.1.2 Cultural Resources*

3159 Cultural resources include historic properties (buildings, sites, and structures including archeological
3160 sites) that are listed or eligible for listing under the National Historic Preservation Act (NHPA),
3161 archeological resources, and (sacred) tribal sites of traditional, cultural, and religious importance.

3162 *3.5.1.3 Public Health and Safety (Including Flood Risk Reduction and Shoreline Protection)*

3163 The main risks to public health and safety can be divided into slow-onset anthropogenic activities, such as
3164 pollution and improper land use practices, and hazardous natural events. The hazardous natural events
3165 include hurricanes, extreme rainfall events, volcanic activity, and earthquakes. Slow-onset events as a
3166 result of changing sea levels can lead to increased risk of flooding and, in some cases, saltwater intrusion
3167 into groundwater supplies. Human activities can release high levels of sediments into receiving water
3168 bodies. There are potential risks to the public from other non-point sources of contaminants.

3169 Measures to reduce risk during extreme events include proper signage and public awareness activities to
3170 educate residents regarding evacuation routes and shelters. Engineering approaches to reduce risk include
3171 levees and spill prevention control mechanisms, as well as countermeasure planning during extreme
3172 events to ensure life and property are secured.

3173 *3.5.1.4 Environmental Justice*

3174 Under Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority*
3175 *Populations and Low-Income Populations*, federal agencies, such as NOAA, must assess whether its
3176 actions have a disproportionately high and adverse environmental and health impacts on minority and
3177 low-income populations. This mandate was expanded to include a similar analysis for children by
3178 Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*.

3179 All seven U.S. coral jurisdictions have minority and low-income populations. The coral reef ecosystem
3180 can be fundamental to the fabric of local communities, providing a food source, materials, and forming
3181 part of their cultural identity.

3182 **3.5.2 Economic Environment**

3183 Coral reef ecosystems, with vibrant colors and high biodiversity, are an economic driver for adjacent
 3184 communities. Coral reefs and associated habitats provide economic and environmental services to
 3185 millions of people through employment, recreation and tourism, shoreline protection, and sources of food,
 3186 building materials, and pharmaceuticals. A recent global economic loss of coral reef ecosystem services
 3187 due to increasing water temperatures is estimated to be \$1 trillion (Hughes et al., 2017).

3188 **3.5.2.1 Coral Reef Ecosystem Value**

3189 The estimated total economic value (TEV) of coral reef services for across all U.S. jurisdictions is just
 3190 over U.S. \$3.4 billion per year (Brander & van Beukering, 2013; Table 3-2). This value is considered to
 3191 be a partial estimate due to the limited geographical coverage and set of services for some state/territory
 3192 TEV estimates (Brander & van Beukering, 2013). Furthermore, U.S. coral reefs are shown to provide a
 3193 large reduction in flood risk that is quantified as saving more than 18,000 lives and with an annual value
 3194 of \$1.805 billion in 2010 U.S. dollars (Storlazzi et al., 2019).

3195 *Table 3-2. Total Economic Value of U.S. Reefs by Jurisdiction as conservative estimates.*

	Area of coral reef valued (ha)	Total Economic Value (millions 2007 USD)
USVI	34,400	187
Puerto Rico	12,642	1,093
Florida	36,000	174
Hawaii	165,990	1,747
American Samoa	22,200	11
CNMI	6,494	65
Guam	7,159	139
Flower Garden Banks	N/A	N/A
Papahānaumokuākea	N/A	N/A
Pacific Island Remote Areas	N/A	N/A
Total	284,885	3,416

Source: Brander and van Beukering (2013)

3225 **3.5.2.3 Marine Transportation**

3226 Coral reefs and associated habitats reduce offshore wave energy and, due to their location and physical
 3227 structure, reefs create calm back reef conditions that aid small craft navigation. Coral reefs also provide
 3228 natural breakwater services in bays with harbors that support the docking of ships and other vessels.
 3229 Marine transportation is an important component of coastal land use. Port development and operations,

3230 including expansion, have resulted in substantial alteration and damage to the natural environment. Port
3231 property often includes brownfields—abandoned industrial facilities where environmental contamination
3232 discourages development. Ongoing impacts include reductions in air and water quality and the
3233 importation of invasive aquatic species (Urban Harbors Institute, 2000).

3234 Although ports are often located in environmentally compromised areas, Port Authorities are also
3235 involved in environmental remediation and clean-up efforts (Urban Harbors Institute, 2000). Maintaining
3236 or improving coastal and marine navigation systems often requires regular dredging of sediment from
3237 waterways. Dredged materials are removed from navigation channels, and 5-10% of those sediments may
3238 be contaminated (Urban Harbors Institute, 2000). If proper cautionary measures are not taken, coral
3239 mortality can occur during port dredging operations (Cunning et al., 2019).

3240 Coral reef ecosystems support cruise ship tourism, sailing, fishery, and marina industries in coral
3241 jurisdictions. There is also a variety of jobs directly associated with small and large marine transportation
3242 interests, including in ports that serve as transportation hubs in many coral jurisdictions. Commerce
3243 associated with marina services such as boat repairs, food and beverage supplies, and other items relevant
3244 to the small craft sailing industry, as well as the shipping industry and mega-yachts in some jurisdictions,
3245 are important to local and regional economies.

3246 *3.5.2.4 Land Use and Cover*

3247 The majority of NOAA’s efforts are located in or directly adjacent to coasts, estuaries, marshes, rivers,
3248 streams, and other aquatic features. As coastal areas are the most heavily developed areas in the U.S., a
3249 significant portion of project sites are in urban and suburban areas, where land uses range from residential
3250 (single- and multi-family) to recreational (e.g., beaches, estuaries, wetland preserves, rivers, and trails) to
3251 industrial (ports and aquaculture).

3252 Impervious land cover, including military bases, industrial zones, and urban development, is a good
3253 indicator of human-developed land-use and is also associated with land-based pollution. Other sites are
3254 located in rural and agricultural areas, in addition to park lands. Tourism and recreational opportunities
3255 are an important use of coastal lands, and are dependent on a clean, healthy coastal environment. These
3256 activities include bird watching, hunting, fishing, beach-going, and boating.

3257 Agriculture is an important land use in coastal and inland areas, affecting nearshore marine, estuarine, and
3258 freshwater resources. Since water is important for successful agricultural production, this land use is often
3259 located near freshwater bodies or in areas with freshwater aquifers. Agriculture often significantly alters
3260 the natural landscape and reduces the availability of high-quality fish habitat by building levees to drain
3261 wet areas or manage floodwaters, and reducing the quantity and quality of water in adjacent water bodies.

3262 *3.5.2.5 Fisheries*

3263 Reef-related commercial, recreational, and subsistence fisheries are economically important. Healthy
3264 coral reefs are important for sustainable fisheries production. Commercial fisheries are those that target
3265 wild stocks of species with the intent to sell their catch at market. Commercial fisheries landings in coral
3266 reef areas are not as large as those in temperate waters. Recreational and charter fisheries in coral reef
3267 areas are typically driven by tourism, with patrons hiring a local guide with knowledge of preferred
3268 fishing areas to maximize their success. For many coral reef-associated communities, subsistence harvest
3269 of coral reef fishes is a primary source of dietary protein. It is also regarded as less wasteful than
3270 commercial harvests due to its reef-to-table nature (Martin et al., 2017).

3271 The harvest of fish and invertebrates for the aquarium industry is more prevalent outside of U.S. waters,
 3272 but Hawaii and Puerto Rico have some active fisheries for the aquarium trade (LeGore et al., 2008;
 3273 Miyasaka, 1997). However, the U.S. is the top importer of these organisms (Bruckner, 2005; Rhyne et al.,
 3274 2017). Demand is driven by aquaria hobbyists, ornamental shell and coral skeleton collectors, as well as a
 3275 live reef food fish trade, which targets the larger reef fish for consumption abroad.

3.6 Overview of Coral Reefs in U.S. States and Territories

3276 This section serves to give relevant details and additional context at the state and territory jurisdictional
 3277 level. Table 3-3 below generally describes the coral environment for the state and territory jurisdictions.
 3278

3279 *Table 3-3. Broad descriptions of the coral environment for the state and territory jurisdictions.*

Jurisdiction	Ocean Basin	Coral Reef Type(s)	Ocean Temperature Range (°C)	Mean tidal range (cm)
USVI	Atlantic Caribbean	Patch, bank-barrier, fringing	26-29	22
Puerto Rico	Atlantic Caribbean	Patch, bank-barrier, fringing	25-28	20
Florida	Atlantic Caribbean	Patch, bank-barrier	23-30	75
Hawaii	Pacific	Barrier, fringing	22-28	39
American Samoa	Pacific	Fringing	27-29	79
CNMI	Pacific	Barrier, fringing	26-30	61
Guam	Pacific	Fringing	27-29	72
Flower Garden Banks	Gulf of Mexico	Patch	20-29	10
Papahānaumokuākea	Pacific	Patch, fringing	18-28	10
Pacific Island Remote Areas	Pacific	Patch, barrier, fringing	N/A	N/A

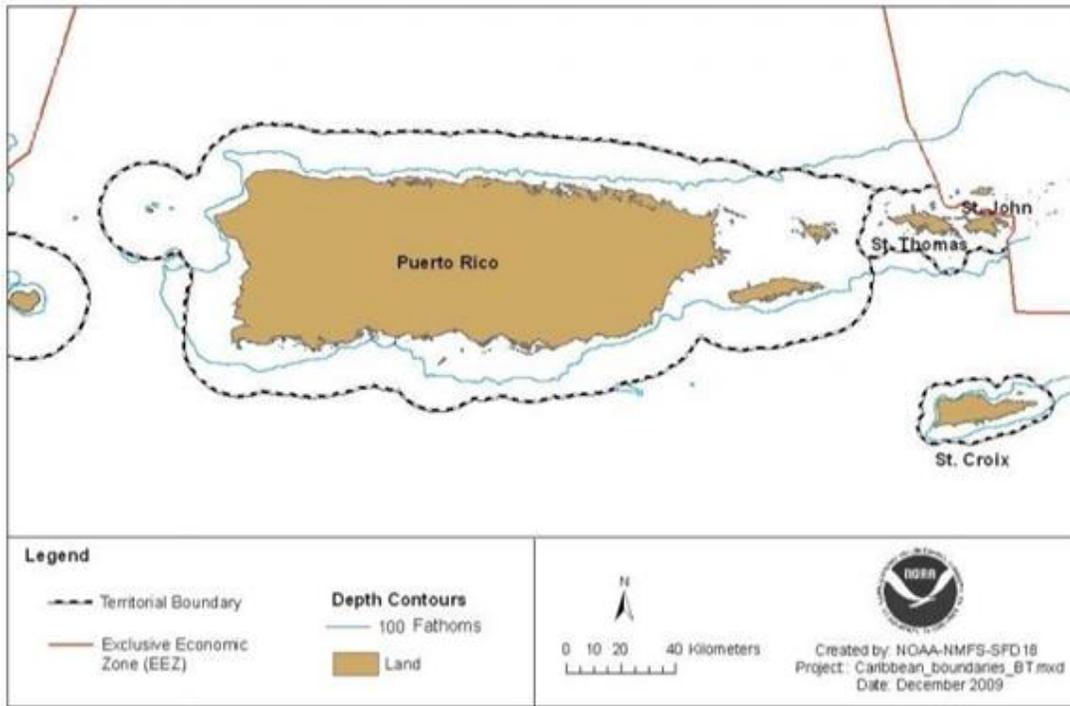
3280 Source for ocean temperature data: www.nodc.noaa.gov; Source for tidal data: tidesandcurrents.noaa.gov (NOAA, 2019a)

3.6.1 U.S. Virgin Islands

3.6.1.1 Physical Environment

3283 The USVI are located in the Caribbean in the northwestern most section of the Lesser Antilles. The total
 3284 area of the USVI is 346 km² (215 mi²). The USVI include three large main islands, St. Thomas (83
 3285 km² [52 mi²]), St. John (52 km² [32 mi²]), and St. Croix (218 km² [136 mi²]), and more than 60 recognized
 3286 cays or rocks (Gould et al., 2013). St. Thomas and St. John, located in the north, are geologically

3287 connected as part of the Puerto Rican bank (Rogers et al., 2008). St. Croix is located on a different shelf
3288 approximately 64 km (40 mi) to the south (Gould et al., 2013) (Figure 3-3).



3289
3290 Figure 3-3. Map of U.S. Caribbean: Puerto Rico and the USVI. Source: NOAA, 2009

3291 St. Thomas and St. John are volcanic in origin, with typically steep terrain and irregular coastlines. St.
3292 Croix is of sedimentary origin and generally consists of more rolling hills with a straighter coastline
3293 (Gould et al., 2013; Nemeth & Platenberg, 2007).

3294 Coastal currents within the USVI are driven by winds and tides and range from 0-40 cm/s (0-15.8 in/s),
3295 but are typically less than 10 cm/s (0-4 in/s) (Rogers et al., 2008). These weak currents are dominated by
3296 tidal action and entrainment within the semi-enclosed bays of the islands (Rogers et al., 2008). Offshore
3297 surface currents (0-5 m [0-16 ft] depth) are stronger on average (23 cm/s [0-9 in/s]; ranging from 12-65
3298 cm/s [5-26 in/s]), while bottom currents (up to 30 m [98 ft] depth) remain weak (average 16 cm/s [6 in/s]);
3299 range from 10-27 cm/s [4-11 in/s]) (Rogers et al., 2008).

3300 ***Climate and Weather***

3301 The climate of the USVI is subtropical. The islands experience warm and humid conditions with minimal
3302 temperature variations between seasons (Runkle et al., 2018). There is less than 6°C (42.8°F) difference
3303 between the mean temperatures of the coolest and warmest months. The highest temperatures occur in
3304 August or September, and the lowest occur in January or February (Gould et al., 2013). The North
3305 Atlantic subtropical high, which brings persistent northeast trade winds to the islands, is the primary
3306 influence on the climate of the region (Runkle et al., 2018).

3307 Precipitation across the USVI varies seasonally, with rainfall generally the heaviest from May to
3308 December along the northern and central portions of the islands (Gould et al., 2013). Though the islands
3309 are not high in elevation, topographic effects on precipitation still occur as the west or upwind sides tend
3310 to be wetter than the east or downwind sides. The average rainfall ranges from 75 cm (29.5 in) in the

3311 coastal areas to 140 cm (55.1 in) at higher elevations. St. Thomas and St. John typically receive slightly
3312 more annual rainfall than St. Croix (Gould et al., 2013).

3313 ***Water Resources***

3314 Short, deeply incised, intermittent watercourses, or ghuts, drain the islands as there are no permanent
3315 rivers or streams in the USVI (Gardner et al., 2008; Olcott, 1999). Drainage tends to occur radially from
3316 central highpoints to the coast (Olcott, 1999). The flows through ghuts tend to be flashy due to the
3317 topography of the islands and rainfall patterns (Gardner et al., 2008).

3318 Urban areas of the USVI rely on desalinated seawater for drinking water, while rural areas depend on
3319 rainwater collection systems and, to a lesser extent, groundwater supplies (Carr, 1990). Most groundwater
3320 exists at relatively shallow (2-20 m [7-66 ft]) depths in unconsolidated alluvial sediments or in shallow
3321 limestone deposits (EPA, 2004). The main aquifer in the USVI is the Kingshill aquifer of central St.
3322 Croix. This aquifer consists of limestone, marl, thin sandy interbeds, and conglomerates, and has a
3323 maximum thickness of about 60 meters (Olcott 1999). Minor aquifers on the other major islands are
3324 generally either alluvial valley aquifers, coastal embayment aquifers, or volcanoclastic-, igneous-, and
3325 sedimentary rock aquifers (Carr, 1990; Olcott, 1999).

3326 While water quality is generally good, increased point and nonpoint source discharges have resulted in a
3327 declining trend (EPA, 2016). Direct discharges, run-off, and vessel wastes all contribute to this trend
3328 (EPA, 2016). Sources of pollutants in USVI ghuts are most often discharge from wastewater systems and
3329 urban runoff from storm sewers. Other frequent sources of pollution are confined animal feeding
3330 operations, minor industrial sources, and collection system failure by municipal sewage systems. Typical
3331 sources of groundwater contamination in the USVI include: bacterial contamination from failing septic
3332 systems; leaking municipal sewer lines; migration of contamination from previous injections and disposal
3333 practices; frequent sewage bypasses (generally described as discharges directly to the sea, but with some
3334 percolation into sub-soils); intrusion of saltwater caused by the over-pumping of the aquifers; invasion of
3335 volatile organic compounds; contamination from leaking underground storage tanks; and the
3336 indiscriminate/illegal discharges of waste (EPA, 2016).

3337 ***3.6.1.2 Biological Environment***

3338 St. Thomas, St. John, and St. Croix and a number of small cays have a wide range of natural resources,
3339 including rare and endangered plants and animals; endemic species; and forests, mangroves, beaches,
3340 coves, cays, seagrass beds, and reefs (Gould et al., 2013). Coral reef ecosystems in the USVI face similar
3341 pressures as reefs elsewhere in the Caribbean (Jeffrey et al., 2005). Stressors impacting the structure and
3342 function of reefs include climate change, diseases, storms, coastal development and runoff, historical
3343 removal of wetlands and mangroves, coastal pollution, tourism and recreation, overfishing and destructive
3344 fishing practices, and ship and boat groundings (NOAA CoRIS, 2019a). Other, more specific stressors,
3345 have included the mass die-off of the long-spined sea urchin (*Diadema antillarum*) in the early 1980s and
3346 mass mortality of *Acropora* species and other reef-building corals due to disease and several coral
3347 bleaching events (Friedlander et al., 2013).

3348 ***Marine***

3349 Marine habitats in the USVI include coral reefs, mangroves, seagrass beds, and sargassum mats. The
3350 variation and connectivity within these marine habitats support a rich variety of marine organisms,
3351 including corals, fish, molluscs, echinoderms, and others.

3352 The USVI currently has *in situ* coral nurseries on St. Thomas (2) and St. Croix (3), managed by The
3353 Nature Conservancy (TNC) and University of the Virgin Islands, respectively. These are relatively small
3354 nurseries (established in 2009); outplanting began in 2011, and approximately 25,000 outplants have been
3355 added to the chosen reefs (79 FR 53851).

3356 Coral reef habitats are found around the three main islands and most of cays of the USVI (Smith et al.,
3357 2018). Fringing, barrier, patch, shelf, submerged shelf-edge, spur and groove, and mesophotic reefs are all
3358 present in the USVI, with mesophotic reefs in waters 30-100 m (98-328 ft) in depth being the dominant
3359 reef structures around much of the territory (Smith et al., 2018). Reefs in St. Thomas and St. John tend to
3360 be comprised of fringing, patch, or spur and groove formations that are distributed variously around the
3361 islands. A well-developed barrier reef system with near-emergent reef crests that separate lagoons from
3362 offshore bank areas is found off the eastern and southern shores of St. Croix. Bank reefs and patch reefs
3363 are located on geological features at greater depths offshore (Jeffrey et al., 2005). Coral communities, not
3364 true coral reefs, are found growing on boulders and mangrove prop roots in shallow-water around most of
3365 the islands' shorelines (Rogers et al., 2008).

3366 In general, the most developed reefs in the USVI are found off the eastern, windward ends of the islands
3367 (Rogers et al., 2008). Higher coral reef cover tends to be found on the lower forereefs of the fringing reefs
3368 around the islands compared to habitats at depths less than 20 m (66 ft) (Rogers et al., 2008). High cover
3369 is found on deeper offshore reefs like those that are part of the reef complexes off the south of St. Thomas
3370 and St. John (Rogers et al., 2008). Well-developed reefs dominated by *Orbicella annularis* complex (*O.*
3371 *annularis*, *O. franksi*, and *O. faveolata*) occur at depths of 33-47 m (108-154 ft) south of St. Thomas
3372 (Rogers et al., 2008). *Agaricia* species become relatively more abundant with depth (Rogers et al., 2008).
3373 Many shallow reefs have extensive stands of dead *Acropora palmata* (elkhorn coral); high density stands
3374 of living elkhorn still occur in some areas (Rogers et al., 2008).

3375 Generally, based on NOAA's mapping of 485 km² (301 mi²) of benthic habitats in the USVI to a nominal
3376 depth of 30 m (98 ft), coral reef and hard-bottom habitats comprise 61%, submerged aquatic vegetation and
3377 covers 33%, unconsolidated sediments comprise 4% of shallow-water areas (Jeffrey et al., 2005). The
3378 percent cover of living coral has been found to vary from 10% to 35% in the USVI (Jeffrey et al., 2005).

3379 The coverage of living coral on various reef structures varies between the main islands. In St. Croix, for
3380 example, percent living coral varied from 4.4% to 39.1% among sites examined in one study (Jeffrey et
3381 al., 2005). Turf algae covering dead coral made up 50% or more of the benthic cover and was dominant at
3382 most sites (Jeffrey et al., 2005). Macroalgae coverage ranged from 3.2% to 34.9%. Sponges and
3383 gorgonians each comprised less than 10% of the substrata at all sites (Jeffrey et al., 2005). The
3384 composition of the coral community was similar among sites, with 10 species representing 95% of the
3385 coral community. *Montastraea* spp. and *Orbicella* spp. tended to be the most dominant corals (Jeffrey et
3386 al., 2005).

3387 At St. Thomas, the percent cover of living coral ranged from 8.3% to 42% (Jeffrey et al., 2005). The
3388 coverage of dead coral covered with turf algae ranged from 15% to 45.6%. The percent cover of
3389 macroalgae ranged from 13.8% to 42.7% (Jeffrey et al., 2005). Sponges and gorgonians each comprised
3390 less than 10% of the benthic cover at all sites, and no gorgonians were found on shelf-edge sites (Jeffrey
3391 et al., 2005). Nearshore sites tended to have a lower percent cover of living coral and higher percent cover
3392 of dead coral covered with turf algae than did mid-shelf and shelf-edge sites (Jeffrey et al., 2005). Species

3393 within the *O. annularis* complex were generally less common at nearshore sites; these sites tended to have
3394 a higher percent composition of the stress-tolerant corals *Porites astreoides* and *Siderastrea siderea* than
3395 mid-shelf and shelf-edge sites (Jeffrey et al., 2005). Overall, the reefs of St. Thomas were generally
3396 dominated by species in the genera *Montastraea* and *Orbicella* (Jeffrey et al., 2005).

3397 In a mutli-year study, Friedlander et al. (2013) observed some general spatial patterns in occurrence and
3398 cover of benthic organisms for St. John (Friedlander et al., 2013). Most coral reefs and hardbottom
3399 substrates in St. John appeared to be dominated by some form of algae, though occasional patches of hard
3400 corals, gorgonians, sponges, and other encrusting invertebrates were present. Another general pattern was
3401 the low average cover of live scleractinian coral (~5%) on coral reef and hardbottom areas (Friedlander et
3402 al., 2013). Friedlander et al. (2013) did, however, find a few hotspots of relatively high coral cover in
3403 southeastern St. John, particularly in Coral Bay (Friedlander et al., 2013). The five most dominant taxa in
3404 terms of coral cover around St. John were *O. annularis* complex, *M. cavernosa*, *P. astreoides*, *P. porites*,
3405 and *S. siderea* (Friedlander et al., 2013). On average, total seagrass cover on seagrass beds was fairly low
3406 (32%) around St. John. *Thalassia testudinum* and *Syringodium filiforme* were the most frequently
3407 observed species. Many seagrass beds had diverse assemblages, containing macro algae, sponges,
3408 gorgonians, as well as living corals and other benthic invertebrates (Friedlander et al., 2013).

3409 Invertebrates are a highly diverse component in the marine ecosystem and predominate coral reefs.
3410 Important invertebrates in the USVI include the scleractinians, commercially harvested Caribbean lobster
3411 (*Panulirus* spp), and queen conch (*Lobatus gigas*) (Johansen et al., 2018). Several species of the order
3412 Scleractinia in the USVI receive protected status from the ESA including elkhorn coral (*Acropora*
3413 *palmata*), the staghorn coral (*A. cervicornis*), the star corals (*Orbicella annularis*, *O. faveolata*, and
3414 *O. franksi*), the pillar coral (*Dendrogyra cylindrus*), and the rough cactus coral (*Mycetophyllia ferox*)
3415 (Johansen et al., 2018). USVI coral habitats are made up of at least 57 species of living corals, with over
3416 40 species of scleractinian corals and three species of *Millepora* (Rogers et al., 2008; Smith et al., 2018).
3417 Other species of importance include sponges, algae-grazing urchins, and crabs.

3418 Hundreds of fish species are known from USVI. For example, two studies have listed 400 species of fish
3419 from 93 families and 236 species, respectively (Rogers et al., 2008; Pittman et al., 2008). Friedlander et
3420 al. (2013) observed that fish species diversity was also highest where coral was most diverse and most
3421 abundant (Friedlander et al., 2013).

3422 Four species of sea turtles (i.e., leatherback, green, hawksbill, and loggerhead) forage and nest within the
3423 territory, all of which are federally protected (Platenberg & Valiulus, 2018). The Caribbean provides
3424 feeding and calving grounds for approximately 30 species of marine mammals. Some species of marine
3425 mammals, including many dolphins and sperm whales, are resident year-round; others, such as the
3426 humpback whale, migrate long distances each year (Platenberg & Valiulus, 2018). ESA-listed species in
3427 the USVI include three baleen whales (blue, fin, and sei), one toothed whale (sperm), and one sirenian
3428 (West Indian manatee).

3429 ***Freshwater and Terrestrial***

3430 Freshwater stream and pond systems are rare habitats in the USVI, and ghuts form the most extensive
3431 network of freshwater habitats in the USVI. The habitat value of these systems are high as they form
3432 some of the most diverse habitats in the USVI and are important for several aquatic species that spend
3433 part of their life cycle in freshwater and part in the marine environment (Gardner et al., 2008). These

3434 systems contain an array of species, including decapods (shrimp and crabs) and catadromous fish
3435 (Platenberg & Valiulus, 2018). Five species of shrimp from the families Palaemonidae and Atyidae are
3436 known from freshwater streams in the USVI (Platenberg & Valiulus, 2018). Observations of crabs are
3437 relatively rare though various crab species are associated with freshwater in the USVI (Platenberg &
3438 Valiulus, 2018). Freshwater fish include the Sirajo goby (*Sicydium plumieri*), mountain mullet
3439 (*Agonostoma monticola*), and small-scaled spinycheek sleeper (*Eleotris perniger*). Catadromous
3440 American eels (*Anguilla rostrata*) can also occasionally be found in freshwater systems in the USVI
3441 (Platenberg & Valiulus, 2018).

3442 Terrestrial habitats in the USVI include forests, shrublands, beaches, and cays. Forests, both dry
3443 subtropical and subtropical moist, are the principal habitat across the larger islands in the USVI
3444 (Platenberg & Valiulus, 2018). Where extreme conditions, such as strong winds and salt spray or
3445 disturbance from agriculture and land use change, limit growth to low, scrubby vegetation, shrublands
3446 and grasslands predominate (Platenberg & Valiulus, 2018). Beaches and shorelines covering the coast of
3447 the USVI may vary widely from rocky cliffs to cobbly beaches to sand, and make up a large percentage of
3448 total area of the islands. Cays are present around the larger islands, particularly the northern USVI
3449 (Platenberg & Valiulus, 2018).

3450 Thousands of terrestrial invertebrate species are found in the USVI, including insects, spiders, scorpions,
3451 millipedes, centipedes, snails, and slugs, among others. Gould et al. (2013) found the USVI terrestrial
3452 vertebrate biodiversity to be composed of over 294 species, including breeding and non-breeding
3453 residents, non-breeding and breeding migratory, vagrant or accidental species, and established exotics
3454 (Gould et al., 2013). Four native amphibians, belonging to two families, the rain frogs and the ditch frogs,
3455 are present in the USVI. All four species occur on St. Thomas and St. John (*Eleutherodactylus antillensis*,
3456 *E. cochraniae*, *E. lentus*, and *Leptodactylus albilabris*), and three occur on St. Croix (*E. antillensis*, *E.*
3457 *lentus*, and *L. albilabris*) (Platenberg & Valiulus, 2018). An additional endemic, *Eleutherodactylus*
3458 *schwartzi*, is believed to be extirpated. Three non-native amphibians are also found in the USVI: cane
3459 toad (*Rhinella marina*), Cuban tree frog (*Osteopilus septentrionalis*), and common coqui
3460 (*Eleutherodactylus coqui*) (Platenberg & Valiulus, 2018). Twenty-three species of terrestrial reptiles exist
3461 in the USVI: 13 lizards (three non-native and four endemic to the Virgin Islands), seven snakes (three
3462 non-native and two endemic), two terrapins (both presumably non-native), and one tortoise (presumed
3463 introduced) (Platenberg & Valiulus, 2018).

3464 Landbirds present in the USVI are primarily songbirds, doves and pigeons, cuckoos, and raptors
3465 (Platenberg & Valiulus, 2018). A wide variety of waterbirds are found in marshes, open water habitats,
3466 and along shorelines. A majority of these birds are migratory, breeding in North America and flying south
3467 to the Caribbean, Central America, or South America for the winter (Platenberg & Valiulus, 2018). The
3468 USVI are also an important habitat for resident and migratory seabirds. Of 39 species of seabirds
3469 recorded, 15 breed in the USVI (Platenberg & Valiulus, 2018). Boobies (Sulidae), pelicans (Pelecanidae),
3470 and frigatebirds (Fregatidae) are resident year-round. Most petrels and shearwaters (Procellariidae),
3471 storm-petrels (Hydrobatidae), tropicbirds (Phaethontidae), and jaegers, gulls, and terns (Laridae) are
3472 migratory (Platenberg & Valiulus, 2018).

3473 The only mammals endemic to the USVI are the six bat species that feed on insects and/or fruit and serve
3474 as both pollinators and seed dispersers (NPS, 2017; Platenberg & Valiulus, 2018). Ten species of

3475 mammals have established feral or free-ranging populations, including the domestic cat (*Felis*
3476 *domesticus*), the small Indian mongoose (*Herpestes javanicus*), and the Norway rat (*Rattus norvegicus*).

3477 Five plant species and five animal species in the USVI are listed as threatened or endangered (Appendix
3478 E).

3479 *3.6.1.3 Cultural Resources*

3480 The USVI, associated with the U.S. since 1917, have a rich cultural history connected to European
3481 explorers and colonizers, and the Taino and Carib Americans Indians, who inhabited the region before the
3482 arrival of the Europeans. Known human settlement in the Caribbean Islands reaches back at least 4,000
3483 years (NPS, 2004). Signs of this long history have been preserved in architecture and artifacts. There are
3484 currently 90 sites listed on the National Register of Historic Places (NRHP), spread across 16 of the 20
3485 subdistricts within the three islands/districts of the USVI (NPS, 2019a). Five sites are additionally
3486 designated National Historic Landmarks. Some properties of interest in the USVI include Fort Christian,
3487 a U.S. National Landmark and the oldest standing structure in the USVI, and Synagogue of Beracha
3488 Veshalom Vegmiluth Hasidim, the oldest synagogue in continuous use in the U.S. (NPS, 2013).

3489 *3.6.1.4 Socioeconomic Environment*

3490 *Land Use and Cover*

3491 The landscape of the USVI is made up of a variety of ecosystems including forests, woodlands,
3492 shrublands, grasslands, wetlands, rocky shores, sandy beaches, and urban environments (Gould et al.,
3493 2013). Gould et al. (2013) identified 67.2% of the USVI as predominantly woody vegetation; 6.9% as
3494 grassland or herbaceous agriculture; 21.5% as developed land; about 1% as water; and 1.9% as natural
3495 barrens. Gould et al. (2013) also broke down these broad classifications further; woody vegetation, for
3496 example, was made up of 4.6% upper elevation and gallery moist forests, shrublands and woodlands;
3497 60.7% dry forests, shrubland and woodland cover; and 1% flooded mangrove forests (Gould et al., 2013).

3498 Historically, dramatic land cover changes on the USVI first came with the development of agricultural
3499 plantations during the 17th and 18th centuries (Gould et al., 2013). Wood-cutting and other economic
3500 activities became more important during the early 19th century (Gould et al., 2013). Pastures and livestock
3501 grazing also grew in importance but eventually gave way to industrialization and urbanization (Gould et
3502 al., 2013). Land use varies from island to island; St Thomas, for example, faces more pressure from urban
3503 development and the tourism industry while St. Croix has seen greater impacts from agricultural activities
3504 such as cattle grazing (Gould et al., 2013).

3505

3506

Table 3-4. Land area coverage of various land cover types in the USVI.

3507

Land Cover Type	Area (km ²)	Area (%)
Forest, woodland and shrubland	236.2	67.2
Grasslands	25.2	7.2
Natural barrens	6.7	1.9
Agriculture	2.2	0.6
Artificial barrens	2.0	0.6
Developed areas	75.7	21.5
Water	3.6	1.0

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Source: Gould et al., 2013

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The USVI also has preservation areas, such as a national park and national monuments, created to conserve coral reef resources to varying degrees (Table 3-5).

3519

3520

Table 3-5. USVI designated marine areas, the year they were initially established and their current size. Asterisk indicates marine portion of the area only.

3521

	Year Established	Area (km ²)
Buck Island Reef National Monument	1961	3.56
Virgin Islands National Park*	1962	22.86
Marine Conservation District	1999	41.00
Virgin Islands Coral Reef National Monument	2001	76.95

3522

Source: Costa et al., 2012; NOAA, 2014; Jaap, 2015

3523

Natural Resource Economy

3524

Coral reef ecosystems in the USVI provide valuable ecological services, supporting a significant recreation and tourist industry and commercial and subsistence fisheries, as well as protecting shorelines from storms and wave action to prevent erosion, property damage, and loss of life (Jeffrey et al., 2005).

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Gorstein et al. (2019) found human participation in recreational coral reef-related activities to be significant, with most USVI residents who were surveyed participating most frequently in swimming (79%) and beach recreation (78%) (Gorstein et al., 2019). Survey results also indicated that 17% of residents dive and 45% of residents snorkel. The same study found that just over 40% of residents indicated that they participate in fishing or gathering of marine resources.

3528

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3531

3532 The USVI's economy was historically dependent on agriculture and trade. In the last several decades,
3533 however, the economy has shifted to one that is mostly tourism-based. In 2016, tourism directly produced
3534 a GDP of \$590.5 million and directly supported approximately 5,500 jobs (Gorstein et al., 2019).

3535 The USVI commercial fishing industry is relatively small and artisanal (Jeffrey et al. 2005). Compared to
3536 much of the U.S. mainland, there is no dealer network, and most commercial fishermen harvest their
3537 catch one day and sell it by the roadside the next, although a few fishermen sell directly to restaurants and
3538 resorts (Fleming et al., 2017). The fleets are largely based in St. Thomas and St. Croix, with a few
3539 fishermen still working from the much less populated St. John. The USVI charter fleet likewise works
3540 mostly from St. Thomas and St. Croix, predominantly the former, due to its larger share of tourism traffic.

3541 A variety of gear types are used across the main islands of the USVI. While traps and fish pots appear
3542 most popular on St. Thomas and St. John, hook and line and spearfishing are the most common on St.
3543 Croix (USVI DPNR, 2017).

3544 Two long-term fisheries independent datasets, collected by the USVI Territorial Coral Reef Regional
3545 Monitoring Program and the NOAA Center for Coastal Monitoring and Assessment, emphasize the
3546 significant differences between the northern USVI and St. Croix in both the occurrence and size of
3547 several species of large and commercially important reef fishes (Kadison et al., 2017). Snappers (family
3548 Lutjanidae) and groupers (family Epinephelinae) are important USVI fisheries, with snapper biomass
3549 much lower on St. Croix sites than St. Thomas or St. John sites, while grouper biomass is low overall, but
3550 relatively higher in St. Thomas and St. John sites. There is a high variability between years for snappers
3551 in St. Thomas and St. John because some sites host spawning aggregations of cubera (*Lutjanus*
3552 *cyanopterus*) and schoolmaster snapper (*L. apodus*) (Smith et al., 2015).

3553 Other major coral reef-associated fisheries in the USVI include Caribbean spiny lobster (*Panulirus argus*)
3554 and queen conch (*Lobatus gigas*). Spiny lobster were the top species landed in 2016 on St. Thomas and
3555 St. John; landings of lobster were much lower on St. Croix (USVI DPNR, 2017). Queen conch is more
3556 frequently landed on St. Croix than on the other main islands (USVI DPNR, 2017).

3557 Species that are currently designated as overfished, meaning that stock biomass is below a determined
3558 threshold for sustainability, include goliath grouper (*Epinephelus itajara*), Nassau grouper (*Epinephelus*
3559 *striatus*), and queen conch.

3560 **3.6.2 Puerto Rico**

3561 The Commonwealth of Puerto Rico is the easternmost archipelago of the Greater Antilles and is
3562 comprised of the main island; the oceanic islands of Mona, Monito, and Desecheo in the Mona Passage;
3563 Caja de Muertos Island on the south coast; Vieques Island; Culebra Island; and a series of smaller islets or
3564 cays known as the “Cordillera de Fajardo” (Garcia-Sais et al., 2005).

3565 **3.6.2.1 Physical Environment**

3566 The main island is approximately 180 km (112 mi) long and 50 km (31 mi) wide and has 620 km (385
3567 mi) of coastline (Gould et al., 2008) (Figure 3-3). The dominant physiographic features of the island of
3568 Puerto Rico are the Central Mountain Range, or Cordillera Central, that runs east-west, a region of karst
3569 hills in the northwest, and the Luquillo Mountains of the northeast (Gould et al., 2008).

3570 Puerto Rican coasts are composed mainly of rocky shores, sandy beaches and dunes, and wetlands.
3571 Wetlands can be found island-wide while rocky shores, as well as the sand beach and dune systems, are
3572 often found in the north coast. The geological, climatological, and oceanographic features that affect
3573 growth and development of coral reefs vary markedly along the coasts (García-Sais et al., 2005).

3574 The north and northwest coasts have a relatively narrow shelf, and ecological communities are subject to
3575 strong wave action during winter from large swells coming from the north Atlantic (García-Sais et al.,
3576 2005). The largest rivers of Puerto Rico also discharge in this area, carrying substantial amounts of
3577 sediments and nutrients to the ocean. Sand dunes are abundant along the north coast, as are rocky beaches
3578 with rich intertidal communities and small seagrass patches (García-Sais et al., 2005). The northeast coast
3579 has a wider shelf, partially protected from wave action by the Cordillera de Fajardo. The east coast
3580 between Fajardo and Vieques is characterized by expansive sand deposits that do not support extensive
3581 coral growth (García-Sais et al., 2005). The south coast shelf is generally wider than that of the north
3582 coast and is subject to relatively low wave energy. Embayments and submarine canyons are found along
3583 the south coast. Small mangrove islets also exist on this coast, many providing hard substrate for coral
3584 development (García-Sais et al., 2005). On the south coast, the shelf-edge drops off at about 20 m with an
3585 abrupt, steep slope. A submerged coral reef lies at the edge of the shelf and gives protection to other reefs,
3586 seagrass and mangrove systems of the inner shelf (García-Sais et al., 2005). The southwest coast is
3587 relatively wide and dry, with many emergent and submerged coral reefs that provide for development of
3588 seagrass beds and fringing mangroves (García-Sais et al., 2005).

3589 Tides in Puerto Rico are generally mixed, with semi-diurnal tides along the Atlantic-facing coast (mean
3590 range: 0.33 m [1.08 ft]) and diurnal tides on the Caribbean side (mean range: 0.20 m [0.65 ft]) (NOAA,
3591 2019a). Currents in the Mona Passage and in the Vieques and Virgin Passages are strongly semidiurnal,
3592 with current velocities up to 2 kt (2.3 mps) (NOAA, 2019a). Large-scale circulation features such as the
3593 Caribbean Current and mesoscale eddies can affect coastal currents.

3594 There are four marine protected areas that the Puerto Rico government jointly manages with NOAA:
3595 Jobos Bay National Estuarine Research Reserve and three seasonal closure areas for spawning
3596 aggregations of red hind grouper (*Epinephelus guttatus*)--Tourmaline Bank, Bajo de Cico, and Abrir La
3597 Sierra (DOE, 2017a).

3598 ***Climate and Weather***

3599 The climate of Puerto Rico is tropical marine with moderate temperatures year round (Runkle et al.,
3600 2018). Temperatures average around 27°C (80°F) in lower elevations and 21°C (70°F) in the mountains
3601 and higher elevations. Temperatures are generally cooler in January, with an average minimum
3602 temperature of 22.2°C (72.0°F) and an average maximum temperature of 28.4°C (83.2°F), and warmer in
3603 August, with an average minimum temperature of 25.7°C (78.2°F) and an average maximum temperature
3604 of 31.8°C (89.2°F) (Runkle et al., 2018). The dominant influence on the island's climate is the North
3605 Atlantic subtropical high, which creates persistent prevailing trade winds from the east and northeast
3606 (Runkle et al., 2018).

3607 The topography of the island also plays a significant role in the climate of the island. The mountains of
3608 the Cordillera Central are the primary factor in the rainfall and temperature variations that occur over very
3609 short distances on the island and serve as a natural divide that separates Puerto Rico into two
3610 climatologically discrete regions. The wetter, more humid regions of the island are found on the

3611 windward, northern side of the mountains, and drier, semi-arid climate is found in the leeward rain
3612 shadow (Gould et al., 2008; Runkle et al., 2018).

3613 Mean annual rainfall on Puerto Rico ranges from below 90 cm (295 in) in the subtropical dry habitats to
3614 over 400 cm (1312 in) in the subtropical wet rain forest (Gould et al., 2008). Puerto Rico has a defined
3615 rainy season that lasts from April to November (Runkle et al., 2018). The rainfall in the wet season is
3616 largely a result of hurricanes and tropical storms. High sea surface temperatures during this season can
3617 also trigger local thunderstorm activity. In the dry season, rainfall is caused by cold fronts moving from
3618 west to east (Runkle et al., 2018).

3619 Due to their position in the Caribbean hurricane belt, the islands of Puerto Rico are significantly affected
3620 by tropical cyclone events (hurricanes, tropical storms, and tropical depressions). These events typically
3621 occur near the islands once every two years, and they can have devastating impacts (Runkle et al., 2018).
3622 Tropical cyclones that have affected Puerto Rico in the 21st century include, but are not limited to,
3623 Tropical Storm Jeanne in 2004, Hurricane Irene (Category 1) in 2011, and Hurricane Irma (Category 5) in
3624 2017 (Runkle et al., 2018). Hurricane Maria (Category 5) made landfall in Puerto Rico in September 2017
3625 as a Category 4 hurricane, but locally winds reached Category 5 intensity. Maria led to overwhelming
3626 destruction across the islands. Extremely heavy rainfall and intense wave action and storm surge caused
3627 extensive damage. Severe flooding and mudslides also devastated much of Puerto Rico, and most
3628 residents lost power for months during the largest power outage in American history (Runkle et al., 2018).

3629 ***Water Resources***

3630 Puerto Rican watersheds are small with steep channel gradients and narrow stream valleys that transport
3631 57% of the mean annual precipitation (911 mm [36 in] of the 1,600 mm/yr [63 in/yr] on average from
3632 1990-2000) to the coast (Warne et al., 2005). Major storms are generally intense and brief, rapidly
3633 producing floods from maximum daily discharge rates that can be more than three orders of magnitude
3634 above base discharge rates before quickly receding on the order of hours to a few days (Warne et al.,
3635 2005). With this runoff comes a substantial amount of transported sediment from upland watersheds to
3636 the coast, with mean annual suspended-sediment discharge from Puerto Rico into surrounding coastal
3637 waters estimated to have ranged from 2.7-9.0 million metric tons for the water years 1990-2000 (Warne et
3638 al., 2005).

3639 Nonpoint source pollution of Puerto Rican rivers and streams via septic tanks, animal feeding operations,
3640 and urban runoff are the major sources of surface water contamination. This pollution causes the
3641 impairment of lakes, reservoirs, and ponds through depletion of dissolved oxygen, increases in fecal
3642 coliform, and pH, among other causes. The causes of impairment for coastal shorelines, bays, and
3643 estuaries are similar and include fecal coliform, low dissolved oxygen, non-mercury metals, turbidity, and
3644 pH.

3645 Puerto Rico has two major aquifers (the karst North Coast Limestone and alluvial South Coastal Plain
3646 aquifers), and dissolved solids in both aquifers are dominated by calcium and bicarbonate ions (Olcott,
3647 1999). In the northern aquifer, the chemical composition of the groundwater changes with proximity to
3648 the Atlantic Ocean; concentrations of magnesium, sulfate, and pH increase closer to the ocean (Olcott,
3649 1999). Groundwater provides 16 percent of the water used in Puerto Rico (Rafael et al., 2016).

3650 *3.6.2.2 Biological Environment*

3651 Puerto Rico has a variety of unique marine and terrestrial ecosystems, including coastal mangrove forests,
3652 seagrass beds, tropical rain forests, tropical dry forests, and coastal plains. Puerto Rico is surrounded by
3653 over 5,000 km² (3,106 ft²) of shallow-water coral reef ecosystems (NOAA CoRIS, 2019b). The present
3654 status of Puerto Rican coral reefs may be one of the most critical in the Caribbean (Garcia et al., 2003),
3655 with approximately 93% of Puerto Rico's coral reefs identified as vulnerable and 84% as high risk
3656 (Gorstein et al., 2017). Extensive urban and industrial development and a history of ineffective
3657 management policies to conserve these ecosystems played a role in the degradation of the reefs (Garcia et
3658 al., 2003). Other historical anthropogenic stressors include deforestation of mangrove forests in the north,
3659 dredging of bays, runoff from large-scale agricultural activities in the coastal plain, deforestation of
3660 riparian areas in large river watersheds, raw sewage disposal into rivers, and establishment of
3661 thermoelectric power plants on the north and south coasts (Garcia et al., 2003). Today, sedimentation,
3662 eutrophication, pollution, algal growth, and overfishing also negatively affect reefs. Other impacts such as
3663 coral bleaching, diseases, invasive species, and physical damage have also contributed to the declining
3664 health of the reefs (Gorstein et al., 2017). Hurricanes are natural catastrophic events that have also caused
3665 massive mortalities to coral reef and other coastal marine communities in Puerto Rico (Garcia-Sais et al.,
3666 2005).

3667 *Marine*

3668 At least three significant types of reefs—rock reefs, hard ground reefs, and coral reefs—are found within
3669 the Puerto Rican shelf (García-Sais et al., 2005; Garcia et al., 2003). Rock reefs are submerged hard
3670 substrate features of moderate to high topographic relief with low to very low coral cover. They are
3671 mostly colonized by turf algae and other encrusting biota. Coral colonies can be abundant in some cases
3672 (e.g., *Diploria* spp., *Siderastrea* spp., *Montastrea cavernosa*, *Porites astreoides*) but grow mostly as
3673 encrusting forms that provide minimal topographic relief (García-Sais et al., 2005; Garcia et al., 2003).
3674 Rock reefs fringe the west and northwest coasts and are likely the main components of deep reef systems
3675 beyond the shelf edge (García-Sais et al., 2005). These coasts are subjected to high wave energy,
3676 abrasion, and sedimentation stress (Garcia et al., 2003). Rock reefs are important habitats for fish and
3677 macroinvertebrates as the reefs are generally the only structure providing underwater topographic relief in
3678 these areas. Some rock reefs are characterized by the development of coralline communities adapted for
3679 growth under severe wave action and strong currents (García-Sais et al., 2005; Garcia et al., 2003).

3680 Hard ground reefs are mostly flat platforms ranging in depth from 5-30 m. These reefs are typically
3681 covered by turf algae, encrusting sponges, and scattered patches of stony corals (García-Sais et al., 2005;
3682 Garcia et al., 2003). Coral colonies on hard ground reefs are generally encrusting forms, which may result
3683 from the high wave action that prevails in the winter months on the north coast (García-Sais et al., 2005;
3684 Garcia et al., 2003). One of the main contributors to topographic relief of hard ground reefs is the barrel
3685 sponge (*Xestospongia muta*) (García-Sais et al., 2005; Garcia et al., 2003). In many areas, low-relief,
3686 coarse-substrate sand channels cut through the hard ground reefs and are devoid of biota (García-Sais et
3687 al., 2005; Garcia et al., 2003). These systems are found off the central north and northeast coastlines
3688 (García-Sais et al., 2005; Garcia et al., 2003).

3689 The coral reef ecosystems in Puerto Rico are mosaics of interrelated habitats, including mangrove forests,
3690 macroalgal beds, seagrass beds, and coral reefs, as well as other coral communities (García-Sais, 2008).
3691 Distribution of these ecosystems varies as the result of geomorphology and different exposure to wave

3692 and wind action, resulting in different types of reef formations that include fringing, patch, spur and
3693 groove, shelf-edge, and cays (Ballantine et al., 2008).

3694 Fringing coral reefs are the most common coral reef formation in Puerto Rico and are found along most of
3695 the northeast, east, and south coastlines (Garcia et al., 2003). Coral is not the main component of the basic
3696 reef structure, but its development has significantly contributed to the topographic relief of the reef,
3697 providing habitat for a diverse biological assemblage consistent with a coral reef community (Garcia et
3698 al., 2003). Fringing reefs are also found off the northeast coast at Rio Grande, Luquillo, Fajardo, Culebra
3699 and Vieques. Fringing reefs on the north coast are characterized by the presence of shallow (0.5-3.0 m
3700 depth) back-reef communities dominated by *Porites porites* habitats and scattered colonies of different
3701 species (Garcia et al., 2003). On the south coast, coral reefs fringe many small islands or cays. These reefs
3702 may be found as fairly extensive coral formations at the mouths of coastal embayments (Garcia et al.,
3703 2003). In some cases, coral growth has led to the formation of emergent island reefs, such as the reefs off
3704 La Parguera where well-developed coral assemblages fringe the forereef section of the islet. A reef flat
3705 with *Porites porites* habitat is generally found with intermixed turtle seagrass (*Thalassia testudinum*) and
3706 scattered small, low-relief coral colonies. Development of the reef flat can lead to the growth of red
3707 mangroves (*Rhizophora mangle*) whose aquatic root system provides habitat for a diverse assemblage of
3708 juvenile reef fishes and invertebrates. As wave action brakes up coral colonies and fragments and deposits
3709 them on the emergent section of the reef, the reef will continue to grow (Garcia et al., 2003).

3710 Shelf-edge reefs are the best developed coral reef ecosystems in Puerto Rico (Garcia et al., 2003). An
3711 extensive reef formation is found at the shelf-edge off the south coast. Another well-developed formation
3712 is the shelf-edge reef at the northern Tourmaline Reef off Bahía Mayaguez. The best developed reef
3713 within Puerto Rican waters is likely the shelf-edge reef found off the southwestern section of Isla de
3714 Mona where extensive sections surpass 60% of live coral cover (Garcia et al., 2003).

3715
3716 On the north coast, where large oceanic swells are present, reefs are generally dominated by macroalgae
3717 and have low abundance of scleractinian corals (1-5% cover) (Ballantine et al., 2008). Alcyonarians and
3718 the hydrocoral *Millepora squarrosa* are common along this coast but essentially absent on other coasts
3719 (Ballantine et al., 2008). The development of reefs on the north coast off Luquillo and other areas on the
3720 northeast coast may be associated with a wider shelf and corresponding reduction in ocean swells
3721 (Ballantine et al., 2008). Garcia et al. (2003) found that of 52 reefs examined, reefs with live coral cover
3722 below 10% were all on the northeast coast, including the island of Vieques. Mainland reefs from the north
3723 and northeast coastlines (Mameyal, Bajíos, Boca Vieja, Morrillos, Siete Mares, Pta. Candeleró) all had
3724 low coral cover with Las Cabezas Reef in Fajardo being the only mainland reef from the northeast
3725 coastline with live coral cover above 10% (Garcia et al., 2003).

3726 Coral reefs along the east coast of Puerto Rico tend to be well-developed, and fringing reefs along the
3727 mainland are the most common reef type in this region (Ballantine et al., 2008). Shallow areas tend to be
3728 dominated by zoanthids and scleractinian coral taxa that are relatively rapid colonizers like *Porites*
3729 *astreoides* and *Siderastrea radians* (Ballantine et al., 2008). Nonetheless, scleractinian coral cover rarely
3730 exceeds 5% with the exception of extensive stands of *Acropora palmata*, which occur occasionally
3731 (Ballantine et al., 2008). On offshore islands, fringing reefs have variable scleractinian cover (Ballantine
3732 et al., 2008). The shallow windward zone (0.3-1.0 m) tends to have low scleractinian and hydrocoral
3733 cover (<10%) while the deeper windward zone (3-5 m) has structures resembling spur and groove

3734 formations with live scleractinian cover between 5% and 20% (Ballantine et al., 2008). At greater depths,
3735 live cover varies between 30% and 80% (Ballantine et al., 2008). Leeward areas typically have high
3736 scleractinian diversity and cover (Ballantine et al., 2008). On the east coast, coral assemblages also occur
3737 on shallow basalt outcrops (Ballantine et al., 2008). Here, scleractinian cover is patchy (1-35%), but non-
3738 reef building taxa like alcyonarians and zoanthids are abundant (Ballantine et al., 2008). Invertebrate
3739 cover in shallow areas of basaltic outcrop formations is typically low and dominated by hydrocorals.
3740 Deeper areas (10-20 m) of basaltic outcrops have low coral cover (<5%) (Ballantine et al., 2008). Shelf-
3741 edge reefs at even greater depths (20-40 m) are common on the east coast and have high scleractinian
3742 richness and cover (85-100%) (Ballantine et al., 2008).

3743 The south and west coasts of Puerto Rico support extensive seagrass, coral reef, and algal communities.
3744 Mangrove forests and coralline keys dot the coast in areas protected from development (Ballantine et al.,
3745 2008). The territory's best-developed reefs occur in the La Parguera area of southwest Puerto Rico
3746 (Ballantine et al., 2008). In this area, an inner reef and a mid-shelf reef generally parallel the coastline
3747 (Ballantine et al., 2008). Depending on the environmental factors present, these reefs are dominated by
3748 algal, alcyonarian, or scleractinian-sponge communities (Ballantine et al., 2008). Fringing reefs bordering
3749 the shoreline are the dominant inshore coral reef habitat in La Parguera (Ballantine et al., 2008).
3750 According to Garcia et al. (2003), shallow reefs with live coral cover of 20% or higher were from the
3751 southeast coast (Garcia et al., 2003). Live coral cover at the deeper reefs studied (15-25 m) was highest at
3752 44% at the shelf-edge reef off La Parguera (Garcia et al., 2003). Other reefs surveyed at depths between
3753 15 and 25 m (49 and 82 ft) from the southwest coast (Penuelas, Turrumote) had live coral cover ranging
3754 from 16 to 27%. *Orbicella annularis*, *Montastrea cavernosa*, *Porites atreoides*, and *Agaricia* spp. were
3755 the most common coral taxa at the deeper reefs studied (Garcia et al., 2003).

3756 At greater than 30 m (98 ft), deep reefs occur along the insular slope of Puerto Rico and associated islands
3757 (Ballantine et al., 2008). Scleractinian cover typically decreases with depth in deep reefs, with the
3758 maximum depth of hermatypic scleractinians between 70 m (21 ft) and 100 m (34 ft) (Ballantine et al.,
3759 2008). Alcyonarian abundances also decrease with depths over 65 m, but antipatharian abundance has
3760 been found to peak at 54 m (177 ft) (Ballantine et al., 2008). Up to depths of 100 m, sponges appear to be
3761 the major structural component of the deep reef fauna while algae account for much of the benthic cover
3762 (Ballantine et al., 2008).

3763 The coral reefs of Puerto Rico have the greatest species richness in the Caribbean, with 125 hard corals,
3764 112 soft corals and gorgonians, and over 200 species of fish (Kelty et al., 2004). At least 69 species of
3765 scleractinian corals, 46 alcyonarian species, 42 octocorals, four species of black coral (anthipatharians),
3766 and four hydrocorals have been identified in Puerto Rico (Ballantine et al., 2008; Garcia et al., 2003). Fish
3767 communities in Puerto Rican waters are represented by 260 species (Dennis et al., 2004), and some of the
3768 habitats described above are considered EFH for different species. The number of fish species has been
3769 found to positively correlate ($p < 0.01$) with live coral cover on reefs surveyed around Puerto Rico (Garcia-
3770 Sais et al., 2005). Reefs with low live coral cover and high benthic algal cover exhibit less diverse fish
3771 communities (Garcia-Sais et al., 2005). The benthic marine algae in Puerto Rico is the best known in the
3772 Caribbean and consists of approximately 500 species (Ballantine et al., 2008).

3773 Five species of sea turtle forage and nest within Puerto Rico; all five species are listed as federally
3774 endangered or threatened (Caribherp, 2019). More than 30 species of marine mammal have been
3775 documented in the Caribbean Sea (UNEP CEP, 2015). These species include sperm whale (*Physeter*

3776 *macrocephalus*), Cuvier's beaked whale (*Ziphius cavirostris*), short-finned pilot whale (*Globicephala*
3777 *macrorhynchus*), rough-toothed dolphin (*Steno bredanensis*), bottlenose dolphin (*Tursiops truncatus*),
3778 Atlantic spotted dolphin (*Stenella frontalis*), Pantropical spotted dolphin (*Stenella attenuata*), spinner
3779 dolphin (*Stenella longirostris*), and striped dolphin (*Stenella coeruleoalba*). ESA-listed species include
3780 the West Indian manatee Puerto Rico stock (Antillean subspecies, *Trichechus manatus manatus*) and five
3781 whale species: sperm, blue (*Balaenoptera musculus*), finback (*Balaenoptera physalus*), humpback
3782 (*Megaptera novaeangliae*), and sei (*Balaenoptera borealis*).

3783 During the last decades, losses to the system due to diseases, unsustainable fishing, and other human
3784 impacts have shaped the current state of the reefs. Important coral reef ecosystem species are sea turtles
3785 (all), sharks (all), butterfly fish (*Chaetodon capistratus*), black urchin (*Diadema antillarum*), and
3786 parrotfishes (all). Culturally important reef fish/marine species include spiny lobster (*Panulirus argus*);
3787 queen conch (*Strombus gigas*); snappers: silk (*Lutjanus vivanus*), lane (*Lutjanus synagris*), and yellowtail
3788 (*Lutjanus chrysurus*); hogfish (*Lachnolaimus maximus*); trunkfish (*Lactophrys spp.*); cowfish
3789 (Tetraodontidae); grunts (Haemulidae); red hind (*Epinephelus guttatus*); queen trigger (*Balistes vetula*);
3790 and octopus (*Octopus spp.*).

3791 ***Terrestrial and Freshwater***

3792 Freshwater habitats in Puerto Rico include rivers, reservoirs, lagoons, streams, and ponds. The central
3793 mountain chain is oriented east to west, and most of the major rivers in Puerto Rico flow toward the north
3794 shore. Rivers with smaller drainage basins discharge on the southeast coast and only small creeks
3795 discharge on the southwest coast. The island has no natural lakes.

3796 Freshwater marshes have diverse vegetation consisting of grasses, sedges, rushes, and broadleaved
3797 aquatic plants while aquatic freshwater environments are dominated by vegetation such as water lily
3798 (*Nymphaea spp.*), alligator weed (*Alternanthera philoxeroides*), naiad (*Najas spp.*), fanwort (*Cabomba*
3799 *caroliniana*), and water hyacinth (*Eichhornia crassipes*).

3800 Native freshwater fish assemblages of the Caribbean islands are dominated by species that migrate
3801 between freshwater and marine ecosystems and depend on the connectivity between riverine, estuarine
3802 and marine environments to complete their life cycles (USFWS, 2018a). Native species of Puerto Rico
3803 include the mountain mullet (*Agnosotomus monticola*), little anchovy (*Anchoa parva*), American eel
3804 (*Anguilla rostrata*), fat sleeper (*Dormitator maculatus*), and Sirajo goby (*Sicydium plumieri*) (Fishbase,
3805 2017).

3806 The landscape of Puerto Rico is made up of a variety of ecosystems including subtropical dry to moist
3807 forest, karst, woodlands, shrublands, grasslands, wetlands, rocky shores, sandy beaches, and urban
3808 environments (Gould et al., 2008). Puerto Rico possesses a varied range of habitats due to the differential
3809 rainfall around the island, a result of the Cordillera Central's influence over precipitation patterns. Puerto
3810 Rico has a diverse native flora with more than 180 higher vascular plant families and 3,100 species
3811 (Miller & Lugo, 2009).

3812 These habitats also harbor many species of terrestrial invertebrates, amphibians, reptiles, birds, and
3813 mammals. Gould et al. (2008) indicated 436 vertebrate species have been recorded in Puerto Rico,
3814 including 328 birds, 57 reptiles, 27 mammals, and 24 amphibians (Gould et al., 2008). Sixty-nine of these
3815 species are endemic (Gould et al., 2008). Mammals in Puerto Rico include 13 living, native species, all of

3816 which are bats. Some important charismatic species for the region are the Puerto Rican parrot (*Amazona*
3817 *vittata*) and the Coquí tree frog (*Eleutherodactylus coqui*) (Miller & Lugo, 2009).

3818 Non-native terrestrial mammals of Puerto Rico include introduced domestic animals and pest species such
3819 as the Indian mongoose (*Herpestes edwardsii*). Other introduced pest species include the black rat (*Rattus*
3820 *rattus*), Norway rat (*Rattus norvegicus*), and the house mouse (*Mus musculus*). Four species of non-native
3821 monkeys escaped from rearing colonies, including the Rhesus monkey (*Macaca mulatta*), and have
3822 occupied the southwest coast (Miller & Lugo, 2009).

3823 Puerto Rico has 21 animals and 50 plants listed as federally endangered or threatened (Appendix E).

3824 *3.6.2.3 Cultural Resources*

3825 Like the USVI, Puerto Rico has a rich cultural history associated with the Taino and Carib peoples, as
3826 well as European and American influences. Associated with the U.S. since 1898, Puerto Rico has 351
3827 properties listed on the NRHP, with one or more NRHP listings in each of Puerto Rico's 78
3828 municipalities (NPS, 2019a). For example, during the 16th century, recognizing the need to protect the
3829 Spanish treasure fleets on their voyages to and from the New World, the Spanish erected extensive
3830 fortifications throughout their territories in the Caribbean Islands and the Gulf of Mexico. Designated a
3831 UNESCO World Heritage Site and National Historic Site, the Spanish system of fortifications in San
3832 Juan, Puerto Rico is the oldest European construction in the U.S. and one of the oldest in the New World
3833 (NPS, 2011).

3834 *3.6.2.4 Socioeconomic Environment*

3835 *Land Use and Cover*

3836 Land cover in Puerto Rico was classified by Gould et al. (2008) as 53% predominantly woody vegetation,
3837 32% grassland, 3% herbaceous agriculture, 11% developed and artificially barren land, <1% naturally
3838 barren land, and 1% fresh water (Table 3-6). The woody areas were further broken down into 26% low
3839 and mid-elevation moist forests, 18% upper elevation wet forests, 7% dry forests, and 1% flooded
3840 mangrove and Pterocarpus forests. The most abundant forest types are the montane wet evergreen
3841 secondary forest, which includes active and abandoned coffee plantations, and young secondary lowland
3842 moist forest on noncalcareous substrates (Gould et al., 2008). Nearly all of the moist and dry grasslands
3843 were found to be maintained by disturbance such as continuous or intermittent cattle grazing and or
3844 frequent burns (Gould et al., 2008). Natural barrens make up less than 1% of the area, but they are an
3845 important component of the landscape, both for human use and as wildlife habitat. Natural barrens
3846 include stony and sandy beaches, rocky cliffs and shelves, active riparian flood plains, and salt and
3847 mudflats (Gould et al., 2008). Development does not occur equally around the island and is concentrated
3848 in the coastal plain and lower hills. Sixty percent of the development occurs in the plains, where the most
3849 productive lands for agriculture are located, while developed areas cover less than 7% of the total area in
3850 the hills and mountains (Gould et al., 2008b).

3851

3852

Table 3-6. Land use/cover area size of Puerto Rico.

Land Use/Cover	Area (km ²)	Area (%)
Water	85.4	1.0
Developed areas	895.7	10.0
Forest, woodland, and shrubland	4718.7	52.7
Grasslands	2864.1	32.0
Agriculture	262.6	2.9
Natural barrens	35.8	0.4
Artificial barrens	86.9	1.0

3853

Source: Gould et al., 2008

3854 Within the land uses presented in Table 3-6, roughly 8% of Puerto Rico's land is designated for
 3855 conservation. This includes public and private properties classified as state forests, national federal
 3856 forests, wildlife refuges, natural reserves, natural protected areas, conservation easements, recently
 3857 acquired lands for conservation, and other lands managed for conservation (Gould et al., 2011).

3858 **Natural Resource Economy**

3859 Communities in Puerto Rico benefit from coral reef resources through tourism, commercial fishing, and a
 3860 range of recreational activities (Gorstein et al., 2017). Leeworthy et al. (2018) found that reef-using
 3861 visitors to Puerto Rico spend over \$1.9 billion annually within Puerto Rico. These expenditures support
 3862 over 3% of jobs, account for nearly 4% of total income to the region, and generate nearly \$2 billion in
 3863 economic output to Puerto Rico (Leeworthy et al., 2018). Coral reefs also protect coastal infrastructure
 3864 and beaches from erosion due to storm events and wave action, as well as provide material to replenish
 3865 beaches (Gorstein et al., 2017).

3866 Gorstein et al. (2017) found that participation in non-extractive recreational reef activities varies in Puerto
 3867 Rico, with the two activities that residents participate in most frequently being beach recreation (83%
 3868 participate) and swimming (51% participate). Participation in extractive activities such as spearfishing
 3869 (5% participate), fishing (14% participate), and gathering of marine resources (6% participate) is less
 3870 common (Gorstein et al., 2017).

3871 Puerto Rico's commercial fishery is a multispecies, multi-gear, small-scale, artisanal fishery where
 3872 harvest is used mostly for local consumption and is an important source of income and sustenance to
 3873 many coastal communities (Matos-Caraballo & Agar, 2008).

3874 In a 2008 study, Matos-Caraballo and Agar found that reef fishes were targeted by 77% of commercial
 3875 fishermen—of those fishermen, 56% targeted deep-water snapper, 49% lobster, 42% pelagic fishes, 33%
 3876 conch, and 31% bait (Matos-Caraballo & Agar, 2008). Tonioli and Agar (2011) found the lobster fishery
 3877 to be the most valuable commercial fishery in Puerto Rico, yielding 265,518 lbs (120 metric tons) valued
 3878 at \$1,617,250 in 2008. SCUBA was the leading gear in this fishery, followed by fish and lobster traps
 3879 (Tonioli & Agar, 2011). Queen conch (*Strombus gigas*) was found to be the second most important

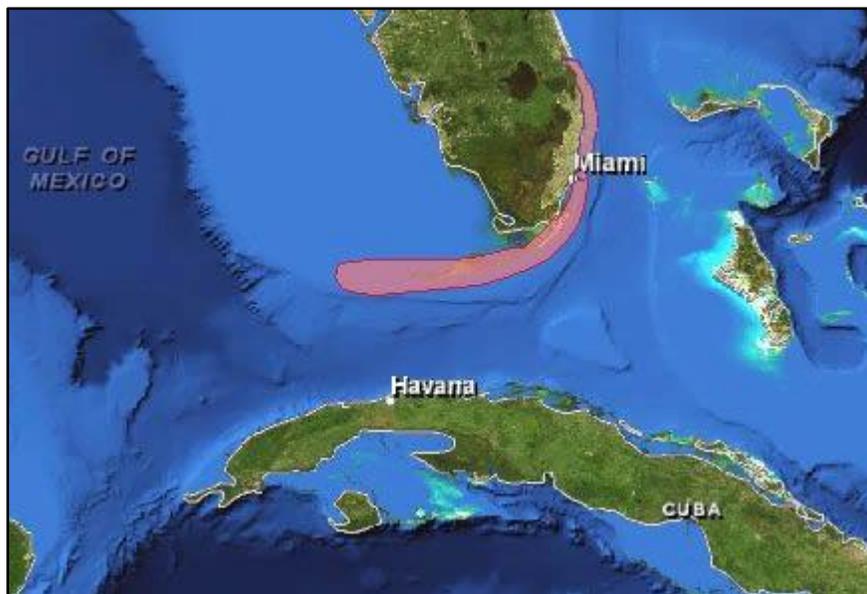
3880 commercial fishery in Puerto Rico, yielding 208,676 lbs (94 metric tons) and \$836,347 in 2008 (Tonioli
3881 & Agar, 2011). The primary gear type was SCUBA (Tonioli & Agar, 2011). The Caribbean Fishery
3882 Management Council has designated queen conch as overfished (NOAA, 2017b).

3883 Gear usage and species targeted vary around the island. For example, the northern coast of Puerto Rico
3884 has a narrow insular shelf and an exposed coast that encourages the use of hook and line and, to a lesser
3885 extent, net gears, and discourages the use of traps and SCUBA (Tonioli & Agar, 2011). Fishermen in this
3886 region favor reef fish species such as yellowtail snapper (*Ocyurus chrysurus*), triggerfish (Balistidae), and
3887 parrotfish (Labridae and Scaridae); deep-water snappers such as silk (*Lutjanus vivanus*) and queen
3888 snappers (*Etelis oculatus*); and pelagic species such as dolphin-fish (*Coryphaena hippurus*), king
3889 mackerel (*Scomberomorus cavalla*), and little tunny (*Euthynnus alletteratus*) (Tonioli & Agar, 2011). By
3890 comparison, the southwest coast has a relatively shallow and extended shelf, where fishermen favor the
3891 use of bottom lines, SCUBA, and, to a lesser extent, troll lines and fish pots. This larger shelf allows
3892 fishermen to target a greater mix of species, including queen conch; spiny lobster; reef fish like
3893 yellowtail, lane (*Lutjanus synagris*), and mutton snappers (*Lutjanus analis*); deep-water snapper like silk
3894 and queen snappers; and pelagic species like dolphinfish, skipjack (*Katsuwonus pelamis*), blackfin
3895 (*Thunnus atlanticus*), and yellowfin tunas (*Thunnus albacares*); and king mackerel (Tonioli & Agar,
3896 2011).

3897 **3.6.3 Florida**

3898 *3.6.3.1 Physical Environment*

3899 Florida (170,304 km² [105,822 mi²]) is the southernmost peninsula of the U.S., dividing the Gulf of
3900 Mexico and the Atlantic Ocean via the Straits of Florida. The Florida Current (up to 180 cm/s [71 in/s]),
3901 flowing east through the Straits of Florida, is adjacent to the Florida Reef Tract, which includes the
3902 Florida Keys National Marine Sanctuary, Biscayne National Park, Dry Tortugas National Park, and
3903 multiple other state and federal protected areas. The Florida Reef Tract, which spans about 370 km (200
3904 nm) from Palm Beach County, Florida to the Dry Tortugas, is the third largest barrier reef in the world
3905 and contains patch reefs and bank reefs (Figure 3-4).



3906
3907

Figure 3-4. Location of the Florida Reef Tract (red). Source: NOAA CoRIS, 2019c

3908 In addition to the Florida Reef Tract, habitats of the Atlantic Ocean and Gulf of Mexico contain both
3909 coral reef communities, patch reefs, and solitary coral colonies. Corals may dominate a habitat (coral
3910 reefs, patch reefs), be a significant component (hard bottom), or be individuals within the shelf region
3911 between central and southern Florida on the Atlantic coast. Immediately north of the Florida reef tract in
3912 southeastern Florida, the hard-bottom habitat is predominated by gorgonians and has several
3913 scleractinians as well (Wheaton & Jaap, 1976). The west Florida shelf in the Gulf of Mexico provides
3914 habitat for corals, particularly at the Florida Middle Grounds (FMG), which has reef-building species.

3915 *Climate and Weather*

3916 Florida's climate ranges from temperate in the north to subtropical in the south as the state lies at the
3917 convergence of these two climate zones (Andrews et al., 2005). Southeast Florida's climate ranges from
3918 subtropical to tropical maritime in Key West (Jaap et al., 2008). The Gulf of Mexico, Caribbean Sea, and
3919 Atlantic Ocean significantly influence Florida's generally warm, humid climate. The Gulfstream majorly
3920 influences water temperature and the transport of flora and fauna to the region. The Gulfstream enters into
3921 the Gulf of Mexico as the Loop Current and reverses flow to return to the Straits of Florida. There, it joins
3922 the main body of the Florida Current before flowing in a northeasterly direction towards Europe
3923 (Andrews et al., 2005).

3924 South Florida experiences dramatic seasonal shifts in weather patterns, with heavy rains occurring
3925 primarily in the summer. North Florida's rainfall occurs mainly in winter because of the influence from
3926 continental frontal systems. Freezes occur yearly in North Florida but are rare in South Florida. Freeze
3927 events influence the range of tropical species up the Florida peninsula as tropical species range farther
3928 north along the coasts, which are better buffered from freeze events than interior areas (Florida FWCC,
3929 2012).

3930 Florida's climate is overlaid on the El Niño Southern Oscillation system cycles. El Niño brings warmer
3931 and wetter winters, fewer hurricanes, and doldrums in late summer that frequently lead to coral bleaching
3932 events, while La Niña results in drier and cooler winters, and more frequent hurricanes. Hurricanes, most
3933 common in August and September, force radical changes in the coral reef, seagrass, and mangrove
3934 communities (Jaap et al., 2008).

3935 Ocean temperatures from data collected over 125 years range from 15.6-32.2°C (60.1-89.9°C) (Jaap et al.,
3936 2008). The lowest temperatures occurred at Fowey Rock near Cape Florida in February and the highest in
3937 August at Sand Key, Key West (Jaap et al., 2008).

3938 *Water Resources*

3939 Florida's freshwater supply comes from the systems of rivers, streams, wetlands, lakes, springs, aquifers,
3940 and estuaries across the state. Freshwater is used for public water supply, agricultural irrigation,
3941 commercial/industrial/institutional uses, domestic and small public supply, recreational irrigation, and
3942 power generation (FDEP, 2018a).

3943 Like the Everglades, the natural landscape of much of the rest of south Florida has been altered with huge
3944 public works projects (Purdum, 2002). Canals, pumping stations, dikes, and weirs have all altered the
3945 watershed, and historic swamps, marshes, and associated sheetflow are commonly replaced by urban
3946 development and agriculture and drained by canals (Purdum, 2002).

3947 Surface waters Florida-wide are impacted by impaired dissolved oxygen, fecal coliform, and
3948 eutrophication, among other things. Land-based pollution to the reef ecosystem occurs by discharges
3949 through inlets and bays, through sheet water flows and discharges coming from the Everglades into
3950 Florida Bay, or through outfalls in the northernmost section of the reef tract. For example, Enochs et al.
3951 (2019) demonstrated the important role that surface water plays on southeast Florida waters and
3952 highlighted the degree to which engineered freshwater systems can contribute to coastal acidification on
3953 localized scales (Enochs et al., 2019).

3954 Supplying approximately 90% of the state's drinking water, Florida's underground aquifers are among the
3955 most productive in the world (South Florida Water Management District, 2010). The largest, oldest, and
3956 deepest aquifer in the southeastern U.S. is the Floridan aquifer. The Floridan aquifer is found beneath all
3957 of Florida and portions of Alabama, Georgia and South Carolina, and extends into the Gulf of Mexico and
3958 the Atlantic Ocean (St. Johns River Water Management District, 2019). This aquifer system is comprised
3959 of a sequence of limestone and dolomite, which thickens from about 250 ft (76 m) in Georgia to about
3960 3,000 ft (914 m) in south Florida. The upper Floridan aquifer is the principal source of water supply in
3961 most of north and central Florida. In the far western panhandle and in southern Florida, the Floridan
3962 aquifer system is deep and produces salty and mineralized water. In these areas, the shallower Sand-and-
3963 Gravel Aquifer (in the west) and the Biscayne Aquifer (in the south) are used for water supply (FDEP,
3964 2015).

3965 Covering more than 4,000 mi² (6437 km²) in southeastern Florida, the Biscayne Aquifer is a surficial
3966 aquifer. It is the most intensely used water source in Florida and supplies water to Miami-Dade, Broward,
3967 and southern Palm Beach Counties. Water from the Biscayne aquifer is also transported by pipeline to the
3968 Florida Keys (South Florida Water Management District, 2010).

3969 In southwestern Florida, aquifers that lie between the Surficial Aquifer System and the Floridan Aquifer
3970 System are collectively referred to as the Intermediate Aquifer System. This aquifer system starts in
3971 Hillsborough and Polk Counties and extends south through Lee and Collier Counties. The Intermediate
3972 Aquifer System is the main source of water supply for Sarasota, Charlotte, and Lee Counties (South
3973 Florida Water Management District, 2010).

3974 Several threats to Florida's groundwater supply exist. Saltwater intrusion into the Biscayne Aquifer is
3975 driven by overuse and lack of replenishment of the aquifer from groundwater sources. Other threats
3976 include competing domestic, agricultural, and commercial interests, the latter including Florida Power
3977 and Light's Turkey Point Nuclear Power Plant.

3978 *3.6.3.2 Biological Environment*

3979 Florida has diverse and unique species and landscapes. Its ecological communities are shaped by the
3980 many different climates across which Florida spans. The proximity of the Florida reef tract to a highly
3981 urbanized coastal zone and growing population contributes to a number of human-related stressors to the
3982 reef communities. Water pollution, overfishing, coastal construction activities, vessel anchoring and
3983 grounding, and ballast water discharge threaten the region's reefs (Banks et al., 2008). Other stressors
3984 include increasing water temperatures and bleaching, and disease (Collier et al., 2008).

3985 *Marine*

3986 Undeveloped areas along the coast of Florida contain extensive mangrove forests and a mosaic of
3987 exposed rock and sediments. The rock formations support coral reef development and the sediments
3988 support the most extensive seagrass beds in the world (Andrews et al., 2005).

3989 Florida has wide-ranging shallow coral reef formations near its coasts. Conditions for extensive coral reef
3990 development around Florida exist largely due to the influence of the Gulfstream together with the
3991 presence of a broad-shallow continental shelf around the peninsula and the absence of any major rivers
3992 (Andrews et al., 2005).

3993 These reefs extend over 300 miles around the peninsula from Stuart near the St. Lucie Inlet in Martin
3994 County on the east coast to the Dry Tortugas in the Gulf of Mexico (NOAA CoRIS, 2019c; Jaap et al.,
3995 2008). The Florida Reef Tract extends from south of Soldier Key (25°31.4' N, 80°10.5' W) to Dry
3996 Tortugas (24°38.4' N, 82°51.8' W) and has coral reef characteristics similar to many areas in the Bahamas
3997 and Caribbean Basin (Jaap et al., 2008; Andrews et al., 2005). The Florida Reef Tract does not include the
3998 reefs and hard-bottom habitats in Miami-Dade (north of Fowey Rock), Broward, Palm Beach, and Martin
3999 Counties that continue north to the St. Lucie Inlet (27°10' N, 80°09' W) (Jaap et al., 2008). All but the
4000 northernmost extent of the reef tract lies within the boundaries of the FKNMS. This 2,900 nmi² (5371
4001 km²) sanctuary was designated in 1990 and surrounds the entire archipelago of the Florida Keys (NOAA,
4002 2007a). The northernmost portion of the reef tract lies within Biscayne National Park (BNP).

4003 Extending north from the reef tract, still rich and diverse reefs and hard-bottom areas span from the
4004 northern border of BNP in Miami-Dade County to the St. Lucie Inlet (Andrews et al., 2005). These reefs
4005 are characterized by three parallel reef lines. The classic reef distribution pattern for central and
4006 southeastern waters of the Florida Atlantic coast consists of an inner reef in approximately 5-8 m (1.5-2.4
4007 km) of water, a middle patch reef zone in about 9-15 m (2.7-4.6 km) of water, and an outer reef in
4008 approximately 18-30 m (2.4-9.1 km) of water (SAFMC, 2019). Nearshore reef habitats in southeast
4009 Florida include hard-bottom areas, patch reefs and worm reefs (*Phrag-matopoma* spp.) (Collier et al.,
4010 2008). The communities in these reefs includes over 30 species of stony corals and a diverse assemblage
4011 of gorgonians and sponges (SAFMC, 2018). Common stony coral species include: *Montastrea cavernosa*,
4012 *Siderastrea siderea*, *Porites astreoides*, *Solenastrea bournoni*, *Meandrina meandrites*, and *Dichocoenia*
4013 *stokesii*. Octocorals and sponges tend to have greater density than stony corals; some of the common
4014 octocoral genera include *Eunicea*, *Antillologorgia*, *Muricea*, *Plexaurella*, *Pterogorgia*, and *Icilogorgia*
4015 (SAFMC, 2018).

4016 Middle reefs between the inner and offshore assemblages have more relief and dissecting channels than
4017 nearshore reefs (Jaap et al., 2008). Octocorals visually dominate, but stony corals are abundant and
4018 include great star coral (*Montastraea cavernosa*), massive starlet coral (*Siderastrea siderea*), and mustard
4019 hill coral (*Porites astreoides*) (Jaap, et al. 2008).

4020 The offshore reef system often has stronger vertical relief and the highest diversity and abundance of
4021 sessile reef organisms (Jaap et al., 2008). Octocorals and large barrel sponges (*Xestospongia muta*) are
4022 most conspicuous, and moderate-sized colonies of star corals are common. Stony corals are somewhat
4023 larger than those located on the middle reef (Jaap et al., 2008).

4024 The reef topography from Palm Beach County to Martin County is characterized by Anastasia Formation
4025 limestone ridges and terraces colonized by reef biota (Collier et al., 2005). Typical organisms are lesser
4026 starlet coral (*Siderastrea radians*) and colonial zoanthids (*Palythoa mammilosa* and *P. caribaeorum*)

4027 (Andrews et al., 2005). *Pseudodiploria clivosa* forms large pancake-like colonies and provides the
4028 majority of the cover, and *Montastraea cavernosa* also attains large sizes (Jaap et al., 2008). Some
4029 extensive aggregations of staghorn coral (*Acropora cervicornis*) are present generally inshore of inner
4030 reefs in Broward County (Andrews et al., 2005).

4031 The most productive reef development occurs seaward of the Florida Keys, and the most extensive living
4032 coral reef in the United States is adjacent to the island chain of the Florida Keys (NOAA, 2019). The
4033 densest and most well-developed reefs are found seaward of Key Largo and Elliott Key. Here, the two
4034 keys help protect the reefs from the effects of water exchange with Florida Bay, Biscayne Bay, Card
4035 Sound, Little Card Sound, and Barnes Sound, which are all situated between the Florida Keys and the
4036 peninsula (Jaap et al., 2008). The bays and sounds are shallow bodies of water and tend to be more
4037 rapidly changed by environmental events compared to the open ocean, resulting in wide swings in
4038 salinity, turbidity, and water temperature (Jaap et al., 2008). Channels between the Keys and the open
4039 ocean allow water from the bays to flow onto the reefs, especially in the middle Keys, which limits
4040 growth and results in poor reef development (Jaap et al., 2008).

4041 Three types of coral reef habitats found in the Florida Keys are hard-bottom, patch reefs, and bank reefs
4042 (Andrews et al., 2005). Hard-bottom is an abundant and conspicuous habitat in this region (Jaap et al.,
4043 2008). It is found at a wide range of water depths and is characterized by rock colonized with calcifying
4044 algae (e.g., *Halimeda spp.*), sponges, octocorals, and several species of stony coral, including smooth
4045 starlet coral (*Siderastrea radians*) and common brain coral (*Diploria strigosa*) (Andrews et al., 2005).

4046 Patch reefs are the most common type of reef in the Florida Keys (Jaap et al., 2008). They vary in size and
4047 morphology but massive stony corals dominate patch reefs, with boulder star coral (*Orbicella annularis*)
4048 being most prevalent (Andrews et al., 2005; Jaap et al. 2008). Other common framework species include
4049 *Colpophyllia natans* and *Siderastrea siderea* (Andrews et al., 2005). Species diversity of stony corals is
4050 highest in patch reef habitats (Jaap et al., 2003). In the Keys, patch reefs are concentrated in north Key
4051 Largo, Hawk Channel between Marathon Key and Key West, and the area off of Elliott Key (Andrews et
4052 al., 2005). Generally, patch reefs found in the lagoon between the outer reefs and the Florida Keys may
4053 include star corals (*Montastraea* and *Orbicella spp.*), fire corals (*Millepora spp.*), regular finger coral
4054 (*Porites porites*), mustard hill coral, starlet corals (*Siderastrea spp.*), brain coral (*Pseudodiploria clivosa*),
4055 and staghorn coral (*Acropora cervicornis*). Elkhorn coral is usually absent. These habitats in the inshore
4056 waters in the immediate vicinity of the Keys are dominated by hardy corals (including *P. clivosa*, *Favia*
4057 *fragum*, *Porites porites*, *P. astreoides*, *Siderastrea radians*, *S. siderea*, *Manicina areolata*, and *Cladocora*
4058 *arbuscula*), which appear to have a greater tolerance to silt, thermohaline changes, and unconsolidated
4059 bottom (Vaughan, 1919; Kissling, 1965).

4060 Bank reefs are the most seaward reef habitats in the Florida Keys (Andrews et al., 2005; Jaap et al., 2008).
4061 These reefs have unique spur-and-groove systems occurring in depths ranging from a few centimeters to
4062 10 m (32 ft). The spur-and-groove systems are a series of ridges and channels built primarily by elkhorn
4063 coral (*Acropora palmata*) (Andrews et al., 2005).

4064 Discontinuous and less biologically diverse coral reef assemblages continue northward along western
4065 Florida shores to the FMG (NOAA CoRIS, 2019c). This region is characterized by extensive hard-bottom
4066 ranging from low or moderate-relief rock outcrops and pavement to high-relief pinnacles and ridges,
4067 which are colonized by sessile macro-fauna such as Scleractinian corals, octo-corals, black corals and
4068 sponges (Collier et al., 2008). Some of these areas have been designated Habitat Areas of Particular

4069 Con-cern (HAPC) such as the FMG and Pulley Ridge which are both dominated by shallow-water coral
4070 reef communities (Collier et al., 2008). The FMG are located 137 km off the west coast of Florida and are
4071 comprised of a series of carbonate ledges and represent the northernmost coral reefs in the continental
4072 U.S. (Collier et al., 2008). The FMG is known to have 19 zooxanthellate species (Jaap et al., 2008).
4073 Pulley Ridge is a rocky feature between the FMG and the southern margin of the Florida shelf that
4074 provides substrate for reef communities. The southernmost 30 km of this feature supports the deepest
4075 hermatypic coral reef in the U.S. (Collier et al., 2008). The Pulley Ridge coral reef ecosystem has up to
4076 60% coral cover over broad areas, with the dominant zooxanthellate Scleractinia are *Leptoseris*
4077 *cucullata*, *Agaricia lamarcki*, and *Agaricia fragilis* (Collier et al., 2008).

4078 Florida's reef ecosystems are rich with species, supporting thousands of invertebrates and fish. There are
4079 47 zooxanthellate species at Dry Tortugas, 38 at Looe Key, 28 in Biscayne National Park, 24 in the area
4080 north of the Miami harbor channel in Miami-Dade County, 36 off Broward County, 24 off Palm Beach
4081 County, and eight in Martin County on the reefs south of the St. Lucie Inlet. In addition to corals,
4082 sponges, shrimps, crabs, and lobsters are prevalent. The Florida Keys alone support more than 500 fish
4083 species, including 389 that are reef-associated (Jaap et al., 2008).

4084 Five species of listed sea turtles (loggerhead, hawksbill, green, leatherback, and Kemp's ridley) frequent
4085 the water of Florida. Marine mammals include numerous whales, dolphins, and one species of coastal
4086 sirenian, the Florida manatee (*Trichechus manatus latirostris*).

4087 ***Terrestrial and Freshwater***

4088 Northern Florida contains broad alluvial riparian habitats, and upland flats and ridges once dominated by
4089 longleaf pine communities. The central peninsula is generally broad flatlands once dominated by longleaf
4090 pine (*Pinus palustris*) and slash pine (*P. ellioti*), dry and wet prairies, and sandy ridges with scrub and
4091 sandhill communities. The southern tip of the peninsula has been heavily modified by development but
4092 tropically influenced hammocks, swamps, rocklands, and the freshwater marshes of the Big Cypress
4093 Swamp, Everglades, and the Florida Keys can still be found. In North Florida, rivers that originate in the
4094 southern Appalachians and Piedmont are home to increasingly rare mollusk and fish species. There are
4095 thousands of lakes throughout the Florida peninsula with Lake Okeechobee in South Florida being the
4096 eighth largest lake in the U.S. The limestone regions of North and Central Florida harbor numerous
4097 springs which, along with limestone caves and sinks, support many rare aquatic invertebrates (Florida
4098 FWCC, 2012).

4099 Florida supports the fourth highest biodiversity in the U.S. and ranks third in the number of species listed
4100 as threatened or endangered by the USFWS. Florida has at least 3,500 native plant species (235 of which
4101 are endemic), 126 inland fish species (7 endemic), 57 species of amphibians (6 endemic
4102 species/subspecies), 127 reptiles (37 endemic species/subspecies), 283 bird species (7 endemic
4103 subspecies), 75 mammal species (58 endemic species/subspecies) and thousands of invertebrates (with at
4104 least 410 known to be endemic) (TNC, 2004; Florida FWCC, 2012).

4105 Sixty-seven plants and 67 animals are listed as threatened or endangered in Florida (USFWS, 2019a;
4106 Appendix E).

4107 *3.6.3.3 Cultural Resources*

4108 Florida reflects a rich diversity of cultural influences from the long and varied history of settlement in the
4109 state. Historic resources include 12,000 year-old Native American sites, the remains of early European
4110 settlements, and more recently, Mediterranean Revival homes, and Art Deco buildings (FDEP, 2019).
4111 Florida has two federally recognized tribes: the Miccosukee Tribe of Indians of Florida and the Seminole
4112 Tribe of Florida (Dania, Big Cypress, Brighton, Hollywood and Tampa Reservations) (NCSL, 2018).

4113 Among the notable examples are the Paleoindian Page/Ladson Site in Jefferson County, dating from
4114 10,000-7,500 B.C.; the Archaic Windover Site near Titusville, which dates from 5,500 B.C.; Crystal
4115 River Indian Mounds (500 B.C.-A.D. 200); Castillo de San Marcos in St. Augustine, constructed between
4116 1672 and 1696 and the oldest masonry fort in the United States; the Town of Eatonville, established in
4117 1887 as the first all-black incorporated town in Florida; Florida's Historic Capitol, restored to its 1902
4118 configuration; Miami Beach Art Deco Architectural District, a world renowned tourist destination; and
4119 Kennedy Space Center, site of U.S.-manned space flights and the launches that put Americans on the
4120 moon (Florida Department of State, 2012).

4121 Florida contains vast underwater historical resources, notably in the Florida Keys where hundreds of
4122 shipwreck sites and artifacts, cultural remains of indigenous peoples' activities, Overseas Railroad
4123 remnants, and historic offshore structures have been documented. An estimated 2,000 shipwrecks are
4124 thought to have occurred in the Florida Keys, with archival research identifying more than 1,000 reported
4125 shipwrecks to date. Underwater historical sites and objects include paleoenvironmental deposits, isolated
4126 cannons, anchors, shipwrecks, and historical aids to navigation. Currently, 14 shipwrecks and five
4127 lighthouses within the Florida Keys National Marine Sanctuary are listed in the NRHP (NOAA ONMS,
4128 2019). Florida has a total of 1,797 properties listed on the NRHP (NPS, 2019a).

4129 *3.6.3.4 Socioeconomic Environment*

4130 ***Land Use and Cover***

4131 Florida has a diverse history of land use and human settlement, in addition to a wide range of natural
4132 communities, high biodiversity, and abundant natural resources. Florida has a substantial percentage of its
4133 lands and waters in some kind of conservation designation (Table 3-6). Combined local, state, and federal
4134 conservation holdings comprise 29.4% of the state (Volk et al., 2017).

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Table 3-7. Major land cover classes based on Florida Cooperative Land Cover data (2015).

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Land Cover Type	Area (km ²)	Area (%)
Urban	22,921.5	15.76
Freshwater Herbaceous Wetlands	18,768.1	12.91
Freshwater Forested Wetlands	18,466.4	12.70
Tree Plantations	18,278.1	12.57
Pasturelands	16,570.9	11.40
Crops, Groves, Nurseries	11,489.4	7.90
Flatwoods	8,982.4	6.17
Shrubs and Other Rural	7,784.7	5.35
Mixed Hardwood-Coniferous	5,380.9	3.70
Freshwater	5,302.8	3.64
Sandhill and Upland Pine	3,816.4	2.62
Scrub	3,175.8	2.18
Mangroves	2,485.2	1.71
Upland Hardwood Forest	2,090.8	1.43
Salt Marsh	1,532.5	1.05
Extractive	1,040.0	0.71
Dry Prairie	716.4	0.49
Coastal Uplands	347.4	0.23
Exotic Plants	267.5	0.18
Rockland Forests	146.4	0.10

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Source: Volk et al., 2017; USDA, 2015

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The majority of Florida is still rural, with much of that land in agriculture or other disturbed cover types. Other than freshwater herbaceous and forested wetlands, the top land cover categories combined from the land cover source data are dominated by urban (high to low intensity) and agriculture (Volk et al., 2017; USDA, 2015).

4164 Impervious land cover is a good indicator of development and is also associated with land-based pollution
4165 that can damage coral reefs. Miami-Dade County has the most impervious land cover out of the five south
4166 Florida counties in absolute terms, while Broward County has the most impervious cover by percentage.

4167 Most of the development in Martin, Palm Beach, Broward, and Miami-Dade Counties lies within 32 km
4168 of the Atlantic coast. The large areas of the non-coastal, western parts of these counties consist mostly of
4169 rural towns, farmland, swamps, and preserves (such as Everglades National Park and Biscayne National
4170 Park). Moving inland, development becomes progressively less dense. Monroe County consists of a large
4171 area of mostly undeveloped land at the very southwestern tip of the Florida peninsula as well as a series
4172 of islands south of the peninsula (the Florida Keys), with Key West being the mostly densely developed
4173 and populous key (Gorstein et al., 2016).

4174 Numerous state (e.g., state parks, aquatic preserves) and federal (e.g., national wildlife refuges, two
4175 former national marine sanctuaries) protected areas also exist in the Florida Keys and contribute to the
4176 overall protection of coral reef species and habitats of this region. BNP, Dry Tortugas National Park
4177 (DTNP), and the FKNMS are within the Florida reef tract. BNP is immediately north of FKNMS in the
4178 Atlantic Ocean, with a small FKNMS area extending along the BNP eastern border. The DTNP, which is
4179 about 70 miles west of Key West, is entirely surrounded by FKNMS. All three protected areas have high
4180 recreational use and several other uses as well.

4181 *Natural Resource Economy*

4182 Coral reefs have important ecosystem functions and provide crucial goods and services. They are also a
4183 tourist attraction, contributing to local income and foreign exchange. In addition, they form a unique
4184 natural ecosystem and a natural protection against wave erosion.

4185 The economic value of Florida's coral reefs is significant. Coral reef activities in Martin, Palm Beach,
4186 Broward and Miami-Dade Counties are estimated to generate \$3.4 billion in sales in general and income
4187 and support 36,000 jobs in the region each year (NOAA CoRIS, 2019c).

4188 In a survey study by Gorstein et al. (2016), residents of South Florida reported participating in non-
4189 extractive recreational reef activity (Gorstein et al., 2016). Swimming (58%) and beach recreation
4190 (60%) were the two activities residents participated in most frequently. Participation in extractive
4191 activities like fishing and gathering was less common, with under a quarter responding that they fished
4192 and 14% indicating that they gathered marine resources (Gorstein et al., 2016).

4193 In addition to local residents, millions of tourists visit to Florida to enjoy SCUBA diving, snorkeling, and
4194 fishing on South Florida's coral reefs. Tourism and recreation are two of Florida's most important and
4195 highest grossing industries, including reef-based tourism and recreation (Collier et al., 2008). Two studies
4196 of natu-ral and artificial reefs in southeast Florida found that a total of \$2.3 bil-lion in sales and \$1.1
4197 billion in income were generated annually from natural reef-related expenditures, and more than 36,000
4198 jobs were supported in the region (Johns et al., 2003; Collier et al., 2008). More recently, a National
4199 Marine Sanctuary Foundation study found that economic activity generated in FKNMS is responsible for
4200 contributing \$4.4 billion and 43,000 jobs across the state of Florida (NMSF, 2019).

4201 Recreational saltwater fisheries in Florida supported 2.3 million licenses that generated \$37.1 million in
4202 revenue during FY17/18. The economic impact totaled \$11.5 billion and supported 106,000 jobs.

4203 Commercial fishing generated \$3.2 billion in income and supported 76,700. The top four species, in terms

4204 of dockside value, harvested in Florida in 2018 were shrimp (\$48.9M), spiny lobster (\$45M), stone crab
4205 (*Menippe mercenaria*) (\$32.5M), and blue crab (*Callinectes sapidus*) (\$12M) (Florida FWCC, 2019).

4206 Inshore, sport fisheries pursue game fishes like spotted sea trout (*Cynoscion nebulosus*), sheepshead
4207 (*Archosargus probatocephalus*), black and red drum (*Sciaenops* spp.), snook (*Centropomus undecimalis*),
4208 tarpon (*Megalops atlanticus*), bonefish (*Albula vulpes*), and permit (*Trachinotus falcatus*). Commercial
4209 fisheries in this area primarily target sponges and crabs (blue and stone) (Jaap et al., 2008). Offshore of
4210 the deep margin of the bank reefs, commercial and sport fisheries capture an array of species like
4211 amberjack (*Seriola dumerili*), king (*Scomberomorus cavalla*) and Spanish (*S. maculatus*) mackerel,
4212 barracuda (*Sphyraena barracuda*), sharks (Class Chondrichthyes), and small bait fishes (e.g.,
4213 Exocoetidae, Mullidae, Carangidae, Clupeidae, and Engraulidae) (Jaap et al., 2008). Further offshore,
4214 commercial and sport fisheries catch dolphinfish (*Corypaena hippurus*), tunas (*Thunnus* spp.), and
4215 swordfish (*Xiphias gladius*), and sport fishers target sailfish (*Istiophorus* spp.), wahoo (*Acanthocybuim*
4216 *solandri*), and white (*Tetrapterus albidus*) and blue (*Makaira nigricans*) marlins. Reef fisheries target the
4217 “snapper-grouper complex,” which consists of 73 species of mostly groupers and snappers, as well as
4218 grunts (Pomadasyidae), jacks (Carangidae), porgies (Sparidae), and hogfish (Labridae) (Jaap et al., 2008).

4219 **3.6.4 Hawaii**

4220 *3.6.4.1 Physical Environment*

4221 Hawaii is the most isolated island chain in the world and can be divided into two areas: the Main
4222 Hawaiian Islands (MHI), consisting of populated, high volcanic islands; and, the Northwestern Hawaiian
4223 Islands (NWHI), consisting of mostly uninhabited atolls, islands, and banks (NOAA & UMCES, 2018;
4224 Friedlander et al., 2005) (Figure 3-5). The MHI form the southern part of the Hawaiian Archipelago,
4225 which trends northwest by southeast in between latitudes 19° N and 29° N (Jokiel, 2008). The MHI are
4226 located in the middle of the North Pacific Subtropical Gyre, centered at about 28°N (Friedlander et al.,
4227 2008). The main islands consist of eight emergent volcanic islands: Niihau, Kauai, Oahu, Molokai, Lanai,
4228 Kahoolawe, Maui, and Hawaii (the Big Island). The islands range in age from seven-million-year-old
4229 Kauai to the geologically young Hawaii Island with active lava flows on its east side (Friedlander et al.,
4230 2008). This section only covers the populated southern portion of the archipelago, the islands of the MHI.
4231 These MHI also represent where most of the NOAA CRCP projects are implemented.

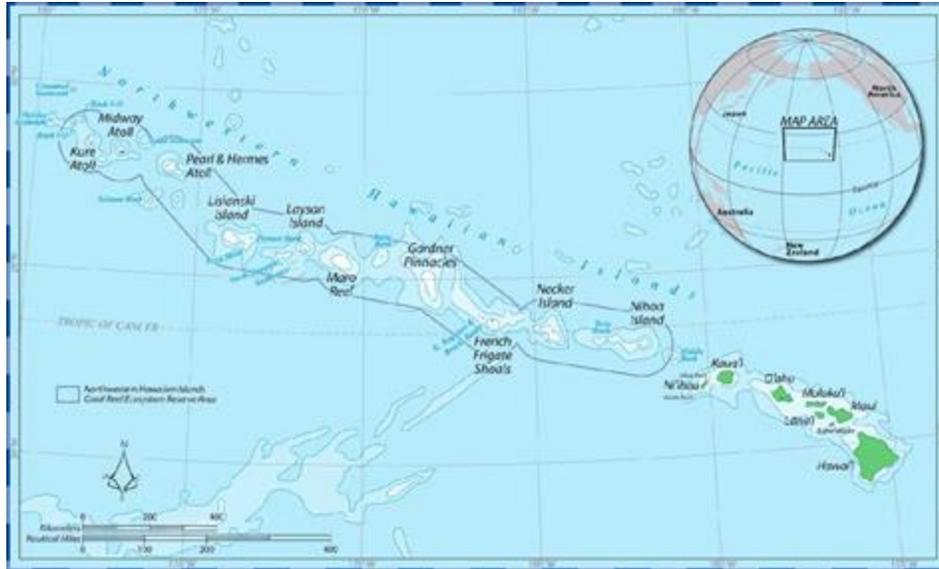


Figure 3-5. Map of the Hawaiian Island chain. Source: Friedlander et al., 2009

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4234 Due to Hawaii's location in the middle of the Pacific Ocean, its coral reefs are exposed to large open
 4235 ocean swells, strong trade winds, and severe weather phenomena. These natural processes have a major
 4236 impact on the structure of the coral reefs and result in distinctive communities. Mean tidal range for
 4237 various stations in the MHI vary from 0.3-0.5 m (0.98-1.64 km) with maximum diurnal change varying
 4238 between 0.3-0.8 m (0.98-2.62 km). The small tidal range and steep nature of Hawaiian shorelines results
 4239 in a very narrow intertidal zone and poorly developed intertidal fauna (Jokiel, 2008). The total potential
 4240 coral reef area in Hawaii (MHI and NWHI) is estimated to be 2,826 km² (1,756 mi²) within the 10-fathom
 4241 curve, and 53,000 km² (32,933 mi²) within the 100-fathom curve, respectively (NOAA, 2009b).

4242 There are many protected areas around Hawaii, including marine managed areas (MMA), marine life
 4243 conservation districts, wildlife sanctuaries, natural area reserves, marine refuges, a national monument, as
 4244 well as several fishery management areas. The two largest protected sites are the Papahānaumokuākea
 4245 Marine National Monument and the Hawaiian Islands Humpback Whale National Marine Sanctuary.
 4246 Hawaii has a mixture of MMAs (e.g., Kahekili Herbivore Fisheries Management Area, Hawaiian Islands
 4247 Humpback Whale National Marine Sanctuary, and the Kikaua Point - Mākolēā Netting Restricted Area),
 4248 which are specific geographic areas designated by statute or administrative rule for the purpose of
 4249 managing a variety of marine, estuarine, or anchialine resources and their use. The resources may include
 4250 any type of marine life (e.g., mammals, fish, invertebrates, algae, etc.) and their habitats. The goal of
 4251 MMAs may also include preservation of cultural or historical resources (Hawaii Division of Aquatic
 4252 Resources, 2019).

4253 ***Climate and Weather***

4254 The Hawaiian climate is characterized by fairly uniform temperature conditions everywhere except at
 4255 high elevations, a two-season year, marked geographic differences in rainfall, and generally humid
 4256 conditions.

4257 The archipelago experiences a mild, subtropical climate due to northeasterly trade winds. Daily
 4258 temperatures remain relatively constant throughout the year, with the difference in average daytime
 4259 temperature at sea level throughout the year being less than 10°C (50°F) (Fletcher et al., 2008). The

4260 seasonal range of sea surface temperatures near Hawaii is only about 3°C (6°F); the average surface water
4261 temperature around Oahu is 24°C (75°F) in winter and 27°C (81°F) in summer (Friedlander et al., 2008).

4262
4263 The trade winds that dominate the Hawaiian climate originate with the North Pacific high pressure center
4264 usually located to the northeast of the islands (Fletcher et al., 2008). These persistent trade winds
4265 approach Hawaii with greatest consistency in the summer. During the winter, from October through
4266 April, the variable and southerly Kona winds interrupt the northeasterly trade winds and bring abundant
4267 rain and cool, cloudy conditions (Fletcher et al., 2008).

4268 Hawaii's warmest months are August and September, and the coolest months are February and March.
4269 Hawaii's heaviest rains occur during winter storms between October and April. (Jokiel, 2008). Ancient
4270 Hawaiians first defined the two seasons that govern Hawaii's climate: "kau wela" (hot season) and
4271 "ho'oilō" (to cause growth, referring to the rains of winter) (Fletcher et al., 2008).

4272 Another major feature of Hawaii's climate is the significant differences in rainfall within short distances
4273 due to the effects of the steep volcanic topography on the high islands (Jokiel, 2008). The mountains
4274 block, deflect, and accelerate the flow of air, giving Hawaii a more varied climate than that of the
4275 surrounding ocean. For example, over the ocean near Hawaii, rainfall averages between 25 and 30 inches
4276 a year; however, the islands receive as much as 15 times that amount in some places and less than one
4277 third in others (NWS, undated). These variations also impact local conditions on the reefs around the
4278 islands.

4279 The surface-water resources of Hawaii are of significant economic, ecological, cultural, and aesthetic
4280 importance. Hawaii contains approximately 3,326 mi (5,353 km) of rivers and streams and 5 mi² (8 km²)
4281 of lakes and reservoirs in 580 watersheds (DOE, 2017c).

4282 Streams supply more than 50% of the irrigation water in Hawaii. Most Hawaiian streams originate in the
4283 mountainous interiors of the islands and terminate at the coast. Streams in Hawaii are flashy in nature as
4284 rainfall is intense, drainage basins are small, basins and streams are steep, and channel storage is limited
4285 (Oki, 2003).

4286 The main issues related to surface water in Hawaii include streamflow availability; the reduction of
4287 streamflow by surface diversions and, in some areas, groundwater withdrawals; floods; water-quality
4288 changes caused by human activities; and erosion and sediment transport. The quality of Hawaii's surface
4289 waters has been affected by urban and agricultural activities. For example, fish from streams in urban
4290 Honolulu have been found to have some of the highest levels of organochlorine pesticides in the nation
4291 (Oki, 2003).

4292 Most Hawaiian islands are built of many thin lava flows from shield volcanoes, forming highly permeable
4293 aquifers. In other regions, thick lava flows that ponded in preexisting depressions form aquifers that are
4294 much less permeable (Izuka et al., 2018). Most fresh groundwater withdrawn for human use comes from
4295 freshwater lenses in the dike-free, high-permeability lava-flow aquifers. The primary limiting factor to
4296 groundwater availability is saltwater intrusion (Izuka et al., 2018).

4297 As each island is small and surrounded by saltwater, Hawaii's aquifers have limited capacity to store
4298 fresh groundwater. Saltwater also underlies much of the fresh groundwater (Izuka et al., 2018). Therefore,
4299 groundwater resources are particularly vulnerable to human activity, short-term climate cycles, and long-

4300 term climate change (Izuka et al., 2018). Outflows from Hawaii’s aquifers include withdrawals from
4301 wells and natural groundwater discharge to springs, streams, wetlands, and submarine seeps. Several
4302 indicators suggest an overall reduction in storage for most aquifers (Izuka et al., 2018).

4303 3.6.4.2 Biological Environment

4304 As one of the world's most isolated archipelagos, Hawaii has high endemism, with about a quarter of its
4305 marine species found nowhere else on Earth. Corals and fish create a marine assemblage that is distinct
4306 from those found elsewhere. The condition of coral reef ecosystems within the Hawaii Archipelago is fair
4307 as many MHI reefs are threatened by temperature stress, ocean acidification, overfishing, and runoff/land-
4308 based sources of pollution (NOAA & UMCES, 2018). Land-based sources of pollution impacting water
4309 quality such as urban growth and coastal developments (i.e., hotels, golf courses, etc.), failing sewages
4310 systems, and unpaved roads are focal points for coral reef degradation (NOAA & UMCES, 2018).

4311 *Marine*

4312 Hawaii has diverse marine habitats, ranging from estuaries, tidepools, sandy beaches, and seagrass beds to
4313 nearshore deep waters, extensive fringing and atoll reef systems, and smaller barrier reef systems (DLNR,
4314 2015). Introduced mangroves exist in a number of places in sheltered embayments or along shorelines
4315 with well-developed fringing reefs or barrier reefs (DLNR, 2015). While valuable components of coral
4316 reef ecosystems in the tropics, mangroves in Hawaii are invasive, have negative ecological impacts, and
4317 have altered coastal ecosystems (Jokiel, 2008).

4318 Island age, reef growth, water depth, exposure to wave action, geography, and latitude are all factors in
4319 the distribution of marine ecosystems in Hawaii (DLNR, 2015). Thus, the marine habitats found on and
4320 around each island depend on the type of island. For example, the island of Hawaii, a large and relatively
4321 young island, has few living structural coral reefs. In comparison, geologically older islands like Oahu
4322 and Kauai are diverse with fringing reefs and lagoons with patch or pinnacle reefs (DLNR, 2015).

4323 Due to its isolated location, Hawaii has an extremely high rate of coastal and marine endemism (DLNR,
4324 2015). However, marine species diversity in Hawaii is relatively low in comparison to other areas of the
4325 Pacific. For example, reef communities in Hawaii experience relatively low coral species diversity
4326 compared to other Indo-Pacific sites (Fletcher et al., 2008). Approximately 57 coral species have been
4327 documented in the MHI, and fewer than 25% of these species are dominant components of the reef
4328 ecology (Fletcher et al., 2008). These species include *Porites lobata*, *P. compressa*, *Pocillopora*
4329 *meandrina*, *Montipora capitata*, *M. patula*, *M. flabellata*, and *Pavona varians* (NOAA, 2009b). One
4330 study examined average coral cover across 1,682 independent transects/sites in the MHI and found it was
4331 $19.9\% \pm 0.6\%$ SE, with seven of 29 coral species accounting for most of the cover (NOAA, 2009b). The
4332 same study also found that coral cover was highest in the southern part of the archipelago and lowest in
4333 the northern part, and coral cover generally decreased with increasing geologic age ($r=-0.64$) (NOAA,
4334 2009b).

4335 The major natural factors in the MHI that influence reef community structure include waves, currents,
4336 substrate type, depth, and island age (Jokiel, 2008). On exposed shores, wave energy is likely the
4337 principal factor contributing to coral community structure and composition as wave energy tends to
4338 suppress reef development in shallow depths (Fletcher et al., 2008; Jokiel, 2008). A continual cycle of
4339 intermediate intensity disturbances results in moderate coral cover and high diversity while high coral

4340 cover with low species diversity often occurs in embayments and reefs sheltered from wave exposure by
4341 nearby islands (Jokiel, 2008). Examples of areas with developed reefs or high coral cover include the
4342 Kona Coast of Hawaii, the south coast of west Maui, the north coasts of Lanai and Kauai, and Kaneohe
4343 Bay, Hanauma Bay, and Barber's Point on Oahu (NOAA, 2009b).

4344 Reef formation in Hawaii is slow with potentially little accretion of living corals taking place (NOAA,
4345 2009b). Nonetheless, a wide range of reef types occurs throughout the MHI. For example, steep unstable
4346 volcanic slopes, rocky shorelines, and beaches with basalt cobble characterize the marine habitats of the
4347 geologically young islands of Hawaii and Maui. Discontinuous apron reefs, the first phase of reef
4348 development that consists of a thin veneer of corals and calcifying organisms, tend to form the coral
4349 communities of these younger islands (Jokiel, 2008). These pioneer apron reefs will continue to
4350 accumulate carbonate materials and eventually grow seaward to form fringing reefs if conditions are
4351 favorable (Jokiel, 2008). Thus, the older islands of Molokai, Oahu, and Kauai tend to have areas of well-
4352 developed fringing reefs that are not common on Maui and Hawaii (Jokiel, 2008). Patch reefs are unique
4353 features in the MHI and are mostly restricted to Kaneohe Bay, Oahu (Jokiel, 2008). Pinnacles, stacks, and
4354 offshore islets are features that occur throughout the MHI and possess a diverse marine fauna. In the islet
4355 of Moku Manu off Mokapu Peninsula (east Oahu), for instance, there is a system of undersea caves with
4356 extremely high abundance and diversity of sponges and associated organisms (Jokiel, 2008).

4357 Wave action has resulted in most of the open coastline of Oahu being fringed by coral reefs with low
4358 natural coral cover. The most well-developed reef assemblages are found in embayments or shelter areas,
4359 such as Kaneohe Bay or Hanauma Bay (NOAA, 2009b). Reef communities are generally healthy except
4360 for local areas where shoreline use is high or in embayments where water circulation is restricted and
4361 point and nonpoint source pollution is an issue (NOAA, 2009b).

4362 Most coral reefs on Maui are also primarily shaped by wave action. Healthy reefs can be found off
4363 Honokowai on the western end and between Olowalu and Papawai. Here, coral cover ranges from 50-
4364 80% (depth: 10-20 m [32-66 ft]) (NOAA, 2009b). In the Auau Channel, reefs are completely sheltered
4365 from wave stress, and healthy reefs exist at 30-40 m (98-131 ft) (NOAA, 2009b). Excessive fishing and
4366 increases in invasive algae species are the two most significant environmental problems affecting coral
4367 reefs on Maui. Invasive algae growth may be related to nutrient loading, periodic natural upwelling, the
4368 low abundance of urchins, or high fishing pressure on herbivorous fishes (NOAA, 2009b).

4369 Almost all of Lanai's reefs are healthy, but some on the northern half of the island experience episodic
4370 mortality due to sediment runoff. All of Lanai's reefs experience fishing pressure but most do not
4371 experience significant pollution (NOAA, 2009b).

4372 The longest fringing reef in Hawaii, 56 km (184 ft) long, is found off the southern coast of Molokai. The
4373 condition of this reef varies from poor to excellent, with much of the reef degradation associated with
4374 sedimentation as a result of poor land use practices (NOAA, 2009b).

4375 High rates of sedimentation have also historically impacted Kahoolawe's reefs as the island was used as a
4376 military target for live firing and bombing for years. The bombing stopped in 1994 and the reefs are now
4377 in a state of recovery (NOAA, 2009b).

4378 The windward and leeward sides of the island of Hawaii support very different reefs (NOAA, 2009b). On
4379 the windward side (except in Hilo Bay), reef structure and composition is governed by wave action and is
4380 characterized by early successional reef stages like apron reefs. The leeward side of the island, however,
4381 supports rich coral reef communities (NOAA, 2009b). Humans have altered and impacted the reefs of the
4382 island of Hawaii. For example, sugarcane waste waters historically degraded the reefs on the Hamakua
4383 Coast, and excessive fishing, aquarium fish collecting, and groundwater intrusion have caused serious
4384 impacts on the reefs on the leeward coast (NOAA, 2009b).

4385 Sedimentation likely plays a significant role in the development of reefs around Kauai (NOAA, 2009b).
4386 Sediments most heavily impact reef communities that are in shallow or enclosed areas that have restricted
4387 circulation. The healthiest reefs in Kauai are found on the exposed northeastern and northern coasts where
4388 the sediment is washed away by waves and currents or in deep water with the least exposure to sediment-
4389 laden streams (e.g., reefs of Poipu and Makahuena) (NOAA, 2009b). In addition to sedimentation, high
4390 fishing pressure, hurricanes, and poor water quality affect reefs off Kauai (NOAA, 2009b).

4391 In addition to reef communities, other unique marine and estuarine habitats occur on the MHI. Anchialine
4392 ponds are salt water ponds in the supra-tidal zone (Jokiel, 2008). They lack a surface connection to the
4393 ocean but porous volcanic rock permits a subsurface connection to the sea (Jokiel, 2008). More than 700
4394 anchialine ponds can be found in Hawaii with most of them occurring on young lava flows on the island
4395 of Hawaii and Maui (Jokiel, 2008). Anchialine ponds are unique Hawaiian ecosystems home to numerous
4396 organisms including endemic species of small red shrimp (*Halocaridina rubra*) (Jokiel, 2008).

4397 Tide pools experience extreme fluctuations in temperature and salinity and are typically inhabited by
4398 hardy species, including a wide variety of algae, echinoderms, mollusks, barnacles, crustaceans, and
4399 worms. Fish species include blennies, gobies, and juveniles of certain species (Jokiel, 2008).

4400 Over 1,200 species of fish, with approximately 580 species adapted to coral reefs, are found in the marine
4401 and estuarine waters of Hawaii (DLNR, 2015). The most commonly harvested species of coral reef-
4402 associated organisms include surgeonfishes (Acanthuridae), triggerfishes (Balistidae), jacks (Carangidae),
4403 parrotfishes (Scaridae), soldierfishes/squirrelfishes (Holocentridae), wrasses (Labridae), octopus (*Octopus*
4404 *cyanea* and *O. ornatus*), and goatfishes (Mullidae) (NOAA, 2009b).

4405 Over 5,000 marine invertebrates are known from Hawaii, including over 100 species of hard, soft, and
4406 precious corals as well as hundreds of types of snails, crabs, lobsters, shrimps, small numbers of worms,
4407 jellyfish, sponges, starfish, and tunicates (DLNR, 2015).

4408 The only native reptiles to Hawaii are saltwater species: the pelagic sea snake (*Pelamis platurus*) and five
4409 species of sea turtle (green, hawksbill, olive ridley, loggerhead, and leatherback) (Mitchell et al., 2005).
4410 All five species of sea turtles are listed as threatened or endangered (Appendix E).

4411 Approximately 26 marine mammals species are considered resident or occasional visitors to Hawaii,
4412 including the Hawaiian monk seal (*Neomonachus schauinslandi*), humpback whale (*Megaptera*
4413 *noveangliae*), false killer whale (*Pseudorca crassidens*), and the spinner dolphin (*Stenella longirostris*)
4414 and bottlenose dolphin (*Tursiops truncatus*) (DLNR, 2015).

4415 ***Terrestrial and Freshwater***

4416 Due to its isolation and climate, Hawaii has over 10,000 species found nowhere else on earth. Rates of
4417 endemism are typically 99-100% for terrestrial insects, spiders, and land snails, 90% for plants, more than
4418 80% for breeding birds, and 15-20% for aquatic fauna (Mitchell et al., 2005).

4419 Terrestrial and freshwater habitats vary throughout the islands. On Kauai, montane bogs, montane wet
4420 forest, lowland mesic forest, lava tube caves, long stretches of sandy beach, and many streams and rivers
4421 result in a diverse range of natural vegetation (DLNR, 2015). Due to its age and relative isolation,
4422 endemism levels are higher on Kauai than other islands (DLNR, 2015). Habitats on Oahu are composed
4423 of montane wet communities, lowland wet communities, lowland mesic communities, lowland dry
4424 communities, and coastal communities. The island also has a network of perennial and intermittent
4425 streams, many of which have been altered (DLNR, 2015). Significant habitat types on Molokai include
4426 montane wet forests and shrublands, coastal system (including dunes and grasslands), perennial streams,
4427 lava tubes and caves, cliffs, bog communities, and nine offshore islets (DLNR, 2015). The mountains of
4428 eastern Molokai are cut into deep valleys by perennial streams, and contain high-quality native habitat for
4429 stream fauna, forest birds, montane-nesting seabirds, and native snails and insects (DLNR, 2015). Lanai
4430 has a history of overgrazing by cattle, goats, and axis deer, and much of the island has suffered from
4431 extensive soil erosion and few native-dominated natural communities remain. Habitats on Lanai are
4432 primarily lowland dry communities and coastal communities (DLNR, 2015). Native vegetation dominates
4433 30% of Maui, which supports a variety of native wildlife. Particular habitats associated with native
4434 wildlife include alpine deserts, subalpine and montane forests and bogs, lowland forests, coastal
4435 communities, anchialine pools, lava tube caves, and freshwater systems (DLNR, 2015). Native habitats on
4436 Kahoolawe include coastal dry shrubland, lowland dry grassland, mixed shrub coastal dry cliff, a high
4437 salinity anchialine pool, intermittent streams, and ephemeral pools. Two-hundred years of goat and sheep
4438 ranching, unmanaged grazing, and mostly unsustainable historical land and resource use practices were
4439 followed by decades of military training exercises and bombings, and has contributed to over 80% of
4440 Kahoolawe now being represented by barren or hardpan soil and/or alien-dominated vegetation (DLNR,
4441 2015). Major native habitat types on the Island of Hawaii include wet montane forest, mesic montane
4442 forest, subalpine mesic forest and shrubland. Smaller areas support alpine shrubland and alpine desert, dry
4443 montane and dry lowland forests, wet lowland forest, coastal forest and coastal shrub and grasslands.
4444 Eighty percent of the known worldwide anchialine pools are on Hawaii. Forty-two percent of the Island
4445 of Hawaii is considered “converted to human use” despite this diversity of habitat types (DLNR, 2015).

4446 There are five native fishes that occur in freshwater streams in Hawaii, and all are mostly small
4447 herbivores or omnivores (Mitchell et al., 2005). Freshwater invertebrates in need of conservation include
4448 two omnivorous shrimps, at least eight species of herbivorous snails, one endemic worm species, and one
4449 endemic sponge species (Mitchell et al., 2005).

4450 The native terrestrial invertebrates of Hawaii include more than 6,000 arthropod species, 1,000 or more
4451 native land mollusks, and many undescribed species. Some species of conservation concern include the
4452 Blackburn’s sphinx moth (*Manduca blackburni*), Oahu tree snails (*Achatinella* spp.), the Kauai cave wolf
4453 spider (*Adelocosa anops*), and Kauai cave amphipod (*Spelaeorchestia koloana*) (Mitchell et al., 2005).

4454 All terrestrial reptiles and amphibians on Hawaii have been introduced and are not native. For example,
4455 the cane toad (*Rhinella marina*) and coqui frog (*Eleutherodactylus coqui*) are invasive species and
4456 considered harmful to native wildlife.

4457 There is only one native terrestrial mammal species in Hawaii, the Hawaiian hoary bat (*Lasiurus cinereus*
4458 *semotus*). The other 16 mammalian species present on the island (e.g., livestock, deer, wallaby, cat, dog,
4459 mongoose, rodents) were introduced either intentionally or accidentally (Mitchell et al., 2005). The Hawaii
4460 Wildlife Center lists 75 native species of birds on its site, including seabirds, shorebirds, waterbirds, birds
4461 of prey, and forest birds (Hawaii Wildlife Center, 2019).

4462 Due to human-induced changes, it is estimated that half of the historically native bird species of Hawaii
4463 have been lost to extinction. Among other taxa, the numbers are far higher: 90% of the native land snails
4464 and thousands more terrestrial insects and spiders. These known extinctions represent 75% of the
4465 recorded extinctions of plants and animals in the United States (Mitchell et al., 2005). Hawaii has the
4466 highest number of threatened and endangered species in the United States with 79 animals and 424 plants
4467 listed as threatened or endangered (USFWS, 2019b).

4468 *3.6.4.4 Cultural Resources*

4469 Coral reefs have long played a significant cultural role within the traditional Hawaiian culture. The
4470 Kumulipo, the Hawaiian creation chant that explains how life began, has corals as among the first
4471 organisms to emerge (NOAA & UMCES, 2018). This provides a strong foundation connecting the people
4472 to the land and the sea that continues to this day (Friedlander, 2008).

4473 The Hawaiian Islands were first settled by Polynesians sometime during the 3rd to 6th century AD during
4474 the age of transpacific migrations. The islands are relatively small and most towns and villages are
4475 located within the coastal zone. Because of this, various aspects of local and indigenous history, culture,
4476 and society are closely related to the surrounding ocean and use of its resources, including coral reefs
4477 (Gorstein et al., 2018). Hawaii's rich and varied cultural history is reflected in the 360 sites listed on the
4478 NRHP (NPS, 2019a). Numerous Native Hawaiian organizations (NHOs) exist throughout Hawaii that
4479 serve the Native Hawaiian community. The NHOs are community service driven, not-for-profit
4480 organizations chartered by the State of Hawaii and controlled by Native Hawaiians; NHO business
4481 activities principally benefit Native Hawaiians (DLNR, 2019).

4482 *3.6.4.5 Socioeconomic Environment*

4483 *Land Use and Cover*

4484 More than 16% of the land on the MHI has been heavily impacted by agriculture, urban development, and
4485 resort development (Jacobi et al., 2017). Native vegetation dominates approximately 31% of the islands
4486 while 36% of the area has habitats that are somewhat disturbed, with a mix of native and nonnative plant
4487 species (Jacobi et al., 2017). Sixteen percent of the islands have less than 5% vegetation cover with most
4488 of this area found in the alpine and sub-alpine zones on the islands of Hawaii and Maui. Some relatively
4489 large non-vegetated areas are found on recent lava flows, primarily on the island of Hawaii (Jacobi et al.,
4490 2017). Most of these low to non-vegetated areas can be considered to be native dominated (Jacobi et al.,
4491 2017).

4492 According to Jacobi et al., forest covers more than 35% of the current landscape of the MHI (Jacobi et al.,
4493 2017). Sixteen percent of the land is mapped as shrubland and approximately 17% as grassland. Non-
4494 vegetated areas compose almost 19% (Jacobi et al., 2017). The remaining area is either agriculture,
4495 developed, or "other" (wetlands and bogs) (Jacobi et al., 2017).

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Table 3-8. Surface area by land cover/use.

Land Cover Type	Area (km ²)	Area (%)
Agriculture	1,190	7.2
Developed	1,032	6.3
Not vegetated	3,113	18.9
Dry forest	927	5.6
Mesic forest	1,639	9.9
Wet forest	3,039	18.4
Dry shrubland	1,478	9.0
Mesic shrubland	841	5.1
Wet shrubland	399	2.4
Dry grassland	1,537	9.3
Mesic grassland	1,010	6.1
Wet grassland	242	1.5
Wetland	37	0.2

Source: Jacobi et al., 2017

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Natural Resource Economy

Much of Hawaii’s economy is based on the islands’ coastal and marine resources. Hawaii’s coral reefs, through tourism and fisheries, are at the heart of many livelihoods. Coral reefs also serve as a natural barrier against wave erosion, storms, and coastal hazards, protecting coastal infrastructure, tourism, beaches, and human life (Cesar et al., 2002). The value of coral reefs to the Hawaii economy has been estimated to be about \$385 million a year (DLNR, 2015). Hawaii’s nearshore coral reef fisheries (recreational and commercial) are valued at \$10.3-16.4 million (Grafeld et al., 2017).

Tourism is a critical and integral aspect of the Hawaiian economy, accounting for the majority of the state’s economy. Indeed, Hawaii supports an almost \$7-billion-a-year tourism and recreation industry and has over 11 million visitors per year (NOAA & UMCES, 2018; Cesar et al., 2002). Wildlife viewing opportunities are worth hundreds of millions of dollars, and Hawaii’s native wildlife and their habitats also provide hundreds of millions of dollars in important goods and services to residents in the form of water quality, in-stream uses, species habitat, hunting, commercial harvest, ecotourism, and climate control (DLNR, 2015).

Gorstein et al. found that participation in non-extractive recreational reef activities varies in Hawaii, with the two activities that residents participate in most frequently being swimming (81%) and beach

4532 recreation (80%). Participation in extractive activities like fishing and gathering of marine resources was
4533 less common, with 45% of respondents indicating that they fished and/or gathered for marine resources
4534 (41% of respondents indicating that they fished, and 27% of respondents indicating that they gathered
4535 marine resources) (Gorstein et al., 2018).

4536 Marine sport fishing is popular in Hawaii, particularly with tourists. Marine recreational fishing is not
4537 currently regulated with a permit system in Hawaii, though some exceptions exist for protected areas and
4538 gear and species restrictions. Since 2004, the overall trend for non-commercial fishing effort in Hawaii
4539 has been downward, with the estimated harvest by weight by non-commercial fishers targeting coral reef
4540 species decreasing by 29% (Gorstein et al., 2018). Non-commercial catch for nearshore coral reef species
4541 is at least nine times the reported commercial nearshore coral reef fish catch according to one study
4542 (Gorstein et al., 2018).

4543 Pelagic waters, deep sea bottoms, and reefs are commercially fished in Hawaii. Commercial landings in
4544 Hawaii were valued at \$116,422,773 for 2017 (NOAA, 2019c). Pole and line, longline, deep bottom hand
4545 line, tuna hand line, and trolling are common commercial harvest methods in the pelagic and deep sea
4546 environments. Nets, traps, hook and line, and spears tend to be used in reef fisheries (WPRFMC, 2019b).
4547 Snapper, jacks, tuna, and Hawaiian grouper are some of the most economically valuable fisheries
4548 (WPRFMC, 2019b).

4549 In Hawaii's bottomfish fishery, the most sought-after fish species are called the "Deep 7": pink snapper
4550 (*Pristipomoides filamentosus*), scarlet/red snapper (*Etelis coruscans*; onaga), Hawaiian grouper
4551 (*Hyporthodus quernus*), squirrelfish snapper (*Etelis carbunculus*), Von Siebold's snapper (*Pristipomoides*
4552 *sieboldii*), flower/Brigham's snapper (*Pristipomoides zonatus*), and ironjaw/silverjaw snapper (*Aphareus*
4553 *rutilans*) (WPRFMC, 2019b). The heavy tackle, deep-sea handline gear is the dominant method for this
4554 fishery.

4555 In 2018, the MHI Deep 7 bottomfish fishery was characterized by decreasing trends in catch and effort
4556 relative to measured averages (WPRFMC, 2019b). Data from various surveys indicate that the importance
4557 of the MHI bottomfish fishery varies among fishermen of different islands, with the differences likely
4558 relating to the proximity of productive bottomfish fishing grounds (NOAA, 2009b). Oahu landings
4559 accounted for roughly 30% of the MHI commercial landings of deepwater bottomfish species from 1998
4560 to 2004. Maui landings from the same time period represented 36% of total MHI deepwater bottomfish
4561 landings, and Hawaii, Kauai and Molokai/Lanai represented 18, 10, and 5%, respectively (NOAA,
4562 2009b).

4563 The non-Deep 7 bottomfish fishery is dominated by uku (blue-green snapper; *Aprion virescens*) with a
4564 smaller contribution from white ulua (giant trevally; *Caranx ignobilis*) (WPRFMC, 2019b). Uku is
4565 commonly caught by deepsea handline, inshore handline, trolling with bait, and miscellaneous trolling.
4566 For 2018, the total number of non-Deep 7 fish caught was higher than the short- and long-term averages
4567 for this fishery, though the pounds caught was lower than the decadal average (WPRFMC, 2019b).

4568 The Coral Reef Ecosystem Management Unit Species finfish landings generally exhibited a decline in
4569 fishing participation, effort, and catch when comparing 2018 data to decadal averages (WPRFMC,
4570 2019b). The fishery was mostly dominated by inshore handline landing of coastal pelagic species such as
4571 akule (bigeye scad; *Selar crumenophthalmus*) and opelu (mackerel scad; *Decapterus macarellus*)

4572 (WPRFMC, 2019b). Other gears common in the Coral Reef Ecosystem Management Unit Species fishery
4573 include purse seine, lay gill net, seine net, and spear. There are 66 different specific finfish species in the
4574 Coral Reef Ecosystem Management Unit Species group, representing a total of 12 families including
4575 surgeonfish (*Acanthuridae*), jacks (*Carangidae*), squirrelfish (*Holocentridae*), rudderfish (*Kyphosidae*),
4576 wrasses (*Labridae*), emperor (*Lethrinidae*), snappers (*Lutjanidae*), mullet (*Mugilidae*), goatfish
4577 (*Mullidae*), parrotfish (*Scaridae*), grouper (*Serranidae*), and shark (*Carcharhinidae*) (WPRFMC, 2019b).

4578 In 2018, the MHI crustacean fishery is comprised of the Heterocarpus deepwater shrimps (*H. laevigatus*
4579 and *H. ensifer*), spiny lobsters (*Panulirus marginatus* and *P. penicillatus*), slipper lobsters (*Scyllaridae*
4580 *haanii* and *S. squamosus*), kona crab (*Ranina ranina*), kuahonu crab (*Portunus sanguinolentus*),
Hawaiian crab (*Podophthalmus vigil*), opaelolo (*Penaeus marginatus*), and ‘a‘ama crab (*Grapsus*
4582 *tenuicrustatus*) (WPRFMC, 2019b). The main gear types used are shrimp traps, loop nets, miscellaneous
4583 traps, and crab traps. In 2018, the crustacean fishery showed an overall decline relative to available short-
4584 and long-term trends (WPRFMC, 2019b).

4585 The mollusk and limu (seaweed) fishery in the MHI is comprised of algae including miscellaneous
4586 *Gracilaria* spp., limu kohu (*Asparagopsis taxiformis*), limu manauea (*Gracilaria coronopifolia*), ogo (*G.*
4587 *parvispora*), limu wawaeiole (*U. fasciata*), mollusks including clam (*Tapes philippinarum*), he’e (day
4588 octopus; *Octopus cyanea*), he’e pu loa (ornate octopus; *Callistoctopus ornatus*), other octopus (*Octopus*
4589 *spp.*), hihiwai (river nerite; *Theodoxus* spp.), opihi ‘alina (yellowfoot; *Cellana sandwicensis*), opihi
4590 makaiauli (black foot; *C. exarata*), opihi (*Cellana* spp.), and pupu (top shell) (WPRFMC, 2019b). The top
4591 gear for this fishery is hand pick, and the secondary gear is spear. The mollusk and limu fishery had
4592 decreases in effort, participation, and pounds landed though it showed an increase in the number caught
4593 relative to short- and long-term trends (WPRFMC, 2019b).

4594 The precious coral fishery is comprised of any coral of the genus *Corallium* in addition to pink coral (also
4595 known as red coral; *Corallium secundum*, *C. regale*, *C. laauense*), gold coral (*Gerardia* spp., *Callogorgia*
4596 *gilberti*, *Narella* spp., *Calyptrophora* spp.), bamboo coral (*Lepidisis olapa*, *Acanella* spp.), and black
4597 coral (*Antipathes griggi*, *A. grandis*, *A. ulex*) (WPRFMC, 2019b). The top gear for this species group is
4598 submersible (WPRFMC, 2019b).

4599 The aquarium fish industry, though relatively small, is one of the largest and most commercially valuable
4600 inshore fisheries in Hawaii (Cesar et al., 2002; Jokiel, 2008). The value of this fishery is estimated
4601 between \$2.3 and \$3.2 million (Cesar et al., 2002; Walsh et al., 2014). The largest share of the aquarium
4602 fish collection occurs along the Kona coast. The most commonly caught fish species include
4603 surgeonfishes, butterflyfishes, and wrasses. The yellow tang (*Zebrasoma flavescens*) dominates the total
4604 catch. Among the invertebrates, feather duster worms, hermit crabs, and shrimp are the main targets
4605 (Cesar et al., 2002; Jokiel, 2008).

4606 Natural resource production also remains important in Hawaii. Crop and livestock sales were valued at
4607 \$516.1 million in 2004 (DLNR, 2015). The primary diversified agriculture crops were flower and nursery
4608 products, \$94.5 million; macadamia nuts, \$40.1 million; coffee, \$19.8 million; cattle, \$22.1 million; milk,
4609 \$20.2 million (DLNR, 2015).

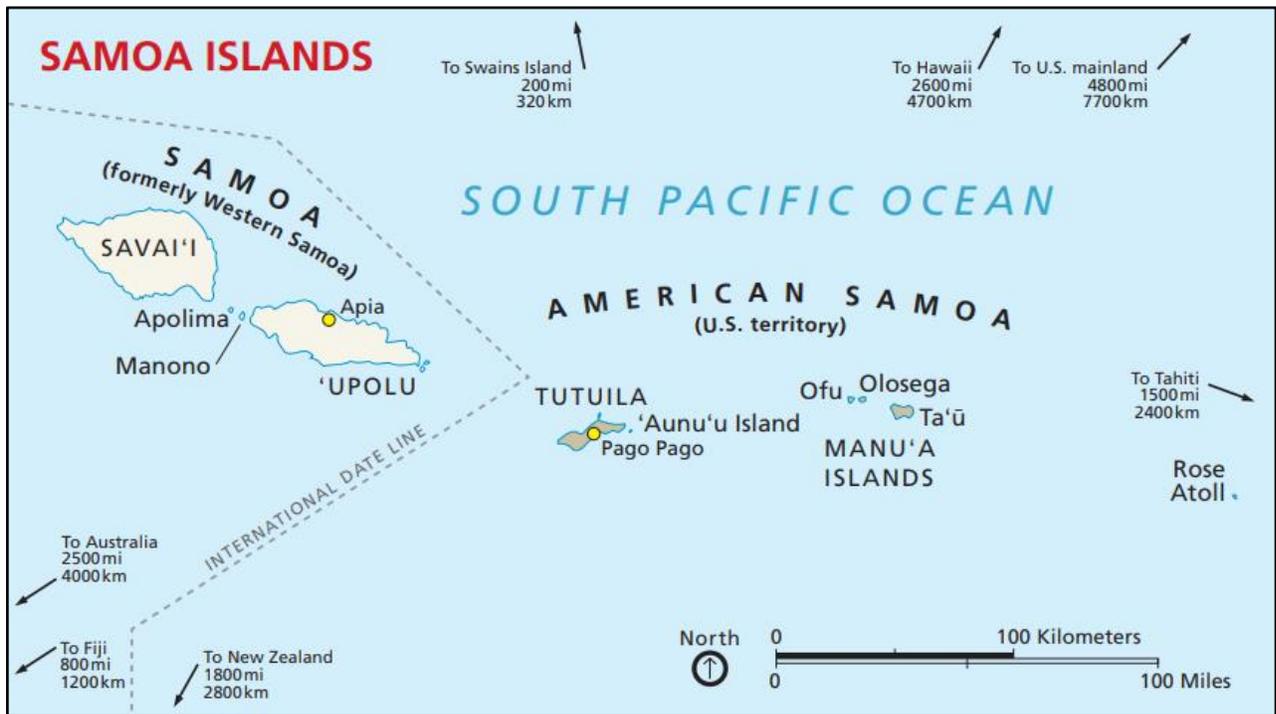
4610 **3.6.5 American Samoa**

4611 **3.6.5.1 Physical Environment**

4612 American Samoa is the southernmost of all U.S. territories and is located approximately 4,200 km
4613 southwest of the Main Hawaiian Islands in the central South Pacific Ocean (NOAA CoRIS, 2019d).
4614 American Samoa is comprised of five volcanic islands (Tutuila, Aunu'u, Ofu, Olosega, and Ta'u) and two
4615 coral atolls (Swains Island and Rose Atoll) (Figure 3-6) distributed over 240 km (149 mi) of ocean. Ofu,
4616 Olosega, and Ta'u are collectively referred to as the Manu'a Islands (NOAA CoRIS, 2019d; Craig et al.,
4617 2005). Island ages generally decrease from oldest in the northwest to youngest in the southeast (Birkeland
4618 et al., 2008). Rose Atoll is uninhabited and is managed as a National Wildlife Refuge by the USFWS
4619 (Craig et al., 2005).

4620 Total land area in American Samoa is almost 200 km² (124 mi²). The geography of the islands tends to be
4621 rocky with numerous mountain ranges created from extinct volcanoes. The archipelago has narrow reef
4622 flats (50-500 m [164-1640 ft]) and steep offshore banks that drop to oce-anic depths within 0.5-8 km (0.3-
4623 5 mi) from shore (Fenner et al., 2008). The shallow-water habitats are composed primarily of fringing
4624 reefs (85% of total coral reef area), a few offshore banks (13%), and the two atolls (3%) (Craig et al.,
4625 2005).

4626 Tides in American Samoa consist of two daily highs and two daily lows, with a mean range of 0.765 m as
4627 measured in Pago Pago harbor (NOAA, 2019a).



4628 Figure 3-6. Map of American Samoa. Source: National Park Maps, 2017
4629

4630 **Climate and Weather**

4631 The climate of the territory is tropical with high humidity and relatively uniform daily temperatures
4632 throughout the year (Birkeland et al., 2008). The annual temperature range across this region is 3°C (6°F);

4633 warmer temperatures (~30°C [86°F]) occur during the summer (January to March), and cooler
4634 temperatures (~27°C [80°F]) occur during the winter (July to September) (NOAA, 2011).

4635 The islands are known to have high annual precipitation, averaging 305 cm per year; however, rainfall
4636 can be highly variable throughout the territory due to topographic influences (NOAA, 2012). The driest
4637 months are typically from June through September, and the wettest from December through March;
4638 however, heavy rain showers occur any month of the year (NPS, 2015). Winds are generally light and
4639 variable during the summer rainy season, except during cyclones, while much stronger east-southeast
4640 trade winds prevail in other seasons (Fenner et al., 2008).

4641 The territory is exposed to tropical storms and cyclones, typical of the South Pacific. These systems
4642 usually form when sea surface temperatures are at their highest, during the months of November through
4643 May. The most recent cyclone to hit American Samoa was Cyclone Gita, which impacted the territory in
4644 early February 2018 with maximum sustained winds of 145 mi/hr (230 km/hr) (NASA, 2018).

4645 Relatively high and stable ocean temperatures persist throughout the year, with an average low of 27.2°C
4646 (81°F) in August and a high of 29.4°C (85°F) in March.

4647 ***Water Resources***

4648 American Samoa's land mass is divided into 41 watersheds, each with an average size of 1.5 mi² (2.4
4649 km²) (Tuitele et al., 2018a). Villages in American Samoa are typically demarcated by the boundaries of
4650 the watershed and the coastal area adjacent the watershed's shoreline. The small, steep watersheds and
4651 periodic intense rainfall lead to flashy surface flows in the nearly 260 mi (418 km) of American Samoa's
4652 perennial streams (Tuitele et al., 2018b). Stream water quality is mostly impacted by development, which
4653 affects hydrology, shade, erosion, and turbidity, as well as poorly constructed and managed human and
4654 piggery waste systems (Tuitele et al., 2018a).

4655 As articulated in the 2010 American Samoa Coral Reef Management Priority document (NOAA CRCP,
4656 2010), the watersheds of Vatia and Faga'alu were identified as priority watersheds for focused coral reef
4657 management efforts. The watersheds were selected by American Samoa's conservation managers in
4658 consideration of each watershed's biological value, degree of risk and threat, and potential for meaningful
4659 management actions. In 2012, Faga'alu was also selected as a priority watershed by the USCRTF for
4660 collaborative coral reef management efforts.

4661 Like many other small tropical islands with highly permeable soils, there is a freshwater aquifer floating
4662 on a layer of salt water beneath the ground of each island (Tuitele et al., 2018b). The Tafuna-Leone plain
4663 on the island of Tutuila is the most productive well site in American Samoa. However, the plain is also
4664 the most populated and industrious area in American Samoa (Tuitele et al., 2018b). Due to the porous and
4665 permeable nature of the volcanic geology, groundwater contamination is a constant risk. Rare dry periods
4666 of two to three months can result in critical drinking water shortages as salt water intrudes on the depleted
4667 fresh water lens (Tuitele et al., 2018b).

4668 ***3.6.5.2 Biological Environment***

4669 Geology and oceanographic conditions have helped shape the coral reef ecosystems of American Samoa.
4670 These ecosystems include numerous species of Indo-Pacific corals, other invertebrates, and fish.
4671 Anthropogenic and environmental stressors that have influenced the communities within these
4672 ecosystems include thermal anomalies, storms, predator outbreaks, fishing, ship groundings, and land-

4673 based sources of pollution (NOAA, 2011). The coral ecosystems of American Samoa are a mosaic of
4674 areas in various stages of recovery from a number of disturbances such as crown-of-thorns predation,
4675 hurricanes, blast fishing, and bleaching from warm-water stress. In areas where the stressor impacts were
4676 more acute, recovery was able to start soon after the event. Some areas that experience chronic stressors
4677 like sedimentation at the mouths of rivers have been much slower to recover if at all (Craig et al., 2005;
4678 Birkeland et al., 2008). While coral species in American Samoa have shown resilience after acute
4679 disturbances and eventually recovered, because of serious overfishing, the coral reef ecosystems cannot
4680 be considered healthy based on the resilience of the corals alone (Craig et al., 2005; Birkeland et al.,
4681 2008). Additionally, many long-term stressors like population growth and its associated impacts and coral
4682 bleaching are increasing or becoming more frequent (Craig et al., 2005; Birkeland et al., 2008).
4683 Nonetheless, coral reefs in American Samoa are considered to be in good condition overall (NOAA &
4684 UMCES, 2018a).

4685 *Marine*

4686 American Samoa has a diversity of marine habitats, including saltwater marshes, mangrove swamps, coral
4687 reefs, and deep-water marine environments.

4688 All of American Samoa's islands are surrounded by fringing coral reefs with the presence of some barrier
4689 reefs. The total area of coral reefs in American Samoa is 296 km² (Craig et al., 2005).

4690 The benthic communities of American Samoan coral reefs appear to be in relatively good condition
4691 (Fenner et al., 2008; NOAA & UMCES, 2018a). On reef flats and slopes, crustose coralline algae has
4692 been found to be dominant, live hard corals second in abundance, dead coral less common (and almost
4693 none recently dead), and brown macroalgae very rare (Fenner et al., 2008). Fenner et al. (2008)
4694 summarized six different studies and observed that crustose coralline algae is an important benthic
4695 component of the coral reef ecosystems in American Samoa (Fenner et al., 2008). Live coral cover as
4696 observed in these studies averaged about 22-34% with mean live coral cover at 28% (Fenner et al., 2008).

4697 Coral cover has been found to vary from island to island in American Samoa. A multi-year study found
4698 coral coverage of 31% for Swains Island, 21% for Tutuila, 21% for Ta'u, 20% for Ofu and Olosega, and
4699 14% for Rose Atoll (NOAA, 2011). Differences also exist in biota distributions on differently exposed
4700 sides of the islands. For instance, studies have found significantly higher coverage of crustose coralline
4701 algae on the Tutuila's south coast than on the north coast (Birkeland et al., 2008). In contrast, filamentous
4702 algae has been found to predominate the north coast (Birkeland et al., 2008).

4703 There are over 500 species of reef-building corals in the southwest Pacific, and more than 300 species
4704 belonging to 60 scleractinian and hydrozoan genera reported for American Samoa (Birkeland et al., 2008;
4705 NOAA, 2011). Levels of diversity also varied around the islands with the lowest generic richness reported
4706 at Swains and the highest at Tutuila (NOAA, 2011). *Montipora* was the primary genus recorded on
4707 average across the islands except at Rose Atoll (NOAA, 2011). Few endemic marine species are said to
4708 exist in American Samoa, perhaps due to the large dispersal rate of pelagic larvae.

4709 Coral reefs also support a high diversity of other biota, including at least 945 species of fish (Fenner et al.,
4710 2008; Birkeland et al., 2008). Fish communities are dominated by small to medium-sized herbivores, like
4711 surgeonfish and parrotfish, though some planktivorous fish, such as small damselfish and fusiliers, may
4712 also be common. Reef fish biomass has been found to be higher on Swains Island and Rose Atoll
4713 compared to the Manua Islands and Tutuila (Fenner et al., 2008).

4714 Invertebrate filter feeders such as sponges, boring clams, feather duster worms, crinoids, black corals,
4715 azooxanthellate soft corals and ascidians are generally rare, small and/or cryptic (Fenner et al., 2008).
4716 Some exceptions exist like the deeper areas of the Pago Pago harbor where sponges and sea fans are
4717 common and the inner reef flat at Leone, which is covered by a thin encrusting grey sponge.

4718 Although two species of seagrass (both of genus *Halophila*) are found in American Samoa, their presence
4719 appears to be dispersed and most likely does not provide essential habitat or food for key species (Fenner,
4720 2019).

4721 Thirty-three species of marine mammals are known to occur in the tropical South Pacific. Eleven of them
4722 have been observed in the waters of American Samoa, including humpback whale (*Megaptera*
4723 *novaeangliae*), minke whale (*Balaenoptera acutorostrata*), sperm whale (*Physeter macrocephalus*), killer
4724 whale (*Orcinus orca*), short-finned pilot whale (*Globicephala macrorhynchus*), common bottlenose
4725 dolphin (*Tursiops truncatus*), spinner dolphin (*Stenella longirostris*), pantropical spotted dolphin
4726 (*Stenella attenuata*), rough toothed dolphin (*Steno bredanensis*), Cuvier's beaked whale (*Ziphius*
4727 *cavirostris*), and false killer whale (*Pseudorca crassidens*) (Fenner et al., 2008). Green (*Chelonia mydas*)
4728 and hawksbill (*Eretmochelys imbricata*) sea turtles nest on beaches in American Samoa. Olive ridley
4729 turtles (*Lepidochelys olivacea*) and leatherbacks (*Dermochelys coriacea*) are rarely reported from pelagic
4730 waters (Craig et al., 2005; Fenner et al., 2008).

4731 Federally listed threatened or endangered marine species include humpback and sperm whales, the green
4732 and hawksbill sea turtles, several fishes (humphead wrasse [*Cheilinus undulatus*], bumphead parrotfish
4733 [*Bolbometopon muricatum*], reef sharks), and six species of corals (Appendix E).

4734 Acute episodic threats to coral reefs in American Samoa include mass coral reef mortality events from
4735 coral bleaching, cyclones, crown-of-thorns starfish outbreaks, *kaimasa* or extreme low tide events, and a
4736 2009 tsunami. Of these, coral bleaching has been the most frequent threat with documented events in
4737 1994, 2002, 2003, 2015, and 2017 (Fenner, 2018).

4738 American Samoa's coral reefs exhibit unique research opportunities. The first coral reef transect ever
4739 recorded in the Pacific (and the second in the world) is the Aua Transect, first examined in 1917
4740 (Birkeland et al., 2008). In addition, corals on the south side of the island of Ofu demonstrate resilience to
4741 extreme warm sea temperatures. The water in these pools have been recorded as high as 94.1°F (34.5°C),
4742 well above coral bleaching thresholds; however, the corals exhibit little to no signs of bleaching (Craig et
4743 al., 2001).

4744 ***Terrestrial and Freshwater***

4745 Wetlands and other freshwater habitats are found throughout American Samoa, and provide food and
4746 habitat for several freshwater species of native fish and invertebrates. Two important freshwater finfish
4747 include eels (*Anguilla mauritiana*) and mountain bass (*Kuhlia rupestris*) (Utzurum, 2006; Fishbase, 2019;
4748 Craig, 2009).

4749 American Samoa has diverse freshwater and terrestrial gastropod fauna, many of which are endemic to
4750 the archipelago, as well as conspicuous freshwater and terrestrial crustaceans. The most abundant
4751 freshwater crustacean is the prawn (*Macrobrachium lar*). Over 2500 species of insects have been
4752 recorded in the Samoan archipelago (Utzurum, 2006).

4753 The herpetofauna of American Samoa is made up primarily of widespread and introduced species, and
4754 includes one introduced amphibian species and at least 13 species of terrestrial reptiles (geckos and
4755 skinks) (Utzurum, 2006). There are no native amphibians in American Samoa, and only one species of
4756 native snake occurs, the Pacific boa (*Candoia bibroni*) (Utzurum, 2006).

4757 Avifauna include land birds and migratory waterbirds, shorebirds, and seabirds. By tropical standards,
4758 avifaunal diversity in American Samoa is lacking (Utzurum, 2006).

4759 There are only three native mammals in American Samoa, all species of bats: *Emballonura semicaudata*
4760 *semicaudata*, *Pteropus samoensis*, and *P. tonganus*. *E. semicaudata* is possibly extinct in the territory
4761 (Utzurum, 2006). Other mammalian species on the island include domestic animals and feral pigs (*Sus*
4762 *scrofa*) (Utzurum, 2006).

4763 Species only found in the Samoan Archipelago include one bird (the Samoan starling), one stream fish,
4764 several land snails, and about 30% of local plant species. Endangered terrestrial species include the
4765 Pacific sheath-tailed bat (*Emballonura semicaudata semicaudata*), the mao (*Gymnomyza samoensis*), the
4766 American Samoan distinct population segment of the friendly ground dove (*Gallicolumba stairi*), two
4767 native land snails (*Eua zebrina* and *Ostodes strigatus*), and others (81 FR 65465).

4768 3.6.5.3 Cultural Resources

4769 The Samoan people's Polynesian ancestors settled the archipelago about 3,000 years ago. Archaeological
4770 sites dating from the early period of occupation are primarily habitation sites and are expected to be
4771 mostly coastal. No habitation sites from this period are listed on the NRHP (NPS, 2019a).

4772 The period between about A.D. 300 and 1000 requires further definition in the study of Samoan
4773 prehistory, but one site type that was probably utilized during this period is the stone quarries. To date,
4774 four large and about six smaller quarries have been identified on Tutuila Island. One of the large quarries,
4775 Tatagamatau, is listed on the NRHP, and two others are being nominated (American Samoa Historic
4776 Preservation Office, 2019b).

4777 Most of the prehistoric surface remains in American Samoa date to the later period of Samoan prehistory.
4778 A large defensive wall on the Tafuna Plain, Tutuila Island, is listed on the NRHP, and there are plans to
4779 nominate a fortification site on Ofu Island. The late prehistoric sites at Maloata and Fagatele Bay, both on
4780 Tutuila, and Faga on Ta'u, are village sites from this time period that are being nominated to the NRHP
4781 (American Samoa Historic Preservation Office, 2019b).

4782 Historic properties from World War II are found throughout the islands in the form of military facilities
4783 such as medical facilities, the Tafuna Air Base, and pillboxes that are scattered along the coastlines
4784 (American Samoa Historic Preservation Office, 2019a). Overall, there are 31 sites listed on the NRHP
4785 (NPS, 2019a; American Samoa Historic Preservation Office, pers. comm., July 2, 2019).

4786 3.6.5.4 Socioeconomic Environment

4787 **Land Use and Cover**

4788 Due to the steep topography of the volcanic islands, land suitable for human activity is restricted to a
4789 narrow band of coastal area between the ocean and the mountains. This results in a concentration of land
4790 use within several hundred yards of the shoreline, while a majority of the island remains covered in
4791 relatively dense tropical forest. Nonetheless, the islands appear dominated by disturbed or previously

4792 disturbed vegetation types as secondary vegetation types and agriculture are prevalent (DOE, 2017d).
 4793 Table 3-9 lists the land cover in American Samoa.

4794 *Table 3-9. Land Cover in American Samoa (Tutuila, Ta'ū, and Ofu).*

4795	Land Use/Cover	Area (km ²)	Area (%)
4796	Bare Land	2.8	1
4797	Cultivated	3.9	2
4798	Developed, open space	8.1	4
4799	Wetland	0.9	<1
4800	Evergreen Forest	152.2	78
4801	Grassland	2.0	1
4802	Impervious Surface	9.2	5
4803	Pasture/Hay	0.2	<1
4804	Scrub/Shrub	16.0	8
4805	Unconsolidated Shore	<0.1	<1
4806	Water	0.3	<1

4807 Source: Adapted from DOE 2017d, using 2010 C-CAP data

4811 Established marine conservation areas in the territory include Rose Atoll National Wildlife Sanctuary,
 4812 National Marine Sanctuary of American Samoa, the National Park of American Samoa, and several
 4813 smaller community-based marine protected areas. The largest coral reef conservation areas on the main
 4814 islands are part of the National Park of American Samoa, which was authorized by Congress in 1988 and
 4815 officially established in 1993 (Atkinson & Medeiros, 2010).

4816 ***Natural Resource Economy***

4817 Tourism is a relatively small industry in American Samoa, particularly when compared to neighboring
 4818 Independent Samoa and other South Pacific destinations such as Fiji (WPRFMC, 2019a). Ecotourism
 4819 consists primarily of hiking and snorkeling and is most commonly pursued in the National Park units of
 4820 American Samoa.

4821 In 2004, the coral reefs of American Samoa were estimated to provide benefits of \$5.1 million/year with
 4822 the territory's mangroves adding an additional \$0.75 million/year. Together, these critical natural
 4823 resources accounted for 1.2% of the American Samoa GDP. Some of the important benefits provided by
 4824 the reefs could be broken down as follows: \$689,000/year benefit due to coral reef fisheries; \$73,000/year
 4825 benefit resulting from recreational uses; \$70,000/year benefit deriving from bottom fishing;
 4826 \$447,000/year benefit relating to shoreline protection provided by the reefs (Fenner et al., 2008).

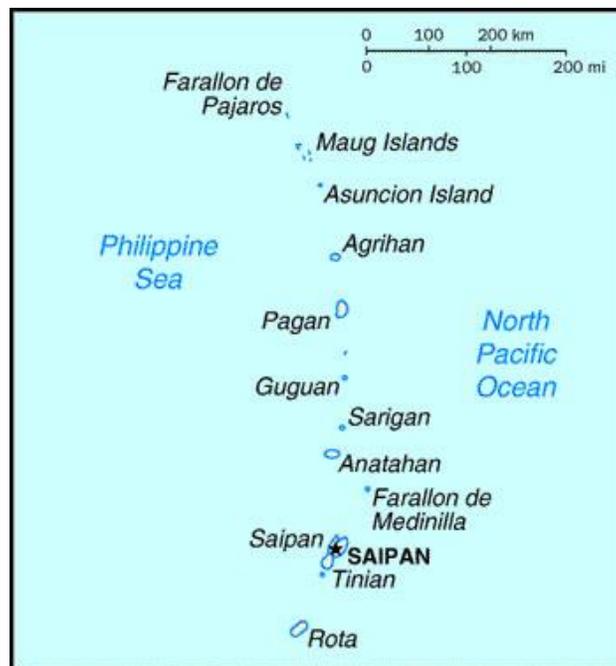
4827 Reef fish are harvested in both subsistence and artisanal fisheries on the five main islands in the territory,
4828 though some fishing also occurs on Swains Island and Rose Atoll (Craig et al., 2005). Commercial fishing
4829 conducted in American Samoa’s waters is dominated by small outboard-engine-powered catamarans,
4830 locally known as *alias*, and typically involves bottom fishing and spearfishing, longlining or trolling
4831 (WPRFMC, 2009b). Recreational and subsistence bottom fishing are rare (WPRFMC, 2009a). Coral reef
4832 fish are not currently exported to off-island markets or the aquarium trade (Craig et al., 2005).

4833 The reef fish catch composition in American Samoa is dominated by six families: Acanthuridae (28%),
4834 Serranidae (12%), Holocentridae (12%), Lutjanidae (7%), Mugilidae (7%), and Scaridae (6%). Atule
4835 (*Selar crumenophthalmus*), a coastal pelagic species, seasonally accounts for a significant portion of the
4836 coral reef catch (NOAA, 2017b). Other commonly harvested species of coral reef-associated organisms
4837 include triggerfishes (Balistidae), jacks (Carangidae), wrasses (Labridae), octopus (*Octopus cyanea*,
4838 *Callistoctopus ornatus*), goatfishes (Mullidae), and giant clams (Tridacnidae) (WPRFMC, 2009b).
4839 Crustaceans are harvested on small scales throughout the inhabited islands of the Western Pacific Region.
4840 The most common harvests include the lobster species Palinuridae (spiny lobsters) and Scyllaridae
4841 (slipper lobsters) (WPRFMC, 2009b).

4842 **3.6.6 The Commonwealth of the Northern Mariana Islands**

4843 **3.6.6.1 Physical Environment**

4844 The Mariana Archipelago comprises 15 islands and is politically separated into the U.S. territories of the
4845 CNMI and Guam (Figure 3-7) (NOAA CoRIS, 2019e). The 14 islands of the CNMI extend 600 km (372
4846 mi) and have a total land area of approximately 474 km² (295 mi²). The islands developed west of the
4847 Mariana Trench along the edge of the Philippine Plate (Pacific RISA, 2019).



4848
4849 Figure 3-7. Map of the CNMI. Source: NOAA CoRIS, 2019e

4850 The principal inhabited islands are Saipan, Guguan, Rota, and Tinian, and the northern, largely
4851 uninhabited islands are Farallon de Medinilla, Anatahan, Sariguan, Gudgeon, Alamagan, Pagan, Agrihan,

4852 Asuncion, Maug Islands, and Farallon de Pajaro (NOAA CoRIS, 2019e). The northern islands are high
4853 volcanic islands, and the southern islands are volcanic in origin but covered with uplifted limestone
4854 derived from coral reefs. The southern islands have the oldest and most developed reefs in the CNMI,
4855 which are predominantly located along the western (leeward) sides (NOAA CoRIS, 2019e; Starmer et al.,
4856 2005).

4857 The largest island, Saipan, is 119 km² (74 mi²) in size and supports approximately 89% of the population
4858 (Liske-Clark, 2015; Yuknavage et al., 2018). Rota and Tinian support the vast majority of the remaining
4859 11% of the population. This uneven dispersal of CNMI's population is an important consideration in the
4860 assessment of environmental impacts as it results in great spatial variation of human uses, including
4861 anthropogenic stress on coral reef ecosystems and watersheds, as well as areas of interest for research
4862 activities. Saipan, Tinian, and Rota have consistently served as central locations for watershed
4863 conservation projects, marine protected area management, and fine-scale in-water research. The
4864 remainder of the CNMI hosts annual research cruises and occasional studies specific to the Marianas
4865 Trench Marine National Monument in the northernmost three islands (Asuncion, Uracas, and Maug).

4866 *Climate and Weather*

4867 The CNMI's climate is within the range of the inter-tropical convergence zone. There is little seasonal
4868 temperature variation; average daily temperatures are approximately 28°C (82.4°F) with a range of 24°C
4869 (75.2°F) to 30°C (86°F) (Richmond et al., 2008).

4870 Rainfall varies between the islands and on the islands themselves. For example, average rainfall on Tinian
4871 is 109-246 cm/year (42-97 in/year), and rainfall is 86-368 cm/year (34-145 in/year) on Saipan (Riegl et
4872 al., 2008). CNMI has well-defined wet and dry seasons with 70% of the total annual rainfall occurring
4873 during the wet season from July to November (Riegl et al., 2008; Richmond et al., 2008). The wet season
4874 is characterized by calmer winds, while the dry season is characterized by consistent northeast trade
4875 winds and frequent light-to-moderate showers. Typhoons bring the most intense rainfall during this
4876 period (Riegl et al., 2008). Dry years occur approximately once every four years as a result of El Niño
4877 Southern Oscillation events in the Pacific (Riegl et al., 2008; Starmer et al., 2008). Sea surface
4878 temperatures generally vary seasonally from about 25°C (77°F) to 29°C (84.2°F) (Riegl et al., 2008). The
4879 primary ocean current influencing the region is the North Equatorial Current (Starmer et al., 2008).

4880 Relative sea levels in the CNMI are also closely tied to El Niño Southern Oscillation conditions across the
4881 Pacific. Lower sea levels are documented during El Niño episodes while higher sea levels occur during
4882 La Niña (Snyder, 2006). Sea level change and variability are highlighted here due to the implications it
4883 poses for both thermal stress on CNMI's coral habitat, as well as the acute threat of enhanced coastal
4884 flooding during periods of higher sea levels.

4885 *Water Resources*

4886 Water does not move across the surface in streams on most of the land area in the CNMI because almost
4887 all rainwater infiltrates the porous limestone substrate where it is present in the southern islands of
4888 Saipan, Tinian, and Rota (Yuknavage et al., 2018; Bearden et al., 2014). Perennial stream reaches
4889 constitute less than three percent of the land in the CNMI, and the majority of the streams are patchily
4890 distributed around Saipan (Yuknavage et al., 2018; Bearden et al., 2014). The streams originate in the
4891 islands' interiors and drain to the coast. The most common sources of surface water quality degradation in
4892 the CNMI are failing sewer lines and other wastewater systems, as well as pollution from nonpoint

4893 sources such as secondary roads, erosion, livestock overgrazing, other storm water sources, and bacteria
4894 from livestock (Yuknavage et al., 2018; Bearden et al., 2014).

4895 Groundwater is the main source of drinking water in the CNMI (Arriola et al., 2016). The principal
4896 aquifers in the CNMI are formed from saturated limestone. Saipan, Tinian, and Rota's limestone rocks
4897 contain a basal freshwater-lens aquifer (Carruth, 2003). This aquifer system is recharged by direct
4898 infiltration of rainfall and by inflow from perched groundwater systems (Carruth, 2003). Sources of
4899 groundwater contamination include underground storage tanks, landfills, septic tanks, failing sewer lines,
4900 and most importantly, salt water intrusion (Bearden et al., 2014).

4901 *3.6.6.2 Biological Environment*

4902 Within the Northern Marianas, climate change stressors such as ocean warming and acidification, are
4903 some of the leading threats to coral reefs. Mass coral bleaching events have occurred four of the last five
4904 years (2013-2017), resulting in reduced coral cover and changes in community composition. Recent
4905 surveys at reef resiliency sites that followed initial transects from 2012-2013 indicate that the coral
4906 ecosystems around CNMI's populated islands have not recovered from these bleaching incidents, with
4907 near 90% mortality of branching corals observed at many sites (Maynard et al., 2015).

4908 Increased population and development in the CNMI also threaten coral reef ecosystems. Effects are most
4909 noticeable on the island of Saipan, though the other southern populated islands also have important coral
4910 reef ecosystems that are threatened by human impacts. In addition to population growth and increased
4911 development, coral reefs in the CNMI are also threatened by unsustainable fishing practices, climate
4912 change, land-based sources of pollution, overuse, and lack of enforcement. CNMI's reefs are reported to
4913 be in fair condition (NOAA & UMCES, 2018b).

4914 *Marine*

4915 There are a variety of coral reef types in the Mariana Islands, including barrier reefs, fringing reefs, patch
4916 reefs, and submerged reefs associated with offshore banks (Riegl et al., 2008; Richmond et al., 2008).
4917 Coral reef communities vary around the islands according to wind and wave action exposure. Corals and
4918 reefs on windward exposures exhibit more signs of wave activity like robust forms and skeletal
4919 characteristics and spur-and-groove formations (Richmond et al., 2008). In addition, there is a noticeable,
4920 broad-scale, reef-community zonation pattern between the northern, volcanically active islands and the
4921 southern, raised limestone islands (Richmond et al., 2008).

4922 The younger volcanic islands in the north are still active and have little fringing and barrier reef
4923 development, while the older islands to the south, including Rota, Aguijan, Tinian, Saipan, and Farallon
4924 de Medinilla, have fringing and barrier reef systems. Coral diversity and colony surface area are
4925 significantly lower on the northern islands than on the southern islands (Richmond et al., 2008; Goldberg
4926 et al., 2008). One study examined the naturally volcanically acidified water at Maug in the northern
4927 islands as an equivalent to near-future predictions for what coral reef ecosystems will experience
4928 worldwide due to ocean acidification (Enochs et al., 2015). The study provided evidence of how
4929 acidification-related stress significantly influences the abundance and diversity of coral reef taxa, leading
4930 to a shift from coral to a non-reef forming macroalgae-dominated state. Another study in this same region
4931 of the CNMI provided further evidence that microborers, especially bioeroding chlorophytes, respond
4932 positively to low pH sites and found evidence that ocean acidification could enhance microboring flora
4933 colonization in newly available substrates (Enochs et al., 2016).

4934 Of the inhabited islands in the CNMI, Rota and Tinian are dominated by fringing reefs, with Rota having
4935 the more developed reef system (van Beukering, 2006). Saipan has the most diverse types of coral reefs
4936 and associated habitats in the CNMI. A fringing and barrier reef system protects the majority of the
4937 beaches along the western side of the island, forming a 12.4 mi² (20 km²) shallow-water lagoon system.
4938 This environment contains large assemblages of seagrass, branching corals, and the last remaining
4939 mangroves in the CNMI (NOAA CoRIS, 2019e). The windward (northern and eastern) shoreline is
4940 dominated by limestone terraces, cliffs, and fringing reef (van Beukering, 2006).

4941 The average percent covers of live coral and macroalgae were similar in Saipan and Tinian/Aguijan:
4942 approximately 38% for live coral and 7% for macroalgae (Maynard et al., 2015). The same study found
4943 that, on average, coral cover was approximately 10% lower on Rota than in Saipan or Tinian/Aguijan
4944 (~28% versus ~38%), and macroalgae cover on Rota was twice that observed in Saipan or Tinian/Aguijan
4945 (~14% versus ~7%). The average coral cover at the forereef sites (all islands combined) was 35%
4946 (Maynard et al., 2015).

4947 Pilot coral nurseries and associated outplantings exist in the Managaha Marine Protected Area adjacent to
4948 Saipan. In addition, restoration efforts have been initiated to install artificial reef along a former ship
4949 grounding site (Vessel Paul Russ, 2014), where coral was damaged along the Saipan Harbor ship channel.

4950 Saipan's nearshore waters and lagoon are fairly rich in biodiversity. Fringing coral reefs border most of
4951 Saipan's coast and contain many endemic and/or endangered species (Appendix E). The Mariana Islands
4952 are reported to have 377 scleractinian corals covering 20 families. Additionally, 195 species of
4953 echinoderms, 650 crustaceans, 800 species of prosobranch gastropods, and 1,000 species of reef and shore
4954 fishes are reported from the Marianas (Richmond et al., 2008).

4955 The Mariana Islands have three species of seagrasses, *Enhalus acoroides*, *Halophila minor*, and *Halodule*
4956 *univervis*, which can be found in well-developed seagrass beds, primarily in Saipan's lagoon (Richmond
4957 et al., 2008; Gourley, 2006). Saipan's lagoon system also contains a third of benthic algal species
4958 (Starmer et al., 2008) and high concentrations of endangered turtle species (Starmer et al., 2005). Green
4959 turtles (*Chelonia mydas*) reside in CNMI southern arc waters while hawksbill turtles (*Eretmochelys*
4960 *imbricata*), leatherbacks (*Dermochelys coriacea*), and olive ridleys (*Lepidochelys olivacea*) are also
4961 known from the CNMI (Starmer et al., 2005).

4962 Cetacean surveys have observed spinner dolphins (*Stenella longirostris*), bottlenose dolphins (*Tursiops*
4963 *truncatus*), pantropical spotted dolphins (*Stenella attenuata*), short-finned pilot whales (*Globicephala*
4964 *macrorhynchus*), pygmy killer whales (*Feresa attenuata*), sperm whales (*Physeter macrocephalus*), and a
4965 dwarf sperm whale (*Kogia sima*) within close proximity to the Saipan Lagoon (Hill et al., 2013). Saipan
4966 is also home to two endemic fish species: wrasse (*Pseudojuloides* sp.) and goby (*Amblyeleotris* sp.)
4967 (Myers & Donaldson, 2003).

4968 ***Terrestrial and Freshwater***

4969 The raised limestone bedrock of the southern Mariana Islands is extremely permeable, so most rainfall
4970 that does not directly run off into the ocean percolates into the ground. Thus, streams occur mostly in
4971 limited areas where less permeable volcanic base materials have been exposed (Arriola et al., 2016).
4972 Saipan's streams do not have perennial flow for the entire length of the streams. Rota also has several
4973 intermittent streams, but Tinian has no streams (Bearden et al., 2014).

4974 In the CNMI, wetlands are also limited in extent, although some artificial wetlands have been created to
4975 increase wildlife habitat. These occur primarily at low elevations where the water table intersects with the
4976 land's surface (Arriola et al., 2016). These freshwater habitats support important species like the
4977 Mariana common moorhen (*Gallinula chloropus guami*), a federally endangered bird.

4978 The CNMI is host to hundreds of species of terrestrial invertebrates including, but not limited to, ants,
4979 mosquitoes, butterflies, scorpions, spiders, centipedes, millipedes, and snails (Berger et al., 2005).
4980 Twenty-eight species of reptiles and amphibians are known to inhabit the CNMI, including six frogs and
4981 toads, 14 lizards, two snakes, and six freshwater turtles. Most of these species are native to CNMI (Kerr,
4982 2013).

4983 Only two native terrestrial mammals occur in CNMI: the Mariana fruit bat (*Pteropus mariannus*) and the
4984 Pacific sheath-tailed bat (*Emballonura semicaudata*). The Mariana fruit bat (also known as the Mariana
4985 flying fox) is listed as federally threatened, and the Pacific sheath-tailed bat is listed as federally
4986 endangered (Appendix E). Other terrestrial mammals have been introduced, including the sambar deer,
4987 pigs, cows, goats, cats, and rodents (Berger et al., 2005).

4988 The Avibase lists 166 bird species for CNMI, with many of the species listed as rare or accidental
4989 (Avibase, 2019). Native forest birds, including the Mariana fruit dove (*Ptilinopus roseicapilla*), Mariana
4990 crow (*Corvus kubaryi*), Rota bridled white-eye (*Zosterops rotensis*), golden white-eye (*Cleptornis*
4991 *marchei*), white-throated ground dove (*Gallicolumba xanthonura*), and rufous fantail (*Rhipidura*
4992 *rufifrons*), are found at their highest densities in the islands' native forest habitat. Secondary forests are
4993 important to several native forest birds, including the nightingale reed-warbler (*Acrocephalus luscinius*)
4994 and Saipan bridled white-eye (*Zosterops conspicillatus*). Grasslands and savannas are important foraging
4995 habitats for the Mariana swiftlet (*Aerodramus bartschi*), an endemic, endangered bird. Migratory
4996 shorebirds such as plovers, whimbrel, turnstones, sandpipers, and reef herons are found in coastal
4997 mangrove habitats, estuaries, and beaches (Comprehensive Wildlife Conservation Strategy for the
4998 Commonwealth of the Northern Mariana Islands, 2005).

4999 In CNMI, 15 animals and 11 plants are listed as federally threatened or endangered (Appendix E).

5000 *3.6.6.3 Cultural Resources*

5001 Archaeological findings cite the earliest human cultural presence in the CNMI at more than 3,500 years
5002 ago (DOE, 2017b). The art and culture of the islands' two indigenous groups, the Carolinians and the
5003 Chamorro, can be found throughout the CNMI. Over the past 500 years, island culture has also been
5004 shaped by Spanish, German, Japanese, and American influences. The waters of the Northern Mariana
5005 Islands are littered with more than 40 sunken warships, auxiliaries, airplanes, tanks, and other military
5006 related debris (NPS, 2019b).

5007 There are 36 individual sites in the CNMI listed on the NRHP (NPS, 2019a), two of which are also
5008 National Historic Landmarks (CNMI Division of Historic Preservation, pers. comm., July 10, 2019). An
5009 approximate count of documented cultural resources in CNMI Historic Preservation Office records by
5010 island are as follows: Saipan - 750, Tinian - 420, Rota - 420, Aguiguan - 70, Pagan - 180, Alamagan - 5,
5011 Anatahan - 1, Sarigan - 5 (CNMI Division of Historic Preservation, pers. comm., July 10, 2019).

5012 *3.6.6.4 Socioeconomic Environment*

5013 *Land Use and Cover*

5014 The CNMI contains a variety of federal, territorial, and local recreational lands, ranging from units of the
 5015 National Park System and Marine Protected Areas to city parks. Developed land covers less than four
 5016 percent of the territory as forest and shrub still dominate the landscape. Land use is also uneven across the
 5017 CNMI, as most developed and disturbed land occurs in the more populated southern islands, particularly
 5018 Saipan (Table 3-10).

5019 *Table 3-10. Land Use/Cover for CNMI (Northern Islands, Saipan, Rota, and Tinian).*

Land Use/Cover	Area (km ²)	Area (%)
Impervious	17.8	4
Developed, open space	18.6	<4
Cultivated Crops	2.9	1
Pasture/Hay	18.4	4
Grassland	63.0	13
Evergreen Forest	239.6	51
Deciduous Forest	21.5	5
Scrub/Shrub	40	9
Wetlands	3.7	1
Bare Land	43.6	9
Open Water	1.3	<1
Unconsolidated Shore	0.004	<1
Unclassified	0.2	<1

5020 Source: Adapted from DOE, 2017b, using 2011 C-CAP data

5021 ***Natural Resource Economy***

5022 The coral reef ecosystems of the CNMI are a critical component of the CNMI’s economy. In addition to
 5023 providing food, coastal defense, and cultural significance for CNMI communities, the coral reef
 5024 environments and particularly CNMI’s local MPAs generate significant revenue from tourists and
 5025 recreational users. While there have been efforts to diversify CNMI’s tourism-based economy, visitors are
 5026 still predominantly engaged in activities such as swimming, snorkeling, diving, and motorized marine
 5027 sports (NOAA & UMCES, 2018b).

5028 Tourism is the largest component of CNMI's economy, excluding federal assistance, and tourist arrivals
 5029 have been increasing since 2011 (NOAA & UMCES, 2018b). Tourism relies heavily upon the islands’
 5030 natural resources. Particularly high commercial and recreational value has been attributed to the Saipan
 5031 Lagoon, Managaha Island, publicly accessible beaches, and the barrier and fringing coral reefs
 5032 surrounding Saipan, Tinian, and Rota. Ocean-related tourism produces over \$40 million per year, and

5033 roughly 30% of tourist arrivals on Saipan have been attributed specifically to marine-related activities. As
5034 of 2006, more than 350,000 diving or snorkeling trips took place in Saipan annually, and these numbers
5035 are estimated to be even greater given the last four years of rapid growth (NOAA & UMCES, 2018b).
5036 These trips generate a direct economic value of over \$4.9 million a year (van Beukering et al., 2006).

5037 As a food source, Saipan’s coral reef ecosystems have an estimated value between \$208,000 and \$1.4
5038 million per year, based on subsistence fishing by household (van Beukering et al., 2006). Additional
5039 surveys of small boat fishermen on Saipan, Tinian, and Rota found that they primarily fished on reefs,
5040 with 93% of these fishermen perceiving reef fish as an important source of food (Hospital & Beavers,
5041 2014).

5042 Most fishermen in the CNMI do not own a boat, and this low level of boat ownership appears to align
5043 with the most common types of fishing techniques used by subsistence and recreational fisherman—
5044 snorkel spearfishing and hook-and-line fishing in waters less than 100 ft (30 m) deep (van Beukering et
5045 al., 2006).

5046 While subsistence fishing is a crucial component of CNMI livelihoods, commercial fishing also provides
5047 economic benefits. In 2018, there was an estimated total of 4,612 lbs (2092 kg) sold for \$21,994 in the
5048 CNMI bottomfish fishery (WPRFMC, 2018). Two distinct types of bottomfish fisheries are identified in
5049 the CNMI: shallow-water bottom fishing, which targets fish at depths down to 492 ft (150 m), and
5050 deepwater bottom fishing, which targets fish at depths greater than 492 ft (150 m). Species targeted by the
5051 shallow-water fishery include the redgill emperor (*Lethrinus rubrioperculatus*), black jack (*Caranx*
5052 *lugubris*), matai (*Epinephelus fasciatus*), sas (*Lutjanus kasmira*), and lunartail grouper (*Variola louti*).
5053 Species targeted by the deepwater bottom fishing depths (>492 ft [>150m]) include onaga (long-tail red
5054 snapper; *Etelis corsucans*), ehu (short-tail red snapper; *E. carbunculus*), yellowtail kalekale
5055 (*Pristipomiodes auricilla*), amberjack (*Seriola dumerili*), blueline gindai (*P. argyrogrammicus*), gindai
5056 (*P. zonatus*), opakapaka (*P. filamentosus*), and eightbanded grouper (*Hyporthordus octofasciatus*)
5057 (WPRFMC, 2018).

5058 Considering the CNMI reef fishery, there was an estimated 29,006 lbs (11,793 kg) sold for \$82,547 in
5059 2018 (WPRFMC, 2018). Some of the common fish types found in the CNMI reef fish markets are
5060 surgeonfishes, parrotfishes, goatfishes, groupers, wrasses, soldier/squirrelfishes, jacks, scads, sweetlips,
5061 mojarras, rudderfishes, and mullets (WPRFMC, 2018).

5062 **3.6.7 Guam**

5063 **3.6.7.1 Physical Environment**

5064 Guam is an unincorporated U.S. territory located at 13° 28’N, 144° 45’E and is the southernmost island in
5065 the Marianas Archipelago (NOAA CoRIS, 2019f) (Figure 3-8). With a land mass of 560 km² (348 mi²)
5066 and a maximum elevation of 405 m (1,392 ft), Guam is the largest island in Micronesia and has a total
5067 shoreline length of 244 km (152 mi) (Burdick et al., 2008). Guam is a volcanic island surrounded by a
5068 coralline limestone plateau. The northern half of the island is relatively flat and composed primarily of
5069 suplifted limestone while the outhern half of the island is composed mainly of dissected, relatively
5070 impermeable volcanic formations, with areas of highly erodible lateritic soils (Burdick et al., 2008;
5071 Richmond et al., 2008). A ridge of highground runs north to south along the western coast. The slope is
5072 steep from the ridgeline to the west but more gradual to the eastern coast.



Figure 3-8. Map of Guam. Source: Nadon, 2019

5074
5075

5076 ***Climate and Weather***

5077 Guam's climate is tropical wet/dry; the weather is generally hot and humid with little seasonal
5078 temperature variation. The mean annual temperature on Guam is 28°C (82°F) (Burdick et al., 2008). The
5079 coolest months are January and February, when temperatures fall to the mid to low 20s°C (70s°F) at
5080 night. Daily maximums and minimums vary no more than 6°C (10°F). Relative humidity ranges from 65-
5081 80% during the day to 85-100% at night (WERI, 2013).

5082 Guam has distinct wet and dry seasons. Most of the average annual rainfall of 218 cm falls during the wet
5083 season from July through November when heavy rains and tropical storms are common (Riegl et al.,
5084 2008; WERI, 2013). The dry season is dominated by persistent easterly trade winds and occasional
5085 showers (Burdick et al., 2008; WERI, 2013).

5086 Sea surface temperatures around Guam range from about 27-30°C (Burdick et al., 2008). The North
5087 Equatorial Current is the dominant oceanic circulation pattern influencing Guam (Riegl et al., 2008).

5088 ***Water Resources***

5089 The hydrologic conditions of southern and northern Guam vary significantly. In northern Guam,
5090 permeable limestone allows virtually all rainfall to infiltrate the rock and recharge Guam's principal
5091 aquifer. In southern Guam, volcanic rocks are relatively impermeable and support a well-developed
5092 surface drainage network of about 100 streams and rivers (WERI, 2013a). The main ridge running along
5093 the western coast divides these watersheds into steep valleys with relatively short streams along the west
5094 and broad floodplains in coastal lowlands with longer, larger rivers to the east (WERI, 2013a).

5095 The northern half of Guam contains the Northern Guam Lens Aquifer, which supplies 80% of Guam's
5096 drinking water. This aquifer is a carbonate island karst aquifer; the bedrock of the aquifer is primarily
5097 comprised of two major limestone units. The body of fresh water within the limestone forms an elongated
5098 lens floating atop the underlying sea water (Bendixson, 2013). Parts of southern Guam are covered by
5099 limestone and contain some groundwater bodies and perched systems that are main sources of freshwater
5100 springs (WERI, 2013a).

5101 The primary pollutants to most waters around Guam are microbial organisms, petroleum hydrocarbons,
5102 and sediment (Burdick et al., 2008). Nonpoint source pollutants include nutrients from septic tank
5103 systems, sewage spills, and livestock and agricultural or chemical pollutants from urban runoff, farms,
5104 and illegal dumping. Such pollutants infiltrate basal groundwater, which discharges in springs along the
5105 seashore and subtidally onto reefs (Burdick et al., 2008).

5106 *3.6.7.2 Biological Environment*

5107 The health of Guam's coral reefs varies considerably around the island (Burdick et al., 2008); generally,
5108 the reefs in the southern part of the island tend to be in poor condition due to, among other things, the
5109 high population base, coastal development, and extensive sediment runoff from large rivers, while the
5110 reefs on the northern part of the island are typically in better condition as the population is lower and
5111 there is less development and no rivers (WPRFMC, 2009c).

5112 Overall the island's reefs are considered to be in fair condition (NOAA & UMCES, 2018c). The
5113 resiliency to impact of many of Guam's reefs has declined over the past 40 years. The average live coral
5114 cover on the fore reef slopes was approximately 50% in the 1960s but was less than 25% by the 1990s,
5115 with only a few sites demonstrating over 50% live cover (Burdick et al., 2008).

5116 Sedimentation, largely from road construction and development, is the major anthropogenic issue for the
5117 central and southern reefs (Richmond et al., 2008). In addition to sedimentation, recreational use and
5118 tourism, along with fishing pressure, have negatively impacted reefs in some areas. Groundings of fishing
5119 vessels, recreational watercraft, and ships carrying cargo have resulted in localized damage to reefs
5120 (Richmond et al., 2008). Marine debris also continues to affect the reefs around Guam (Burdick et al.,
5121 2008).

5122 Coral bleaching events have previously been considered uncommon for Guam, with just a handful of
5123 reported events between 1970 and 2007. However, since 2013, coral bleaching associated with ocean
5124 warming has become the most severe threat to Guam's reefs. Widespread bleaching occurred in 2013 and
5125 2014. Although island-wide coral bleaching did not occur in 2015, extensive mortality of coral
5126 communities in shallow reef flat areas was associated with extreme low tides during an El Nino event. As
5127 a result of these back-to-back events, Guam lost about half its staghorn corals, equivalent to about 17.5
5128 hectares (Raymundo et al., 2019). In 2016, Guam's reef flats were severely impacted by coral bleaching,
5129 though deeper reefs did not see the same impacts (Raymundo et al., 2019). In 2017, multiple coral genera
5130 at depths to 40 m suffered moderate to severe bleaching with widespread mortality, but reef flats
5131 experienced only mild to moderate bleaching (Raymundo et al., 2019). Initial estimates suggest that live
5132 coral cover decreased by up to 60% in some areas from 2013-2017 (Raymundo et al., 2019).

5133 Historical use and World War II operations have contributed to a number of coastal areas around Guam
5134 being contaminated with toxic chemicals. PCBs, for example, have been found in seafood caught in

5135 various locations, and monitoring indicates that PCBs remain a persistent problem in some areas (Burdick
5136 et al., 2008).

5137 ***Marine***

5138 Coral reefs almost completely surround Guam. Guam has several types of reefs, including fringing, patch,
5139 submerged, and barrier reefs, and offshore banks. Fringing reefs predominate and extend around much of
5140 the island (Burdick et al., 2008). A broad barrier reef encloses Cocos Lagoon on the southwest tip of the
5141 island (WPRFMC, 2009c). Surrounding Apra Harbor is a raised barrier reef (Cabras Island), a greatly
5142 disturbed barrier reef (Luminao Reef), and a coral bank (Calalan Bank) (WPRFMC, 2009c). Patch reefs
5143 are near Ana'e Island on the southwest coast and Pugua Reef on the northwest coast (WPRFMC, 2009c).

5144 Coral cover was higher on average in shallow (25%) survey areas than in deep areas (19%) (Maynard et
5145 al., 2016). Differences in coral cover between the shallow and deep survey sites were driven by
5146 differences in macroalgae cover as coralline algae (12% shallow and 10% deep) and other cover (41%
5147 both depths) were very similar between the depths. Average macroalgae cover was 22% in the shallow
5148 and 30% in the deep (Maynard et al., 2016). Guam's reefs are in fair condition and are moderately impacted by
5149 pollution, overfishing, and climate change (NOAA & UMCES, 2018c).

5150 On Guam, there are over 5,000 species of coral reef organisms, including well over 300 stony corals and
5151 more than 1,000 species of reef-associated fish (NOAA & UMCES, 2018c; Porter et al., 2005; Burdick et
5152 al., 2008). Guam's reefs contain all of the major genera of reef-building corals, notably species of
5153 *Acropora*, *Porites*, *Pocillopora*, *Favia*, *Favites*, *Montipora*, *Fungia*, *Pavona*, *Montastrea*, *Leptoria*,
5154 *Leptastrea*, *Psammacora*, and *Galaxea* (Richmond et al., 2008).

5155 Apra Harbor, which hosts the largest and most developed mangrove forest (approximately 70 ha) in the
5156 Mariana Islands, and two smaller areas in the southern villages of Merizo and Inarajan contain the extent
5157 of mangrove growth on Guam.

5158 Three species of sea turtles have been recorded inhabiting the waters off Guam: green (*Chelonia mydas*),
5159 hawksbill (*Eretmochelys imbricata*), and leatherback (*Dermochelys coriacea*). Fourteen species of marine
5160 mammals have been reported in Guam's waters, including dugongs (*Dugong dugon*), baleen whales, and
5161 toothed whales (Guam DAWR, 2006).

5162 ***Terrestrial and Freshwater***

5163 Guam is home to a variety of terrestrial habitats, including limestone and ravine forests, savanna complex,
5164 and strand vegetation. Due primarily to contrasting soil types between the north and south and
5165 anthropogenic and natural disturbances, vegetation is highly variable across the island (WERI, 2014).
5166 Vegetation in the north tends to be dominated by thick secondary scrub and urban vegetation (i.e., lawns
5167 and ornamental trees and shrubs) inland, and by strand and limestone forests in coastal areas. Vegetation
5168 in the south is generally dominated by savanna and patches of forest, which are mostly riparian and form
5169 along valleys and ravines. The low-lying portions of river valleys are occupied by swamp forests,
5170 marshes, and occasional cultivated clearings (WERI, 2014). Guam has more than 320 native plant
5171 species.

5172 Under natural conditions, Guam hosted a diversity of native terrestrial animal species. Three native
5173 mammals were known to Guam, including the Marianas fruit bat (*Pteropus mariannus mariannus*), little
5174 Marianas fruit bat (*P. tokudae*), and Pacific sheath-tailed bat (*Emballonura semicaudata rotensis*).

5175 However, the Marianas fruit bat is the only extant species. Six native reptiles, five skink species, and one
 5176 gecko species are still found in the wild. Several native tree snail species still exist in low numbers. Over
 5177 100 species of birds have been documented on the island including migrant, wetland, seabird, and forest
 5178 birds, though only a few native wetland and forest birds persist in the wild (Guam’s Comprehensive
 5179 Wildlife Conservation Strategies, 2006). Eighteen species of animals and 15 species of plants are listed as
 5180 federally threatened or endangered in Guam (Appendix E).

5181 Guam has also experienced high rates of extinction, and many terrestrial species are endangered due
 5182 primarily to the introduction of non-native species, such as the brown tree snake (*Boiga irregularis*).
 5183 Though much native habitat remains available, the introduction of the brown tree snake has resulted in the
 5184 loss of many of Guam’s native species of birds and lizards (Guam’s Comprehensive Wildlife
 5185 Conservation Strategies 2006). Historically, Guam did not have any known native species of amphibians,
 5186 but introduced populations quickly colonized much of the island, and at least nine species of frogs and
 5187 toads are known to inhabit the Mariana Islands Archipelago. Introduced mammals include pigs, water
 5188 buffalo, Philippine deer, feral cats and dogs, shrew, the black rat, Norway rat, and house mouse (Guam’s
 5189 Comprehensive Wildlife Conservation Strategies 2006). The most notorious invasive plant that thrives in
 5190 scrub areas is tangantangan (*Leucaena leucocephala*). After being seeded on the island by U.S. military
 5191 following WWII, the tangantangan out-competed many native plants and covered large parts of the island
 5192 (WERI, 2014).

5193 *3.6.7.3 Cultural Resources*

5194 Guam’s oldest archaeological sites are from the Pre-Latte and Latte Periods of Chamorro occupation,
 5195 prior to western contact in 1521. Other archaeological and architectural resources show evidence of
 5196 Guam’s status as a former possession of Spain and as an American territory, while numerous structures
 5197 and relics attest to the island’s occupation by Japan and subsequent reoccupation by the U.S. during
 5198 World War II (DOD, 2010). There are 128 properties listed on the NRHP (NPS, 2019a).

5199 *3.6.7.4 Socioeconomic Environment*

5200 **Land Use and Cover**

5201 As listed in Table 3-11, evergreen forest and grasslands account for 65% of land cover in Guam.
 5202 Developed open space covers approximately 11% of the territory. Scrub/Shrub accounts for nine percent
 5203 of land cover, and impervious surface covers approximately 10% of Guam.

5204 *Table 3-11. Land Cover in Guam.*

Land Cover/Use	Area (km ²)	Area (%)
Bare Land	10.9	2
Cultivated	2.4	<1
Developed, open space	58.8	11
Wetlands	16.3	3
Evergreen Forest	246.5	45
Grassland	107.6	20

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Impervious Surface	52.6	10
Palustrine Aquatic Bed	0.008	<1
Pasture/Hay	0.1	<1
Scrub/Shrub	46.8	9
Unconsolidated Shore	0.5	<1
Water	1.5	<5 ²¹¹

Source: Adapted from DOE, 2017e, using 2011 C-CAP data

5213 Approximately 20% of Guam has been designated as local or federal conservation lands. For example,
5214 there is the federally owned War in the Pacific National Historical Park, Guam National Wildlife Refuge,
5215 and two Naval Ecological Reserve Areas, Orote and Haputo (Guam’s Comprehensive Wildlife
5216 Conservation Strategy, 2006). In 1997, Guam established five marine preserves, Tumon Bay, Piti Bomb
5217 Holes, Sasa Bay, Achang Reef Flat, and Pati Point, in response to declining reef fish stocks. The
5218 preserves set aside approximately 15.5% (118.4 m² [36.1 km²]) of Guam’s nearshore (600 ft [< 183 m])
5219 waters, restrict fishing, and prevent taking or altering aquatic life, including living or dead coral and any
5220 other resources; however, three of the five preserves have some limited fishing, such as cultural take
5221 using traditional fishing methods or bottom fishing below 100 ft (30 m) (Burdick et al., 2008).

5222 The Department of Defense continues to carry out training activities on Guam that may impact coastal
5223 waters and reefs. Though the frequency of these activities appears to have decreased since 2004, their
5224 cumulative impact remains a concern. The impacts are not known for the training activities occurring in
5225 the W-517 Warning Area, which encompasses Santa Rosa and Galvez Banks. The type and frequency of
5226 security training activities have continued to increase with increasing military presence in the Marianas
5227 and is expected to further increase in association with the Guam military expansion (Burdick et al., 2008).

5228 **Natural Resource Economy**

5229 Guam’s reef resources provide numerous goods and services for the residents of Guam, including cultural
5230 and traditional use, tourism, recreation, fisheries, and shoreline and infrastructure protection. Coral reef-
5231 related tourism contributes \$323 million per year to Guam’s economy (NOAA & UMCES, 2018c). The
5232 tourism industry supports over 21,000 jobs annually (NOAA & UMCES, 2018c).

5233 Guam’s fisheries are both economically and culturally important and target a large number of fishes and
5234 invertebrates. Bottomfishing on Guam is a combination of recreational, subsistence, and small-scale
5235 commercial fishing. In 2018, in the bottomfish fishery, there was an estimated 3,557 lbs (1613 kg) sold
5236 for \$17,022 (WPRFMC, 2018). There are two distinct fisheries separated by depth and species
5237 composition. The shallow-water complex (< 500 ft [152m]) makes up the largest portion of the total
5238 bottomfish harvest and effort, and primarily includes reef-dwelling snappers of the genera *Lutjanus*,
5239 *Aphareus*, and *Aprion*; groupers of the genera *Epinephelus*, *Variola*, and *Cephalopholis*; jacks of the
5240 genera *Caranx* and *Carangoides*; Holocentrids (*Myripristis* spp. and *Sargocentron* spp.); emperors of the
5241 genera *Lethrinus* and *Gymnocranius*; and dogtooth tuna (*Gymnosarda unicolor*). The deep water complex
5242 (> 500 feet [152m]) consists primarily of groupers of the genera *Hyporthodus* and *Cephalopholis*, jacks of

5243 the genera *Caranx* and *Seriola*, and snappers of the genera *Pristipomoides*, *Etelis*, and *Aphareus*
 5244 (WPRFMC, 2018).

5245 Considering Guam’s reef fishery for 2018, there were 133,941 pounds sold for \$392,548 (WPRFMC,
 5246 2018). Shore-based fishing accounts for most of the fish and invertebrate harvest from coral reefs around
 5247 Guam. The coral reef fishery harvests more than 100 species of fish, including members of the families
 5248 Acanthuridae, Carangidae, Gerreidae, Holocentridae, Kyphosidae, Labridae, Lethrinidae, Lutjanidae,
 5249 Mugilidae, Mullidae, Scaridae, and Siganidae. Hook and line is the most common method of fishing for
 5250 coral reef fish on Guam (75% of fishers and gear). Throw net is the second most common method, and
 5251 other methods include gill net, snorkel spearfishing, SCUBA spearfishing, surround net, drag net, hooks
 5252 and gaffs, and gleaning (WPRFMC, 2018).

5253 **3.7 Overview of Coral Reefs in U.S. Federal Jurisdiction**

5254 In addition to the U.S. coral reefs that occur within populated states and territories described in Section
 5255 3.6, the CRCP conducts activities (i.e., monitoring) in coral reef areas that are not managed by local
 5256 jurisdictions but are solely within U.S. federal jurisdiction. National Marine Sanctuaries, for example, that
 5257 fall within state or territory boundaries are described within the appropriate jurisdictional section of
 5258 Section 3.6. Table 3-12 generally describes the coral environment for the U.S. federal jurisdictions.

5259 *Table 3-12. Broad descriptions of the coral environment for the U.S. federal jurisdictions*

Designation	Agency	Ocean Basin	Coral Reef Type(s)	Ocean Temperature Range (°C)	Mean tidal range (cm)
Flower Garden Banks National Marine Sanctuary	NOAA	Gulf of Mexico	Patch	20-29	10
Papahānaumokuākea		Pacific	Patch, fringing	18-28	10
Pacific Island Remote Areas		Pacific	Patch, barrier, fringing	N/A	N/A

5260 Source for ocean temperature data: www.nodc.noaa.gov; Source for tidal data: tidesandcurrents.noaa.gov

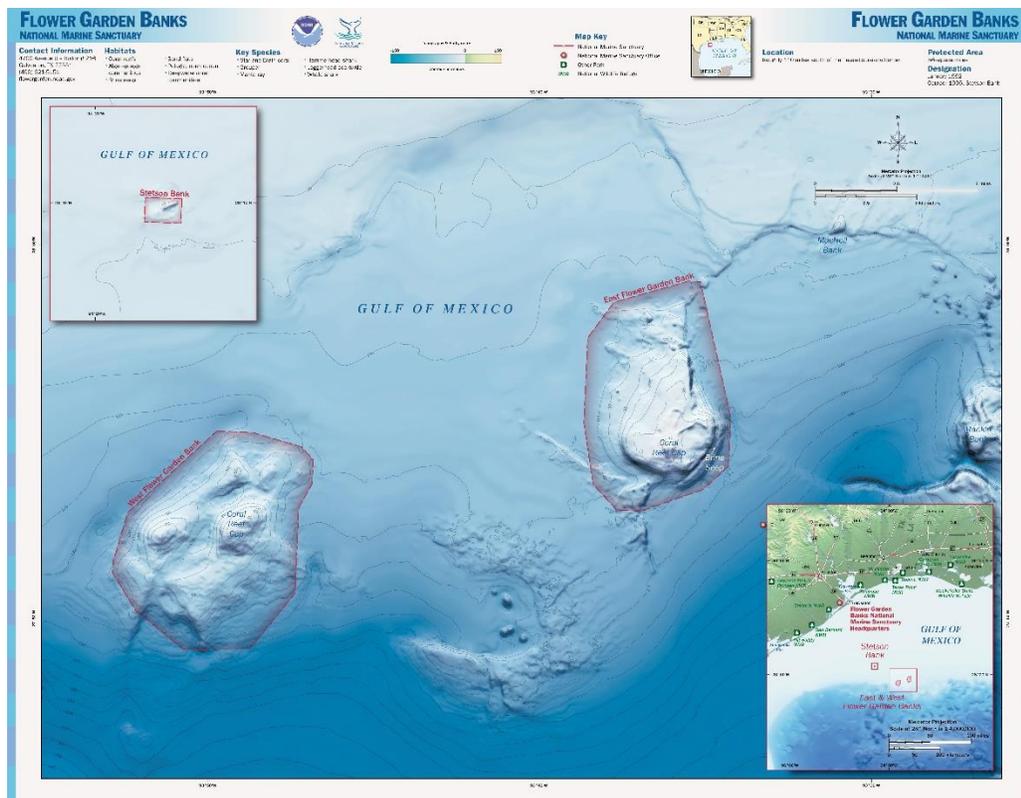
5261 **3.7.1 Flower Garden Banks National Marine Sanctuary**

5262 The Flower Garden Banks National Marine Sanctuary (FGBNMS) is one of 14 federally designated
 5263 underwater areas protected by NOAA's Office of National Marine Sanctuaries and is the only sanctuary
 5264 site completely located within the Gulf of Mexico (OMNS, 2012). The original designation, on January
 5265 17, 1992, includes West Flower Garden Bank and East Flower Garden Bank, and Stetson Bank was added
 5266 to the sanctuary in 1996 (OMNS, 2012).

5267 **3.7.1.1 Physical Environment**

5268 The FGBNMS is situated 112-185 km (73-115 mi) off the coasts of Texas and Louisiana, atop three
 5269 underwater mountains called salt domes (OMNS, 2012). The reef caps at East and West Flower Garden
 5270 Banks are about 21 km (13 mi) apart, and Stetson Bank lies about 77 km (48 mi) to the northwest of West
 5271 Flower Garden Bank. The open ocean between the individual banks has a depth of 61-152 m (200-492 ft)
 5272 (OMNS, 2012). Each bank has its own sanctuary boundary (Figure 3-9). East Flower Garden, West

5273 Flower Garden, and Stetson Banks are only three among dozens of banks scattered along the continental
 5274 shelf of the northwestern Gulf of Mexico. All of these banks are part of a regional ecosystem, heavily
 5275 influenced by current patterns within the Gulf. Inflows from the large watershed that drains two-thirds of
 5276 the continental U.S. also plays a significant role in the health of this region.



5277
 5278 Figure 3-9. Map of the Florida Garden Banks National Marine Sanctuary. *Source: FGBNMS*

5279 **Currents**

5280 The Gulf of Mexico is fed from the south by warm Caribbean water, which enters the Gulf via the
 5281 Yucatan Channel and forms the Gulf Loop Current. The Loop Current generally enters the Gulf and then
 5282 curves east toward Florida's coast and becomes the Florida Current, which exits the Gulf through the
 5283 Straits of Florida. The Loop Current varies after entering the Gulf either by curving almost immediately
 5284 to the east or by traveling west toward Louisiana's coast before looping around to the east toward Florida.
 5285 In the latter case, the main current passes directly over the banks along the continental shelf (NOAA,
 5286 2007b).

5287 Circular eddies often form when small current formations break away from the Loop Current and move
 5288 westward, across the FGBNMS and other banks to the west. The Loop Current brings animal larvae, plant
 5289 spores, and other imports from the Caribbean and may account for some Caribbean species found in the
 5290 northern Gulf of Mexico. Furthermore, the Loop Current also transports organisms from the northern
 5291 Gulf to parts of Florida and the southern Atlantic (NOAA, 2007b).

5292 Meanwhile, shallow, wind-driven currents flow into the Gulf from the Yucatan Channel travel to the
 5293 northwest following the Mexico, Texas, and Louisiana coastlines before turning east. These currents also

5294 cross over the FGBNMS and other banks from the opposite direction of the Gulf Loop eddies and add to
5295 the Caribbean influence in the region.

5296 *3.7.1.2 Biological Environment*

5297 The East and West Flower Garden Banks coral reef communities likely began developing on uppermost
5298 portion of the salt domes 10,000 to 15,000 years ago (NOAA, 2007b). The northwestern Gulf of Mexico
5299 location provides all the habitat characteristics required for stony corals: a hard surface for attachment,
5300 clear sunlit water, warm water temperatures (between 68-84°F [20-29°C]), and a steady food supply
5301 (NOAA, 2007b). Scientists believe that corals at the Flower Garden Banks probably originated from
5302 Tampico, Mexico, which has the closest coral reefs to the Flower Garden Banks (NOAA, 2007b).

5303 The Stetson Bank has very different habitat compared to the Flower Garden Banks. Stetson's winter water
5304 temperatures are 4°F (-15.5 °C) cooler, on average, than those of the Flower Garden Banks, which is
5305 enough to hinder coral growth enough that no true coral reef exists at Stetson Bank (NOAA, 2007b).
5306 Instead, coral colonies are interspersed with a much denser population of sponges with the siltstone
5307 bedrock showing. The predominant coral species at the East and West Flower Garden Banks include large
5308 boulder corals, such as brain coral and mountainous star coral. Coral cover is over 50% at these two banks
5309 (Johnston et al., 2019). Corals form the basis for a complex, balanced ecosystem, that provides a regional
5310 reservoir of shallow-water Caribbean reef species such as crustaceans (e.g., crabs, lobsters, and shrimp),
5311 mollusks (e.g., clams, octopus and snails), echinoderms (e.g., sea cucumbers and starfish), fish (e.g.,
5312 groupers, eels, wrasse, parrotfishes, sharks, and rays), sea turtles (e.g., loggerhead turtle and hawksbill
5313 turtle) and marine mammals (i.e., beaked whales, Atlantic spotted dolphins (*Stenella frontalis*), and
5314 bottlenose dolphins) (FGBNMS, 2018).

5315 While the FGMNMS is relatively far offshore and more isolated than other coral reefs in the U.S. Atlantic
5316 and Caribbean, it has been impacted by similar stressors. Two invasive species, the lionfish (Johnson et
5317 al., 2013) and orange cup coral (*Tubastrea coccinea*) are found within FGBNMS (Pretch et al., 2014).
5318 During 2016, water temperatures in both the East and West Flower Garden Banks were above 30°C (86
5319 °F) for an extended period of time, and corals within these banks showed signs of bleaching and paling
5320 stress (Johnston et al., 2019). While some seabirds may use FGBNMS, the banks are completely
5321 submerged, and there is no island habitat in FGBNMS to support any terrestrial or freshwater biota.

5322 *3.7.1.3 Cultural Resources*

5323 The FGBNMS does not have any historic properties or traditional cultural resources (ONMS, 1991).

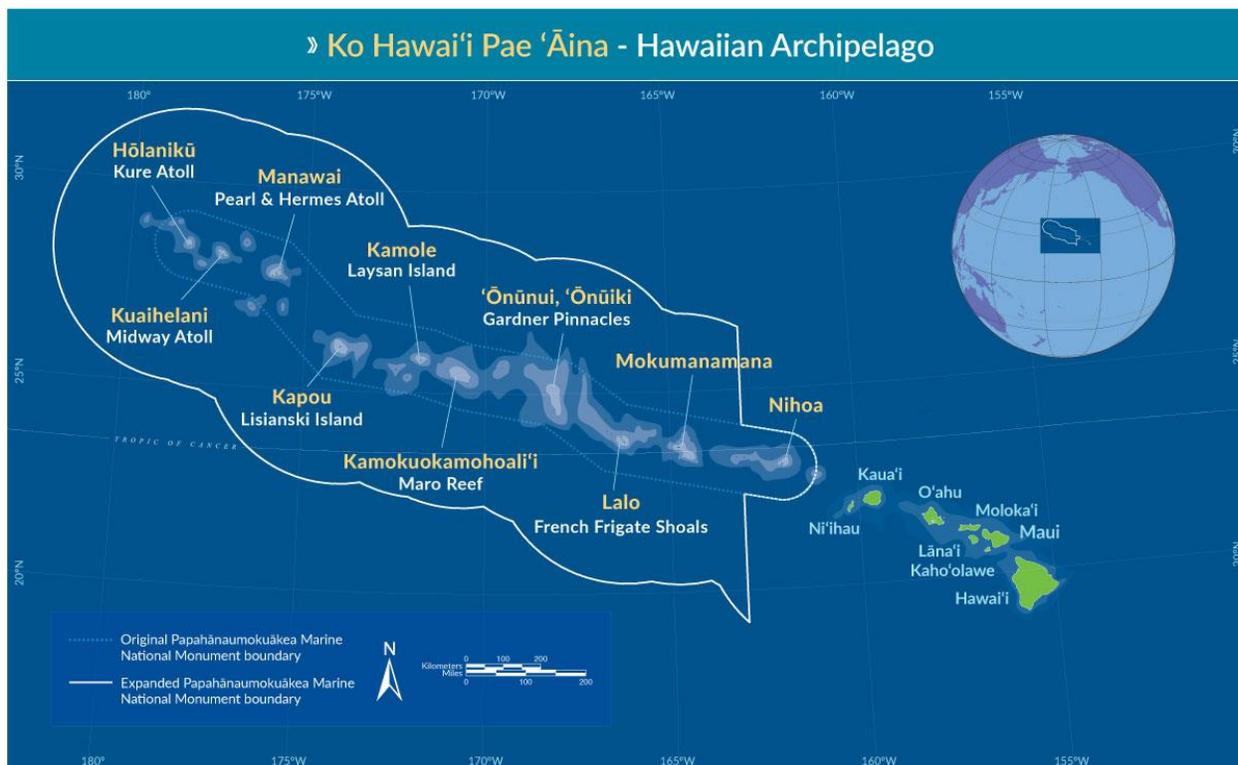
5324 *3.7.1.4 Socioeconomic Environment*

5325 The FGBNMS provides economic opportunities for charter dive and fishing vessels, which take visitors
5326 on guided trips for either purpose. Additionally, private vessels use the FGBNMS for fishing and diving
5327 as well.

5328 ***3.7.2 Papahānaumokuākea Marine National Monument***

5329 On June 15, 2006, Presidential Proclamation 8031 established the Northwestern Hawaiian Islands Marine
5330 National Monument under the authority of the Antiquities Act (54 U.S.C. 320301-320303) to protect the
5331 natural and cultural resources. The monument was later renamed Papahānaumokuākea Marine National
5332 Monument (Figure 3-10), and then expanded under Presidential Proclamation 9478 in August 2016. The

5333 area encompassed by the original designation is approximately 140,000 mi², and the expansion added
 5334 approximately 443,000 mi² resulting in a total protected area of 582,578 mi² - roughly the size of the Gulf
 5335 of Mexico. Papahānaumokuākea is the largest contiguous, fully protected conservation area in the U.S.
 5336 and one of the largest marine conservation areas in the world. It is larger than all the country's U.S.
 5337 national parks combined (Papahānaumokuākea Marine National Monument, 2019).



5338 Figure 3-10. A map of Papahānaumokuākea Marine National Monument and the adjacent main Hawaiian Islands.
 5339 Source: NOAA NOS, 2019

5340 **3.7.2.1 Physical Environment**

5341 **Water Resources**

5342 Access to fresh water is the primary limiting factor for terrestrial plants and animals living on the small
 5343 Northwestern Hawaiian Islands. A hydrologic feature called a freshwater lens, common to atolls and other
 5344 low-lying islands in the Pacific, allows terrestrial species to survive. The less-dense freshwater and
 5345 rainfall percolate through the sediment on land to the sea where it then forms a convex lens that floats
 5346 atop the seawater. The size and amount of the catchment area, precipitation, and saltwater inundation
 5347 determine the size lens. Lenses can be as shallow as 10-20 cm (3.9-7.9 in), or as deep as 20 m (66 ft).
 5348 Changes in precipitation patterns and sea level rise due to climate change are major concerns for Pacific
 5349 communities that depend on these freshwater lenses for survival (Papahānaumokuākea Marine National
 5350 Monument, 2019).

5351 **3.7.2.2 Biological Environment**

5352 The Papahānaumokuākea Marine National Monument is one of the largest marine protected areas in the
 5353 world, encompassing 1.5 million km² (582,578 mi²) of islands and water from the island of Nihoa to
 5354 beyond Midway Atoll (Pew, 2017). More than 7,000 species, including 22 species of seabirds, 24 species

5355 of whales, at least a dozen species of sharks, four commercially important species of tuna, five species of
5356 endangered sea turtles, and monk seals, live in the marine protected area, and a fourth of them are
5357 endemic to the area (Pew, 2017). The monument safeguards key ecosystems, including shallow-water and
5358 deep-sea coral reefs, seamounts, and pelagic zones. The following is a general description of the
5359 biological resources found throughout the monument.

5360 ***Marine***

5361 On Nihoa Island marine life is limited to the reef system surrounding the island. In deeper waters, along
5362 the Raita Bank where species of sharks and jacks are found. Limu (algae), wana (sea urchin), and opihi
5363 (limpet) live in the shallow-waters of the island (USFWS, 2018b). On Mokumanamana (Necker Island)
5364 marine life includes gray reef sharks (*Carcharhinus amblyrhynchos*) and manta rays. Shark Bay, for
5365 example, has a high diversity of sea cucumbers, sea urchins, and lobsters. Little coral life exists in the
5366 shallow areas due to run off from the heavily eroded and scoured rock surfaces of the island (USFWS,
5367 2018b).

5368 French Frigate Shoals, which is a classic atoll, has one of the most significant reef systems in the NWHI.
5369 The reef supports the greatest variety of coral species and over 600 species of other invertebrates such as
5370 sponges, coral worms, snails, lobsters, crabs, shrimp, clams, oysters, sea urchins, and sea stars. Many of
5371 these invertebrates are endemic to the shoals. Over 150 species of red, green, and brown algae are found
5372 on the reefs. The outer reef waters support gray reef sharks, butterflyfish, and large schools of jacks and
5373 groupers (USFWS, 2018b).

5374 Gardner Pinnacles has many coral species and a large population of giant opihi, the endemic Hawaiian
5375 limpet. Acroporid table corals have been noted on the leeward side, while tube, stony, and soft corals
5376 have been found throughout the reef. Gardner Pinnacles' waters have high fish species richness; examples
5377 include the redlip parrotfish (*Scarus rubroviolaceus*), the double-bar goatfish (*Parupeneus crassilabris*),
5378 and the reef triggerfish (*Rhinecanthus rectangulus*) (USFWS, 2018b).

5379 Maro Reef (Koanakoia) is a submerged open atoll with less than one acre of emergent land. At very low
5380 tide, only a small coral rubble outcrop of a former island is believed to break above the surface. The
5381 shallow-water reef ecosystem covers nearly half a million acres and is the largest coral reef in the NWHI.
5382 It is biologically rich with 95% coral cover in some areas, one of the highest observed in the NWHI. Maro
5383 Reef contains marine habitat ranging from sandy lagoons to steep reef slopes, large coral heads, ocean
5384 pinnacles, and patch reefs (USFWS, 2018b). Maro Reef has a greater diversity of coral than most any
5385 other reef system in the NWHI chain. Many areas of the reef, particularly on the west side, have a large
5386 number of coral species, including rice coral (*Montipora capitata*) and finger coral (*Porites compressa*),
5387 that grow abundantly on the reef slopes. The reefs support numerous butterflyfish and surgeonfish
5388 species. Large ulua (*Giant Trevally* [*Caranx ignobilis*]) and omilu (*Bluefin Trevally* [*Caranx*
5389 *melampygus*]) have been seen in the reef's open waters, along with white-tip and grey reef sharks. On
5390 Laysan Island, although the reef is the smallest of the NWHI, it is rich. Numerous sea turtles and monk
5391 seals (*Monachus schauinslandi*) appear on the island. Several species of Hawaiian surgeonfish and large
5392 schools of convict tangs are in the shallow, wave-washed waters around the island. Twenty-seven species
5393 of stony coral are reported, and branching corals are common (USFWS, 2018b).

5394 Pearl and Hermes Atoll (Holoikauaua) is a large atoll with several small islets forming 80 acres (0.32
5395 km²) of land and nearly 300,000 acres (1214 km²) of coral reef habitat. The atoll extends over 20 mi (32
5396 km) across and 12 mi (19 km) wide. Pearl and Hermes reef is a true atoll, fringed with shoals, including
5397 permanent and ephemeral sandy islets. The islets provide important dryland habitat for seals, turtles, and
5398 birds in need of rest, protection from predators, or nesting grounds (ONMS, 2014). The atoll has a high
5399 diversity of fish species including saber squirrelfish (*Sargocentron spiniferum*), eels, Galapagos sharks
5400 (*Carcharhinus galapagensis*), sandbar sharks (*Carcharhinus plumbeus*), ulua (giant trevally [*Caranx*
5401 *ignobilis*]), angelfish, aweoweo (Hawaiian bigeye [*Priacanthus meeki*], uhu (parrotfish), and numerous
5402 lobsters (USFWS, 2018b).

5403 Laysan Island (Kauō) has approximately 915 land acres (3.7 km²) and is surrounded by 145,334 acres
5404 (518 km²) of coral reef. Laysan Island's rocky intertidal habitat supports numerous invertebrate species,
5405 algae, and juvenile fishes. Surgeonfish and large schools of convict tangs (*Acanthurus triostegus*) are
5406 frequently found in the shallow waters around the island. The reef and island also support sea turtles and
5407 monk seals (*Monachus schauinslandi*). Twenty-eight species of stony coral have been identified within
5408 the reefs around Laysan Island (NOAA NOS, 2019).

5409 Lisianski Island is over 12 miles (19 km) at its widest point and includes 400 acres of land. Lisianski is a
5410 low sand and coral island approximately 20 million years old and reaches a height of 40 ft (12 m) above
5411 sea level. The coral cover around the island, including the reef area call Neva Shoals, totals 310,000 acres
5412 (1,255 km²) (ONMS, 2014). Nearshore reef fishes are abundant and diverse (USFWS, 2018b). Aggressive
5413 predators such as sharks are found near the reefs and Trevally jacks (ulua, *Caranx ignobilis*) have been
5414 observed. Twenty-four different species of coral were found in one major survey at Lisianski (USFWS,
5415 2018b). In addition, a wide variety of algae are commonly found close to the island. Midway Atoll
5416 (Pihemanu) consists of three small sandy islets, also known as the "Midway Islands," totaling 1,540 acres
5417 and a large elliptically shaped barrier reef measuring approximately five miles in diameter. The atoll is
5418 surrounded by approximately 88,500 acres (358 km²) of coral reef. Numerous patch reefs dot the lagoon.
5419 Kure Atoll (Mokupāpapa) is located at the northern extent of coral reef development. The atoll is nearly
5420 circular with a six-mile diameter enclosing nearly 200 acres (0.81 km²) of emergent land. Kure contains
5421 80,000 acres (324 km²) of coral reef habitat that almost forms a circle around the lagoon except for
5422 passages to the southwest (ONMS, 2014). The only permanent land in the atoll is crescent-shaped Green
5423 Island, located near the fringing reef in the southeastern part of the lagoon.

5424 As indicated above, a large variety of coral species are located throughout the NWHI within the
5425 monument, and coral reefs provide habitat for other marine species. A total of 57 stony coral species are
5426 known in the shallow-waters of the NWHI, of which 17 endemic species account for 37-53% of the
5427 relative abundance surveyed on each reef in the NWHI (Friedlander et al., 2005). Seven acroporid species
5428 have been documented in the central NWHI, despite their near absence from the MHI. Coral cover varies
5429 significantly across the NWHI. Most regions have low coral cover with the exception of Maro Reef and
5430 Lisianski Island having comparatively high coral cover. Despite their high latitudes, more species of coral
5431 have been reported for the NWHI (52 spp.) than the MHI (48 spp.) (Friedlander et al., 2005). Coral reef
5432 habitats harbor a diversity of macro and micro algae. Currently, a total of 355 algal species have been
5433 recorded from shallow-water coral reef habitats of the NWHI. The NWHI contain a large number of Indo-
5434 Pacific algal species not found in the MHI, such as the green calcareous algae (*Halimeda velasquezii*).
5435 Unlike the MHI where invasive species (e.g., invasive algae, *Kappaphycus alvarezii*) have overgrown

5436 many coral reefs, the reefs of the NWHI are largely free of invasive species. Approximately 98% of the
5437 monument's area is deeper than 328 ft (100 m) (ONMS, 2014).

5438 Banks and shoals occurring within the monument also provide important habitat for marine life. There are
5439 approximately 30 submerged banks throughout the NWHI. An unnamed bank is located just to the east of
5440 French Frigate. To the west are South East Brooks Bank, St. Rogatien Bank, and another unnamed bank.
5441 Raita Bank is just west of Gardner Pinnacles. The crest or top of Raita Bank is nearly 60 ft (18 m) from
5442 the ocean surface. Pioneer Bank is only 22 nm (41 km) from Neva Shoals, and the features combine to
5443 form a major coral reef ecosystem rich in biodiversity with a variety of marine habitats. Bank areas
5444 provide extensive fish habitat, and a few are known to provide foraging habitat for endangered Hawaiian
5445 monk seals (*Monachus schauinslandi*) (ONMS, 2014).

5446 Prior to the establishment of the monument, commercial bottomfishing had been conducted in the NWHI
5447 for over 60 years, but with the establishment of the monument, commercial bottomfishing was phased out
5448 and ultimately closed on June 15, 2011 (Monument Proclamation 8031) (ONMS, 2014). However,
5449 historic fishery data indicate which fish populations exist in the area. The fish distribution and abundance
5450 are patchy and appear to be associated with cavities or oceanic current patterns that serve as prey
5451 attractants (Kelly et al., 2004). Common fish species include onaga (*Etelis coruscans*), ehu (*E.*
5452 *carbunculus*), opakapaka (*Pristipomoides filamentosus*), kalekale (*P. sieboldii*), lehi (*Aphareus rutilans*),
5453 gindai (*P. zonatus*), hapuupuu (*Epinephelus quernus*), uku (*Aprion virescens*), white ulua (*Caranx*
5454 *ignobilis*), black ulua (*C. lugubris*), butaguchi (*Pseudocaranx dentex*), taape (*Lutjanus kasmira*), yellow
5455 tail kalekale (*Pristipomoides auricilla*), and kahala (*Seriola dumerili*). Lobster species include Hawaiian
5456 spiny lobster (*Panulirus marginatus*), slipper lobster (*Scyllarides squammosus*), green spiny lobster (*P.*
5457 *penicillatus*), ridgeback slipper lobster (*S. haanii*), and sculptured slipper lobster (*Parribacus*
5458 *antarcticus*), with the last three having low abundance (USFWS, 2018b).

5459 In addition, many pelagic fish species benefit from the monument. An average of 10,000 sharks were
5460 caught each year in the waters surrounding the NWHIs prior to the expansion of the monument in 2016
5461 (Pew, 2017). With their role in the food web, tiger sharks (*Galeocerdo cuvier*), gray reef sharks
5462 (*Carcharhinus amblyrhynchos*), and Galapagos sharks (*Carcharhinus galapagensis*) are ecosystem
5463 regulators, and their populations can grow in these waters (Pew, 2017).

5464 ***Seabirds and Shorebirds***

5465 The NWHI are home to one of the largest groupings of tropical seabirds in the world, including 14
5466 million birds from 22 species, with 5.5 million individuals breeding in the area annually. Eleven species
5467 are considered imperiled or of high conservation concern (Pew, 2017).

5468 Breeding seabirds are likely to forage near colonies, though the distance they travel to feed varies,
5469 depending on the species, chick size, and dependence of their young. Papahānaumokuākea protects
5470 important seabird foraging habitat, as well as vital reproductive, nesting, and nurturing sites essential to
5471 the survival of bird species that inhabit the islands. For example, Midway Atoll, despite being heavily
5472 used by humans, boasts the largest nesting colonies of both Laysan and black-footed albatrosses in the
5473 world (ONMS, 2014). At Garden Pinnacles, scientists have observed 19 seabird species, 12 of which
5474 breed on the steep cliffs. Two species of migratory shorebirds, the ruddy turnstone (*Arenaria interpres*)
5475 and the Pacific golden plover (*Pluvialis fulva*), often stop over to rest or feed here as commonly noted in

5476 all the NWHI (USFWS, 2018b). Laysan Island has the largest, diverse bird colony in the NWHI, where
5477 huge populations of seabirds nest, and migratory shorebirds visit. Birds found at Laysan include the
5478 black-footed albatross (*Phoebastria nigripes*), the Laysan albatross (*P. immutabilis*), the Christmas
5479 shearwater (*Puffinus nativitatis*), the wedge-tailed shearwater (*P. pacificus*), and the bristle-thighed
5480 curlew (kioea, *Numenius tahitiensis*). Migratory shorebirds seen on the Lisianski Island include the
5481 Pacific golden plover, the wandering tattler (ulili, *Heteroscelus incanus*), the bristle-thighed curlew, and
5482 the Bonin petrel (*Pterodroma hypoleuca*) (USFWS, 2018b).

5483 ***Terrestrial Species***

5484 On Nihoa Island, niches in rocky outcroppings provide habitat for some rare bird, insect, and plant life in
5485 the NWHI. Forty terrestrial arthropods, including a giant cricket and giant earwigs, and two endemic
5486 landbirds, Nihoa finch and Nihoa millerbird (*Acrocephalus familiaris kingi*), are found only on Nihoa.
5487 Native, endangered plants include the loulu of Nihoa fan palm and native 'ohai shrub (USFWS, 2018b).

5488 Terrestrial animal life on Mokumanamana includes the blue gray noddy (*Procelsterna cerulea*), land
5489 snails, and 15 endemic insects such as wolf spiders and bird ticks. Gardner Pinnacles is home to a wide
5490 array of insects and one species of plant, the succulent sea purslane (*Portulaca*) (USFWS, 2018b).

5491 Laysan Island was formed from geologic forces pushing upward and by coral growth. It has fringing
5492 reefs, and a hypersaline lake in the middle of the island, the only lake in the island chain. Laysan has the
5493 largest, diverse bird colony in the NWHI. Several land birds became extinct including the Laysan
5494 honeycreeper (*Himatione fraithii*) and millerbird (*Acrocephalus familiaris familiaris*), but two endemic
5495 land birds remain -- the hardy Laysan finch (*Telespiza cantans*) and Laysan duck (*Anas laysanensis*).
5496 Fifteen species of endemic insects also exist on Laysan (USFWS, 2018b).

5497 On Pearl and Hermes Atoll, sandbar islets support coastal dry grasses, vines, and herbal plants, including
5498 16 native plant species and 12 introduced species. The plants survive because they are salt-tolerant and
5499 able to recover from frequent flooding events (USFWS, 2018b).

5500 ***Marine Mammals***

5501 A total of 24 different species of marine mammals, including whales, dolphins, and Hawaiian monk seals
5502 (*Monachus schauinslandi*), have been observed in the NWHI (ONMS, 2014). Humpback whales
5503 (*Megaptera novaeangliae*) and sperm whales (*Physeter macrocephalus*) are migratory, so their presence
5504 within the Hawaiian archipelago is seasonal or occasional, respectively (USFWS, 2018b).

5505 Pods of resident bottlenose dolphins are common throughout the archipelago, and spinner dolphins
5506 (*Stenella longirostris*) are known to occupy nearshore waters of atolls for rest and socializing (USFWS,
5507 2018b). Hawaiian monk seals are the only marine mammal solely dependent on coral reefs and are the
5508 most endangered pinniped in U.S. waters, and it is discussed in the Endangered Species section below in
5509 more detail.

5510 ***Endangered Species***

5511 Twenty-three species of plants and animals known to occur in the NWHI are listed under the ESA. Of
5512 those ESA-listed species that occur in the marine ecosystem, the Hawaiian monk seal (*Monachus*
5513 *schauinslandi*) and the green sea turtle (*Chelonia mydas*) are discussed further as the NWHI serve as an

5514 important breeding ground for these species. Over 90% of all sub-adult and adult green turtles found
5515 throughout Hawaii originate from the NWHI. After more than 25 years of protecting nesting and
5516 foraging habitats in the Hawaiian Archipelago, the Hawaiian green sea turtle population is showing some
5517 signs of recovery. Green sea turtle nesting sites occur at Pearl and Hermes Atoll, Lisianski Island, Maro
5518 Reef, and French Frigate Shoals. French Frigate Shoals is the primary nesting site for green sea turtles,
5519 accounting for 400 nesting sites or 90% of all nesting within the Hawaiian Archipelago (ONMS, 2014).
5520 Nesting at French Frigate Shoals occurs from late April through September with a peak in June through
5521 July. Each female deposits 1-5 egg clutches (average 1-2) at 11-18 day intervals (USFWS, 2018b).

5522 Monk seals (*Monachus schauinslandi*) live in warm subtropical waters and spend two-thirds of their time
5523 at sea, and they use waters surrounding atolls, islands, and areas farther offshore on reefs and submerged
5524 banks. When on land, monk seals breed and haul-out on sand, corals, and volcanic rock. Monk seals are
5525 often seen resting on beaches during the day. The Hawaiian monk seal was listed as an endangered
5526 species under the ESA in 1976 and is protected by the State of Hawaii under HRS 195D. While 80 to 100
5527 Hawaiian monk seals coexist with humans in the MHI, the great majority of the population lives among
5528 remote islands and atolls within monument. Their range generally consists of the islands, banks, and
5529 corridors within the monument, although individuals have been found farther than 50 nm (93 km) from
5530 shore. Designated critical habitat for this species under the ESA encompasses all beach areas, sand spits
5531 and islets, including all beach crest vegetation to its deepest extent inland, lagoon waters, inner reefs, and
5532 ocean waters out to a depth of 20 fathoms (36.5 m) around the following: Pearl and Hermes Atoll; Kure
5533 Atoll; Midway Atoll, except Sand Island and its harbor; Lisianski Island; Laysan Island; Maro Reef;
5534 Gardner Pinnacles; French Frigate Shoals; Mokumanamana; and Nihoa (50 CFR 226.201) (ONMS,
5535 2014).

5536 3.7.2.3 Cultural Resources

5537 Papahānaumokuākea is important to Native Hawaiians, with significant cultural sites found on the islands
5538 of Nihoa and Mokumanamana, both of which are on the National and State Registers for Historic Places.
5539 Mokumanamana has the highest density of sacred sites in the Hawaiian Archipelago and has spiritual
5540 significance in Hawaiian cosmology. Papahānaumokuākea is also home to historic resources associated
5541 with the Battle of Midway and 19th century commercial whaling (Papahānaumokuākea Marine National
5542 Monument, 2019).

5543 Today, Native Hawaiians remain deeply connected to the Northwestern Hawaiian Islands on
5544 genealogical, cultural, and spiritual levels. Kauai and Niihau families voyaged to these islands indicating
5545 that they played a role in a larger network for subsistence practices into the 20th century (Tava & Keale,
5546 1989). In recent years, Native Hawaiian cultural practitioners voyaged to the Northwestern Hawaiian
5547 Islands to honor their ancestors and perpetuate traditional practices. In 1997, Hui Mālama i Nā Kūpuna o
5548 Hawaii Nei repatriated sets of human remains to Nihoa and Mokumanana that were collected by
5549 archaeologists in the 1924-25 Bishop Museum Tanager Expeditions (Ayau & Tengan, 2002). In 2003, a
5550 cultural protocol group, Nā Kupeu Paemoku, traveled to Nihoa on the voyaging canoe Hōkūlea to
5551 conduct traditional ceremonies. In 2004, Hōkūlea sailed over 1,931 km to the most distant end of the
5552 island chain to visit Kure Atoll as part of a statewide educational initiative called “Navigating Change.”
5553 In 2005, Nā Kupueu Paemoku sailed to Mokumanamana to conduct protocol ceremonies on the longest
5554 day of the year, June 21 (the Summer Solstice).

5555 *3.7.2.4 Socioeconomic Environment*

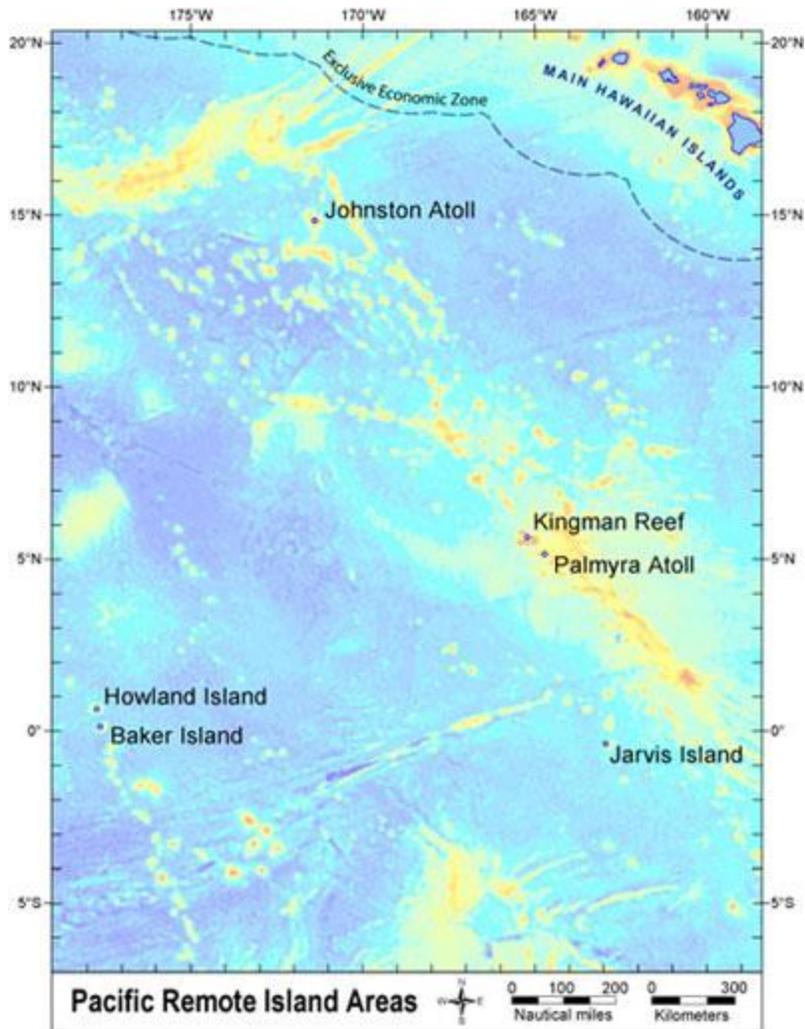
5556 Currently, there is no public access for general visitation. Due to recent reductions in refuge staff and
5557 operational capacity, historical and eco-tour access is currently not offered (Papahānaumokuākea Marine
5558 National Monument, 2019). No private vessels have use of the monument for diving or fishing.

5559 ***3.7.3 Pacific Remote Islands Marine National Monument***

5560 The Pacific Remote Islands Marine National Monument (PRIMNM) encompasses seven islands and
5561 atolls across the central Pacific Ocean (Figure 3-11). Six of the islands -- Baker Island, Howland Island,
5562 Jarvis Island, Johnston Atoll, Palmyra Atoll, and Kingman Reef -- are located between American Samoa
5563 and Hawaii, and Wake Atoll is located between Guam and the Northwestern Hawaiian Islands. The U.S.
5564 claimed most of these uninhabited islands under the Guano Islands Act of 1856 (48 U.S.C. §§ 1411, et
5565 seq.). These seven islands are National Wildlife Refuges and were made into a Marine National
5566 Monument via Proclamation 8336 (74 FR 1565) in 2009 and expanded by the 2014 Proclamation 9173
5567 (79 FR 58645) to become one of the largest marine protected areas in the world with an area of 370,000
5568 nautical mi² (1,270,000 km²). All except Wake and Johnston are administered as National Wildlife
5569 Refuge by the USFWS of the Department of the Interior. Johnston Atoll is managed by the Department of
5570 Defense. Wake Atoll is under the jurisdiction of the Department of the Interior, and managed by the
5571 Department of Defense. During World War II, the U.S. constructed and occupied military bases at
5572 Johnston, Palmyra, Wake, Midway, and Baker. Jarvis and Howland were also briefly occupied or utilized
5573 during the war. With the closure of the military base at Johnston Atoll in 2004, only Wake Island remains
5574 an active U.S. military base (NOAA CoRIS, 2019e). Palmyra Atoll is the only refuge open for general
5575 public visitation (by special-use permit only). The entire monument is closed to commercial fishing and
5576 other resource extraction activities, such as deep sea mining (2014 Proclamation 9173 [79 FR 58645]).

5577 *3.7.3.1 Physical Environment*

5578 The islands/atolls have different sizes of landmass (0-2.7 mi² [4.3 km²]) and different amounts of reef
5579 areas (0.77-36.3 mi² [1.2-58.4 km²]) (Brainard et al., 2018). Their relative locations are shown in Figure
5580 3-11.



5581

5582

Figure 3-11. Pacific Remote Island Areas location map. *Source: NOAA CoRIS, 2019e*

5583 *3.7.3.2 Biological Environment*

5584 The PRIMNM includes seamounts, deep-sea corals, shallow-water coral reefs, and terrestrial habitats
 5585 with an exceptional level of biomass and diversity. The seven islands and atolls within the PRIMNM are
 5586 relatively pristine and in good health (Brainard et al., 2018).

5587 Baker Island is a low-lying arid island surrounded by coral reefs made up of staghorn (*Acroporidae*), table
 5588 (e.g., corals that form broad horizontal surfaces), brain (*Mussidae* and *Merulinidae*), rose (*Manicina*
 5589 *areolata*), and plate (*Fungiidae*) corals. These reefs support a variety of fish such as moray eels,
 5590 squirefishes and soldierfishes, sea basses and groupers, snappers, goatfishes, damselfishes, wrasses,
 5591 parrotfishes, and sharks. Scientists have recorded 104 species of coral (USFWS, 2016a) and 247 species
 5592 of fish (USFWS, 2016b) around Baker Island. Sea turtles and bottlenose dolphins use marine habitat near
 5593 the island. Grass and herb vegetation supports nesting seabirds such as frigatebirds (*Fregatidae*), boobies
 5594 (*Sulidae*), and sooty terns (*Onychoprion fuscatus*) (USFWS, 2016b). Additional terrestrial species include
 5595 the snake-eyed skink (*Cryptoblepharus poecilopleurus*), the mourning gecko (*Leipidodactylus lugubris*),
 5596 hermit crabs, terrestrial mollusks, and insects.

5597 Howland Island is also a low-lying island surrounded by coral reefs. Howland has a 109 species of stony
5598 coral (USFWS, 2016c) and 342 species of reef fish (USFWS, 2016d). Notable marine species around
5599 Howland include the giant clam (*Tridacna maxima*) and the humphead wrasse (*Cheilinus undulatus*)
5600 (USFWS, 2019c). Sea turtles and bottlenose dolphins are also frequently present. Howland Island is
5601 vegetated with grasses, herbs, and shrubs and is home to the snake-eyed skink, the mourning gecko, the
5602 strawberry hermit crab (*Coenobita perlatus*), and a variety of seabirds and shorebirds (USFWS, 2016d).

5603 Jarvis Island is another low island surrounded by coral reefs with similar species to Baker and Howland
5604 Islands. Scientists have identified 62 species of coral (USFWS, 2019e) and 252 species of fish (USFWS,
5605 2016f) at Jarvis Island. A 2006 survey of the Jarvis revealed a low density of macroinvertebrates, which
5606 were mostly sea urchins and sea cucumbers (Miller et al., 2008).

5607 Johnston Atoll consists of four islands (two natural and two formed by coral dredging) and one lagoon.
5608 Scientists have documented 54 coral species, 93 species of algae, about 300 species of fish, and a variety
5609 of other marine invertebrates (e.g., worms, octopus, clams, sea urchins, starfish, nudibranchs, and
5610 sponges) around Johnston Atoll. Johnston Atoll is home to one endemic angelfish (*Centropyge nahackyi*)
5611 (USFWS, 2016g and 2016h). Green sea turtles (*Chelonia mydas*) also use the atoll for nesting and
5612 foraging. The landmass on Johnston Atoll has a variety of trees, grasses, and shrubs that supports nesting
5613 seabirds and shorebirds (USFWS, 2016h).

5614 Palmyra atoll and Kingman Reef is 36 mi (58 km) apart. Palmyra Atoll originally consisted of
5615 approximately 50 islets and two lagoons. However, the atoll has been modified by humans and natural
5616 processes (Collen et al., 2009), and currently there are 26 islets and several lagoons (USFWS, 2017).
5617 Palmyra's land area is 0.77 m² (1.2 km²) (Brianard et al., 2018) and has an extensive reef with 176 species
5618 of corals, 147 species of algae, and about 418 species of fish (USFWS, 2014). The waters around Palmyra
5619 also support green sea turtles and hawksbill sea turtles. Researchers have documented 205 species of coral
5620 and 225 species of fish around Kingman Reef (USFWS, 2013). Kingman Reef does not have any land
5621 mass but has two coral rubble ridges (USFWS, 2013). Both Palmyra and Kingman have a high biomass of
5622 fish and apex predators (i.e. snappers, jacks, and sharks) (USFWS, 2013; NOAA, 2018b). These areas are
5623 the only atolls found for thousands of miles, making them essential nesting sites and foraging areas for
5624 seabird colonies.

5625 Wake Atoll consists of a large lagoon with three coral islands (Peale, Wake, and Wilkes). The islands are
5626 on the rim of a volcano, and the volcano's crater is in the center of the lagoon. The reefs around Wake
5627 Atoll have about 100 species of coral and 323 species of fish (Kenyon et al., 2013; USFWS, 2016i).
5628 Green sea turtles are frequently observed around the atoll. The island vegetation includes trees, shrubs
5629 and grasses. The land supports a variety of crabs (e.g., hermit crabs, fiddler crabs, ghost crabs, and rock
5630 crabs), geckos and skinks, and a variety of seabirds and shorebirds (e.g., albatross, boobies, terns, and
5631 plovers) (USFWS, 2016j and 2016k).

5632 The PRIMNM has diverse coral and fish populations and low human influence. The condition of the reefs
5633 can be used as a baseline from which to draw conclusions about potential impacts to other Pacific reef
5634 areas from anthropogenic threats related to development. These islands also present an opportunity to
5635 study how sea level rise, ocean acidification, and warming waters affect coral reefs in the absence of
5636 substantial human influence. For the PRIMNM, the main threats to reef ecosystems are climate change
5637 and illegal fishing by international fishing boats. Widespread and catastrophic coral mortality was

5638 reported at Jarvis Island in the aftermath of the exceptionally strong 2015-2016 El Niño warming event.
5639 Hard coral cover declined from 17.8% in April 2015 (pre-bleaching) to 0.31% in May 2016 (post-
5640 bleaching), representing a catastrophic decline of 98% across all coral taxa, reef habitats, and depths
5641 (Brainard et al., 2018). This event highlights that management cannot control all threats and provides no
5642 refuge from global El Niño events.

5643 Furthermore, some islands were used for military exercises in the past and, therefore, have highly altered
5644 landscapes. The extreme isolation of reefs in the PRIMNM and the low elevation of their islets/atolls
5645 make them easy targets for ship groundings. Grounded vessels can physically reduce large areas of
5646 healthy reef to rubble when they run aground. In addition, shifts from healthy hard coral-dominated reefs
5647 to those dominated by fleshy algae have been linked to iron leaching from wrecks. Recent shipwreck
5648 extraction projects on Palmyra Atoll and Kingman Reef have been successful at removing grounded
5649 vessels but at high monetary expense (USFWS, 2014). Management of the PRIMNM has had positive
5650 outcomes due to its protected status; however, the scale and scope of the islands, their remoteness, and
5651 limited resources and staff present challenges to management.

5652 *3.7.3.3 Cultural Resources*

5653 The PRIMNM does not have any historic properties or traditional cultural resources.

5654 *3.7.3.4 Socioeconomic Environment*

5655 There are no permanent residents of these islands, but past and current use, including illegal fishing
5656 pressure, does have an effect on the reefs. For reference, only Palmyra and Wake have any human
5657 presence, and those estimates are about 25 and 100 people, respectively, which are generally only military
5658 (Wake) or scientists (NOAA CRCP, 2018). Baker, Howland, Jarvis, Kingman, and Johnston have no
5659 human population. Due to the islands' remoteness, enforcement against illicit activities within the
5660 PRIMNM is challenging. During a routine inspection of a foreign vessel in 2010, NOAA agents found
5661 evidence of illegal fishing activities in waters off Howland and Baker Islands that were hidden from
5662 vessel tracking system (NOAA CRCP, 2018). Unauthorized entry (without illegal fishing) is also a
5663 problem because of the introduction of invasive species from ship hulls or ballast water.

5664 **4. ENVIRONMENTAL CONSEQUENCES**

5665 This chapter describes the expected environmental impacts of three programmatic alternatives for
5666 implementing the CRCP: No Action Alternative, Alternative 1, and Alternative 2. The intent of this
5667 DPEIS is to provide a document from which subsequent, project-specific actions may be tiered, followed
5668 by narrower, decision-focused reviews (40 C.F.R. §§ 1502.20 and 1508.28) to avoid repetitive broad-
5669 level analyses in the subsequent tiered NEPA reviews. Analysis of site-specific variables is beyond the
5670 scope of this DPEIS. Future project-specific environmental analysis would describe the specific effects of
5671 each project or activity if not fully addressed within this DPEIS. The scope and range of impacts of this
5672 DPEIS are more qualitative in nature than those typically found in project- or site-specific NEPA reviews.

5673 **4.1 Approach to Analysis**

5674 This analysis presents potential direct, indirect, and cumulative environmental impacts of Alternative 1
5675 and Alternative 2 when compared with the No Action Alternative for relevant resources throughout the
5676 U.S. jurisdictions of the Atlantic Ocean (i.e., the Gulf of Mexico, South Atlantic and Caribbean Sea) and

5677 Pacific Island Region. Proposed projects and actions related to the CRCP will undergo project-specific
 5678 analysis to determine consistency with the analysis completed for this DPEIS to help determine what, if
 5679 any, additional NEPA analysis is required for the project. This document is expected to serve as the basis
 5680 for tiering. It may also be used for incorporation by reference to the greatest extent practicable. To
 5681 determine whether an action may result in significant impacts, context and intensity of the action are
 5682 considered (Table 4-1) per 40 C.F.R. § 1508.27 and NAO 216-6A.

5683 **Scope of impacts evaluated.** Impact evaluations must include direct, indirect, and cumulative effects.
 5684 These categories are used to describe the timing and proximity of potential impacts to the affected area
 5685 only. They have no bearing on the significance of the potential impacts, as described below, and are used
 5686 only to describe or characterize the nature of the potential impacts. The CEQ regulations (40 C.F.R. §
 5687 1508.8 and 1508.7) define these effects as follows:

- 5688 ● Direct effects are caused by the action and occur at the same time and place as the action.
- 5689 ● Indirect effects are caused by the action and occur later in time or farther removed in distance but
 5690 are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other
 5691 effects related to induced changes in the pattern of land use, population density, or growth rate
 5692 and related effects on air and water and other natural systems, including ecosystems.
- 5693 ● Cumulative impacts are those that result from the incremental effect of the activity, added to other
 5694 past, present, or reasonably foreseeable future actions.

5695 An impact may be significant whether it is direct, indirect or cumulative. We consider two primary factors
 5696 to determine whether an impact to a resource may be significant: context and intensity.

5697 *Table 4-1. Criteria of context and intensity for considering potential impacts of actions.*

Type	Context		Intensity	
	Duration	Geographic Extent	Magnitude	Quality
Direct	Temporary	Local	Negligible	Adverse
Indirect	Short-term	Larger Scale	Minor	Beneficial
Cumulative	Long-term		Moderate	
	Permanent		Major	

5698

5699 **4.1.1 Context**

5700 Context refers to duration (e.g., short- or long-term impacts) and area (local, statewide, etc.) of impacts
 5701 (40 C.F.R. § 1508.27(a)).

5702 **Duration of Impact.** Both short- and long-term effects are relevant. An impact lasting for a finite period
 5703 and of short duration relative to a proposed project and the environmental resource is considered short-
 5704 term for purposes of this DPEIS. In general, the impacts of construction and associated activities (e.g.,
 5705 vehicle use, use of staging areas for equipment, construction, area closure) undertaken to implement a
 5706 project are expected to be short-term. Effects that persist beyond construction, such as the function of a
 5707 created wetland, are expected to be long-term. These characteristics are determined case-by-case and do
 5708 not refer to any specific time period.

5709 **Geographic Extent.** Impacts of proposed activities can occur at a variety of geographic scales and

5710 defining the scale is important to the decision-making process (Nash, 2014). For the purposes of this
5711 analysis, impacts are assessed in two ways:

- 5712 ● Localized impacts are site-specific and generally limited to the immediate surroundings of a
5713 project site. Local impacts of watershed restoration and management activities would include the
5714 project area and areas with a direct nexus to the project area such as connected downstream
5715 waters and coastal waters that a sediment plume may reach. Local impacts of other activities
5716 include the project area, which would be defined prior to project implementation, based on the
5717 anticipated range of direct impacts. For example, the project area for the removal of a derelict
5718 vessel from a coral reef would be established during the permitting process to identify resources
5719 and geographic area potentially impacted.
- 5720 ● Large-scale impacts are those that extend beyond the project area.

5721 **4.1.2 Intensity**

5722 Intensity refers to the severity of impact (NOAA, 2009a) and could include the timing of the action (e.g.,
5723 more intense impacts would be expected during critical periods like spawning, breeding, or storm events).
5724 Intensity is also described in terms of whether the impact would be beneficial or adverse. An adverse
5725 impact is one having unfavorable or undesirable outcomes for the environment. A single act might result
5726 in adverse impacts to one resource and beneficial impacts to another resource.

5727 No quantitative guidance regarding magnitude of impacts is offered by CEQ. Therefore, further
5728 clarification is provided with respect to criteria used in this DPEIS to determine the potential significance
5729 based on differing levels of the magnitude of an impact to a resource. Our analysis defines magnitude at
5730 the following levels: negligible, minor, moderate, and major. The magnitude or intensity of a known or
5731 potential impact is defined on a spectrum ranging from no impacts to major impacts. The qualitative
5732 assessment taking into account both context and intensity is thus based on a review of the available and
5733 relevant reference material, professional judgment using standards that include consideration of the
5734 permanence of an impact or the potential for natural attenuation of an impact; uniqueness or
5735 irreplaceability of the resource; abundance or scarcity of the resource; geographic, ecological, or other
5736 context of the impact; and the potential that mitigation measures can offset the anticipated impact.

- 5737 ● Negligible. This relative term is used to describe *no* detectable or measurable impacts to the
5738 structure or function of a resource.
- 5739 ● Minor. This relative term is used to describe impacts to the structure or function of a resource that
5740 are *detectable, short-term, localized or larger scale, and not severe*. These are typically localized
5741 to the project site but may in certain circumstances extend beyond a project site.
- 5742 ● Moderate. This relative term is used to describe impacts to the structure or function of a resource
5743 that are *detectable, short or long-term, localized, and possibly severe* OR impacts are *detectable,*
5744 *long-term, extensive or localized, but not severe*.
- 5745 ● Major. This relative term is used to describe impacts that are *obvious, detectable and/or*
5746 *measurable, long-term, large scale, and severe*. They may result in substantial structural or
5747 functional changes to the resource. Generally, major impacts are those that, in their context and
5748 due to their severity, are indicators of “significance” (40 C.F.R. § 1508.27).

5749 **4.2 Issues Eliminated from Further Analysis**

5750 NEPA and CEQ regulations direct agencies preparing an EIS to “avoid useless bulk... and concentrate
5751 effort and attention on important issues” (40 C.F.R. § 1502.15) and to “identify and eliminate from
5752 detailed study the issues which are not significant or which have been covered by prior environmental
5753 review” (40 C.F.R. § 1506.3). All source documents relied upon for the NEPA analyses in this DPEIS are
5754 available to the public and links are provided in the discussion of the environmental consequences where
5755 applicable. Consequently, activities for which impacts are not expected or are expected to be negligible
5756 were eliminated from further analysis. The rationale for any resource initially considered but eliminated
5757 from further analysis is presented below.

5758 **4.2.1 No Impact Anticipated**

5759 Resource issues were eliminated from further analysis if the resource was considered outside the scope of
5760 the proposed action, irrelevant to the decision to be made regarding the CRCP alternatives, or unaffected
5761 by the proposed action or alternatives. Resources subsequently eliminated from further analysis are listed
5762 below with a brief explanation.

- 5763 ● **Oceanographic Processes.** Tides, winds, upwelling, and other processes in the Atlantic and
5764 Pacific oceans occur at a scale beyond the effects of the proposed activities and thus have no
5765 potential to be significantly impacted by any of the alternatives. As a result, oceanographic
5766 processes were eliminated from further analysis in this DPEIS.
- 5767 ● **Geology.** The geologic stability of the land and ocean bottom would not be compromised by any
5768 of the proposed activities, and no geologic hazards (e.g., landslides, earthquakes, and volcanic
5769 eruptions) are expected to occur as a result of any of the proposed alternatives. Proposed projects
5770 are limited to surficial soils and sediments, which are included for further analysis. Geologic
5771 features (e.g., beaches, cliffs, subtidal bottoms, and hard coral reef structures) would not be
5772 impacted. Vessel groundings can damage reef structure, potentially destabilizing bottom geology
5773 and fracturing reef platforms, and result in fundamental topographic shifts (Raymundo et al.,
5774 2018; Lirman et al., 2010). However, very few vessels would be involved with the in-water
5775 activities proposed under CRCP alternatives, and training and general BMPs would avoid and
5776 minimize reef damage under all alternatives. Therefore, impacts to geologic resources are not
5777 anticipated and were eliminated from further analysis in this DPEIS.
- 5778 ● **Environmental Justice.** EO 12898 states that, to the greatest extent practicable, federal agencies
5779 must “identify and address, as appropriate, disproportionately high and adverse human health or
5780 environmental effects of its programs, policies, and activities on minority populations and low-
5781 income populations.” Proposed activities are not expected to differentially impact minority or
5782 low-income populations or communities under the three alternatives and, therefore,
5783 environmental justice issues are not included for further analysis.
- 5784 ● **Children’s Welfare.** Children are addressed specifically under EO 13045, *Protection of Children*
5785 *from Environmental Health Risks and Safety Risks* (62 FR 19885), because, in certain
5786 circumstances, they may be more vulnerable or disproportionately impacted when compared to an
5787 adult exposed to the same event. Children may volunteer to assist with some land-based
5788 restoration activities, such as planting native plants, cleaning up marine debris, and participating
5789 in *in-situ* educational activities; however, to the extent there may be impacts to children, there are
5790 no known disproportionate effects. Therefore, potential impacts to children’s welfare were

5791 excluded from further analysis.

5792 **4.2.2 Negligible Impacts Anticipated**

5793 A second tier of resources eliminated from further analyses was developed based on an expectation of
5794 negligible impacts. For this second tier of analysis, the rationale for eliminating the resource from further
5795 analysis is provided, consistent with the level of impact anticipated.

- 5796 ● **Climate.** Global climate change has been linked to human activities, especially greenhouse gas
5797 (GHG) emissions associated with burning fossil fuels (IPCC, 2007). Implementing activities
5798 outlined in this DPEIS would involve only small quantities of fuel for vehicles, equipment, and
5799 boating operations during implementation and monitoring activities, and energy requirements are
5800 not expected to result in detectable adverse impacts to resources. In general, activities supported
5801 by NOAA enhance resilience to climate change through increases in protective green
5802 infrastructure. Negligible impacts to climate are anticipated under any of the proposed
5803 alternatives and differences between the alternatives with respect to impacts would also be
5804 negligible. Thus, impacts to climate were eliminated from further analysis in this DPEIS.
5805 Subsequent environmental reviews for CRCP projects tiered from this DPEIS will include an
5806 appropriate level of analysis of GHG emissions and assess any project for site-specific
5807 considerations related to climate change.
- 5808 ● **Air Quality.** As described for climate, air emissions will be generated as a result of CRCP
5809 proposed activities, but not to levels higher than what currently occur under the No Action
5810 Alternative and emissions would not be outside the normal range of emissions from other
5811 activities in the Atlantic, the Pacific Island Region, and priority international areas. Additional air
5812 emissions would not be detectable in comparison with background emissions. Therefore, impacts
5813 from proposed activities would be negligible. Moreover, no differences in impacts to ambient air
5814 quality between alternatives are anticipated. Thus, this resource was subsequently eliminated
5815 from further analysis.
- 5816 ● **Ground Water Quality.** Ground water occurs beneath the land surface and may occur as part of
5817 an aquifer, as underground springs or connections between aquifers or springs and coastal waters,
5818 and as a source of water to surface water such as springs, rivers, and lakes. Submarine
5819 groundwater discharge can also occur, resulting in direct discharge or seepage of ground water
5820 through porous substrates into marine waters. No impacts to aquifers are anticipated as a result of
5821 any of the proposed projects and groundwater is therefore eliminated from further analysis.
5822 However, surficial groundwater that occurs close to the surface as part of the interstitial make up
5823 of soils could be influenced just as soils and surface water are. Therefore, potential impacts to
5824 these surficial waters are presented in specific resource sections.
- 5825 ● **Sound.** Airborne sound will be generated during CRCP activities from sources including vessel
5826 motor and mechanical equipment operation (e.g., pumps, compressors, heavy equipment) and
5827 aircraft performing LiDAR surveys. The proposed activities are of short duration, and the types of
5828 sound generated are not unusual to everyday activities and, therefore, not anticipated to impact
5829 resources in the watershed. Airborne vessel sound is also anticipated but would be negligible
5830 offshore, and there is no scientific evidence supporting a disturbance of nesting or breeding sea
5831 turtles and seabirds in the presence of vessels surveying in nearshore waters (NOAA, 2013).
5832 Airborne sound from survey and mapping activities are not likely to adversely affect marine
5833 mammals, ESA-listed species, critical habitat or essential fish habitat (EFH), cultural resources,

5834 or other aspects of the environment (NOAA, 2013). In-water sound may be generated during
5835 proposed activities from sources such as vessels and surveying instruments. Potential in-water
5836 effects are considered negligible due to minimal overlap between acoustic echosounder
5837 frequencies and the functional hearing range of marine mammals in the area. The downward-
5838 oriented focus of the echosounder, rather than a widespread beam, also reduces the potential
5839 impacts of echosounder. Risk from in-water survey activities is further reduced by BMPs that
5840 require lowest possible power and ping rates during multibeam and single beam surveys.
5841 Potential effects of aircraft sound on marine mammals and fish, as well as sea turtles and seabirds
5842 during nesting, were also evaluated in the OCS PEA (2013). The PEA concluded that “[w]hile
5843 operations would temporarily add to the general sound in the air, aircraft sound from lidar
5844 operations would not have a long-term adverse impact on the environment based on the short
5845 duration (five hours), low intensity (aircraft flies 1,000-1,200 ft above the land and sea surface),
5846 and limited survey locations (less than one lidar survey per year).” Consequently, this DPEIS
5847 does not treat sound as a separate resource and does not include a detailed discussion of the sound
5848 environment. Rather, the impacts of sound on biological resources likely to be caused by CRCP
5849 activities, particularly impacts to marine mammals (e.g., potential impacts of echosounder on
5850 marine mammals), are addressed on a resource-by-resource basis where appropriate.

5851 ***4.2.3 Activities Addressed in Previous NEPA Assessments and Incorporated by*** 5852 ***Reference***

5853 In addition to resources eliminated from further analysis, impacts from many activities are also addressed
5854 through summary analysis (i.e., impacts analyses, incorporated by reference and summarized) in this
5855 DPEIS based on evaluations and conclusions from previous NEPA documents addressing activities,
5856 resources, and impacts substantially similar to those anticipated for the CRCP. NOAA’s NEPA
5857 Procedures (NAO 216-6A, Companion Manual [NEPA Manual, 2017]) state, “[d]ecision makers may use
5858 existing NOAA environmental assessments and environmental impact statements (EAs and EISs) to
5859 analyze effects associated with a proposed action, when doing so would build on work that has already
5860 been done, avoid redundancy, and provide a coherent and logical record of the analytical and decision-
5861 making process.” In cases where the impacts of an activity were evaluated in a previous NEPA document
5862 on a resource addressed in the present analysis, the impact is briefly described, and the relevant document
5863 is referenced. The primary NEPA analyses relied on in this DPEIS are briefly summarized below and
5864 used throughout this DPEIS to support impacts analyses for substantially similar activities and resources.

- 5865 ● The 2013 Office of Coast Survey’s Programmatic Environmental Assessment is cited hereafter as
5866 “OCS PEA 2013”, incorporated by reference in Chapter 2, evaluated impacts of hydrographic
5867 surveys on various resources and concluded that the proposed activities would have no significant
5868 adverse impact on physical, biological, or socioeconomic resources in the Atlantic, Pacific Island
5869 Region, and priority international areas. The document is relevant to this DPEIS because of the
5870 same or similar activities and resources analyzed, particularly mapping, monitoring, and research.
5871 The OCS PEA 2013 evaluated potential survey impacts, including: risk of vessel strikes,
5872 echosounder and other sounds, light detection and ranging (lidar) surveys, vessel transit
5873 operations, anchoring, bottom sample collection, sound speed data collection, tide gauge
5874 installation and operation, and coast survey laboratory activities, and other potential impacts. The
5875 OCS PEA 2013 and subsequent FONSI concluded these activities would have no significant
5876 impacts to the coastal and marine environment, sea turtles, sea birds, seagrasses, mangroves,

5877 corals, EFH, threatened and endangered species and critical habitat, cultural environment,
5878 National Marine Sanctuaries, and others. In addition, BMPs implemented by NOAA vessels
5879 include avoidance and minimization of impacts to known reefs and hardbottom areas, anchoring
5880 in areas with documented absence of coral reefs, and anchoring in areas known to be devoid of
5881 corals.

5882 ● The NOAA *Deepwater Horizon*: Final Programmatic Damage Assessment and Restoration Plan
5883 and Final Programmatic Environmental Impact Assessment (PDARP/PEIS) is cited hereafter as
5884 “NOAA PDARP/PEIS 2016” (NOAA 2016b) The NOAA PDARP/PEIS 2016 was prepared for
5885 the purpose of evaluating the effects of programmatic approaches to restoring natural resources
5886 injured as a result of the *Deepwater Horizon (DWH)* oil spill in 2010. The document is relevant to
5887 this DPEIS because its assessing impacts to the same or similar resources resulting from activities
5888 similar to those proposed for the CRCP (e.g., coral restoration activities such as coral transplants,
5889 water quality restoration activities such as reduced sedimentation, and habitat restoration
5890 activities such as debris removal and installation of mooring buoys). The NOAA PDARP/PEIS
5891 2016 presents an analysis of proposed restoration projects for watershed, coral reef, water quality,
5892 and habitat restoration, among other project types. The Record of Decision for the NOAA
5893 PDARP/PEIS 2016 concluded that subsequent restoration plans would consider what additional
5894 NEPA analyses may be necessary, including whether the conditions and environmental effects
5895 described in the NOAA PDARP/PEIS 2016 have changed. The Record of Decision concluded
5896 that all practicable means to avoid, minimize, or compensate for environmental harm from the
5897 action had been considered programmatically, and that project-specific measures would be
5898 adopted during subsequent restoration planning efforts. Impacts of creation, restoration, and/or
5899 enhancement of coastal habitats (e.g., coastal wetlands) to physical resources were considered
5900 primarily adverse in the short term due to disturbance or entrainment during construction and
5901 replacement of existing habitat by newly restored habitat. Adverse impacts were out-weighed by
5902 long-term benefits of, for example, restored freshwater flows, sediment, and nutrient loads;
5903 restored sediment dynamics and deltaic processes; and overall coastal resiliency. The appropriate
5904 level of NEPA analysis for each subsequent restoration plan will be or is being determined by the
5905 lead federal agency for each plan. Many of the same or similar activities and resources analyzed
5906 for this DPEIS were also analyzed as part of the NOAA PDARP/PEIS 2016.

5907 ● The 2015 NOAA Restoration Center PEIS *for Habitat Restoration Activities Implemented*
5908 *Throughout the Coastal United States* is cited hereafter as “NOAA RC PEIS 2015” (NOAA RC
5909 PEIS, 2015). The document is relevant to the DPEIS because of the similarity in activities and
5910 resulting impacts to resources. For example, the NOAA RC PEIS evaluates the potential impacts
5911 of habitat restoration activities such as coral reef restoration (e.g., elimination of land based
5912 sources of pollution and controlling invasive species), debris removal from coastal and marine
5913 environments (e.g., derelict fishing gear and other persistent debris), invasive species removal,
5914 and wetland restoration on coastal and marine resources under the jurisdiction of NOAA. The
5915 NOAA RC PEIS 2015 assessed potential impacts of restoration projects on various resources and
5916 concluded that the proposed activities would have no significant adverse impact on physical,
5917 biological, or socioeconomic resources under U.S. jurisdictions. Potential impacts of planning,
5918 design, and permitting studies, fish and wildlife monitoring, public education and outreach, debris
5919 removal, invasive species control, bank restoration and erosion reduction, coral reef restoration,

5920 road and trail stabilization, revegetation, water conservation, wetland restoration, seagrass
5921 restoration, mangrove restoration, shoreline stabilization, and planting activities were evaluated.
5922 The NOAA RC PEIS 2015 and subsequent Record of Decision concluded that proposed activities
5923 described in the NOAA RC PEIS 2015 would have no adverse impact on physical, biological,
5924 and cultural resources. Activities anticipated to require further analysis were identified in the
5925 NOAA RC PEIS, 2015. Many of the activities and resources analyzed for this DPEIS were the
5926 same or similar to those analyzed as part of the NOAA RC PEIS 2015.

5927 ● The National Park Service General Management Plan and EIS for Biscayne Bay, referred to
5928 hereafter as the “NPS EIS 2015” (NPS EIS, 2015), analyzed the potential impacts of eight
5929 alternative management plans on Park resources (e.g., such as water quality, hardbottom habitat,
5930 seagrasses, corals, and fish and wildlife, wetlands, and cultural resources). The proposed
5931 alternatives included numerous activities to manage Park resources and visitor use and improve
5932 facilities and infrastructure. The selected alternative resulted in implementation of additional
5933 restrictions such as prohibiting anchoring in reserve zones, installing mooring buoys, building
5934 boardwalks over wetlands, and providing additional treatment of invasive and exotic species to
5935 reduce damage to Park resources. The corresponding Record of Decision concluded that activities
5936 under the selected alternative would not cause impairment (i.e., “an impact that... would harm the
5937 integrity...”) of Park resources or values, including epibenthic biota, other invertebrates, fish,
5938 seagrasses, and other resources. The analysis of many activities and resources in the NPS EIS
5939 2015 for Biscayne Bay are also relevant to activities CRCP activities considered in this DPEIS.

5940 ● The NOAA 2013 Marine Debris Program PEA is cited hereafter as the “MDP PEA 2013” (MDP
5941 PEA, 2013). The MDP PEA analyzed the potential impacts of implementing the MDP 2013 to
5942 conduct activities including marine debris research and prevention and reduction of marine debris
5943 throughout its jurisdiction (i.e., all coastal and nearshore habitats in state and territorial waters, plus
5944 offshore habitats within the U.S. Exclusive Economic Zone and high seas). The MDP PEA 2013 is
5945 relevant to the DPEIS because of similar or the same resources analyzed and the similarity in the
5946 debris removal activities analyzed here. For example, the MDP PEA 2013 analyzes impacts of
5947 research and assessment, prevention, reduction, and removal, outreach and education, and
5948 collaboration and tools relevant to the impacts of marine debris on coastal and marine resources
5949 under NOAA’s jurisdiction. The proposed project targets plastics, glass, metal and rubber,
5950 derelict fishing gear, and derelict vessels and supports local, state, and national partnerships to
5951 assess and reduce marine debris and to protect and conserve the nation’s marine environment and
5952 navigation safety from impacts of marine debris. The corresponding FONSI concluded that all
5953 projects would likely result in at least minor, short-term improvements and cumulatively in long-
5954 term substantial benefits. Adverse impacts of the proposed activities are expected to be minimal,
5955 and primarily associated with research and removal activities. Implementation of site-specific
5956 marine debris activities may have very localized and temporary adverse impacts over the short-
5957 term and on a small scale and would provide benefits in the long-term on a larger scale. No
5958 substantial social or economic impacts related to the proposed action, nor any social or economic
5959 impacts related to potential biological or physical environmental impacts are expected.

5960 ● The NOAA Coral Reef Ecosystem Division PEA is cited hereafter as the “CRED PEA 2010”
5961 (CRED PEA, 2010). The CRED PEA 2010 presents an analysis of potential effects of CRED
5962 research activities under the Pacific Reef Assessment and Monitoring Program component and

5963 the marine debris component, which together include monitoring, mapping, and research
5964 activities such as those described for the OCS PEA 2013. The document is relevant to this DPEIS
5965 because of the same or similar activities and resources analyzed, particularly mapping,
5966 monitoring, and research. The Coral Reef Ecosystem Division program covered all areas in the
5967 U.S.-affiliated Pacific Islands with coral reef ecosystems, including coral reefs and their
5968 associated habitats, benthic invertebrates, algae, and fish species that use these habitats. The
5969 geographic area includes populated portions of Hawai'i, American Samoa, Guam, and the
5970 Commonwealth of the Northern Mariana Islands (CNMI). The marine debris component includes
5971 monitoring, assessment, and mitigation of the effects of derelict fishing gear in coral reef
5972 ecosystems. The FONSI concluded that the proposed activities would not result in significant
5973 adverse impacts to the resources evaluated, similar to the OCS PEA 2013.

5974 ● The Office of National Marine Sanctuary 2018 Draft PEA for Field Operations in the Southeast
5975 and Gulf of Mexico National Marine Sanctuaries is cited hereafter as "ONMS 2018" (NOAA
5976 ONMS, 2018b) The document is relevant to this DPEIS because of the same or similar activities
5977 and resources analyzed, particularly mapping, monitoring, and research. The ONMS PEA
5978 assesses the potential impacts of survey and monitoring activities on the condition and spatial
5979 distribution of seagrass, coral, and hard-bottom habitats to inform and develop management
5980 strategies. Activities included vessel and aircraft operations, non-motorized craft, SCUBA and
5981 snorkel operations, onshore fieldwork, sea floor equipment deployment, AUVs/ROVs, and other
5982 sampling activities, similar to the OCS PEA 2013, but in the Gulf of Mexico and Southeast
5983 Atlantic.

5984 ● The NOAA National Coastal Centers for Coastal Ocean Science is cited hereafter as "NCCOS
5985 EA 2016" (NCCOS EA, 2016) and assessed hydrographic surveying and mapping activities in
5986 Puerto Rico and the USVI addresses the collection of multibeam and split/beam acoustics
5987 echosounder data and field verification activities and tiers from the OCS PEA 2013. The
5988 document is relevant to this DPEIS because of the same or similar activities and resources
5989 analyzed, particularly mapping, monitoring, and research. Multibeam and split/beam acoustics
5990 may have potential adverse effects such as avoidance behavior of cetaceans or turtles, although
5991 potential effects are reduced due to minimal overlap in the acoustic echosounder frequencies and
5992 the functional hearing range of the marine mammals in the area and the downward oriented focus
5993 of the echosounder. The subsequent FONSI determined the proposed activities are not likely to
5994 adversely impact marine mammals, corals, seagrasses, ESA-listed species, critical habitat or EFH,
5995 cultural resources or other aspects of the environment.

5996 ***4.2.4 Activities Eliminated from Further Analysis***

5997 Activities such as outreach and education, data analysis and modeling, and program and interagency
5998 coordination and administration are included in the CRCP under all three alternatives. No adverse impacts
5999 to any of the resources analyzed for this DPEIS are anticipated. The impacts of implementing these
6000 activities would be the same for all three alternatives and all the resources analyzed. Therefore, an
6001 analysis of impacts to resources is presented here rather than repeating the information for each resource.
6002 Overall, these activities are intended to result in indirect, long-term, local and larger-scale benefits to all
6003 resources. Activities would support the continued implementation of the most successful projects and,
6004 therefore, result in effective and efficient habitat restoration and coral reef resource management.

- 6005 ● **Public outreach and education.** Projects that provide environmental education classes,
6006 programs, and centers; encourage and maintain partnerships with local school systems; and/or
6007 fund the development of education materials would have direct and indirect, long-term, minor
6008 beneficial impacts to all resources. Benefits of educating local citizens and youth about
6009 environmental issues in the community and beyond, habitat restoration, and conservation would
6010 promote environmental stewardship, an understanding of living coastal and marine resources and
6011 environmental issues, and a sense of community pride. Educational materials developed would
6012 encourage conservation and environmental stewardship and educate the public on the benefits of
6013 habitat restoration projects. Projects conducted by youth groups would generally benefit the
6014 community both through their results and by promoting community cohesion. Additional NEPA
6015 analysis will be completed if the proposed project would have adverse effects that are beyond the
6016 scope of those analyzed here, including adverse effects that are significant.
- 6017 ● **Data analysis and modeling.** Data analysis and modeling provide information needed to support
6018 decision making and policies pertaining to coral reefs and other systems. Understanding how
6019 resources may be affected by local human-induced disturbances and global climate change is
6020 important to recovery of coral reefs. Ecosystem models provide information needed to account
6021 for complex reef dynamics and their responses to multiple disturbances and are needed to support
6022 planning and implementation of ecosystem-based management. Benefits of data analysis and
6023 modeling would accrue to coastal and marine sources, are focused on coral, and provide
6024 information critical to the successful management of coastal and marine resources.
- 6025 ● **Program and interagency coordination and administration.** The benefits of these activities
6026 include coordination among U.S. Atlantic and Pacific jurisdictions and priority international
6027 areas, and local, state, and other federal agencies to ensure resources are available for proposed
6028 activities. NOAA oversees U.S. coordination efforts through the USCRTF by serving as its co-
6029 chair and steering committee secretariat. The CRCP reviews plans, policies, and regulations
6030 related to coral reef conservation and management; supports meetings; manages CRCP data;
6031 implements and manages external funding opportunities; and supports program staff and travel to
6032 implement the program. The CRCP also provides support for international conferences such as
6033 the International Coral Reef Symposium.

6034 **4.2.5 Resources Retained for Further Analysis**

6035 The resources retained for further analysis include physical, biological, cultural, and socioeconomic
6036 resources. Resources such as sediments and soils, water quality, and ESA-listed species, occur in and are
6037 discussed with respect to both the watershed and the coastal/marine environment, as appropriate.
6038 Similarly, if a resource differs distinctly among the U.S. jurisdictions in the Atlantic, Pacific Island
6039 Region, and priority international areas, distinctions are presented. Resources expected to be impacted by
6040 the proposed action and alternatives and expected to have impacts that may range from negligible to
6041 major are carried through for further analysis. Cumulative impacts are presented separately and follow
6042 individual resource analyses.

6043 *Physical Environment*

- 6044 ● Sediments and Soils
- 6045 ● Terrestrial Habitats and Biota
- 6046 ● Wetlands and Floodplains

- 6047 ● Water Resources
- 6048 *Biological Environment*
- 6049 ● Seagrass
- 6050 ● Mangroves
- 6051 ● Coral and Associated Invertebrates and Algae
- 6052 ● Fish
- 6053 ● Other: Invasive Species

- 6054 *Regulatory Environment*
- 6055 ● Essential Fish Habitat
- 6056 ● Other Protected Species

- 6057 *Socioeconomic Environment*
- 6058 ● Cultural Resources
- 6059 ● Public Health and Safety
- 6060 ● Economic Environment

6061 Potential impacts to resources are analyzed for activities described in Chapter 2 for each alternative. For
 6062 organizational purposes, impacts to resources are presented for groups of activities (listed below, based on
 6063 Table 2-1).

- 6064 ● Monitoring, mapping, and research
- 6065 ● Coral restoration and interventions
- 6066 ● Watershed restoration and management
- 6067 ● Reducing physical impacts to coral reef ecosystems

6068 **4.3 Physical Environment**

6069 **4.3.1 Sediments and Soils**

6070 Terrigenous (terrestrial derived) and marine sediments and soils provide habitat for numerous organisms,
 6071 ranging from bacteria and burrowing organisms in terrestrial and coastal environments to hard bottom and
 6072 coral reefs in coastal and marine environments. Because sediments are critical to both terrestrial and
 6073 seafloor habitats, excess sediments in stormwater runoff or reduced sediments due to erosion can affect
 6074 land surface and seafloor. Sediment can be transported across the watershed and into downstream and
 6075 coastal waters where it may accumulate or be resuspended into the water column and adversely impact
 6076 habitats and biota due to the introduction of pollutants, burial of habitats, suffocation of sessile animals
 6077 such as coral, and/or water quality degradation. Point and nonpoint source pollutants, such as excess
 6078 sediment, nutrients, metals, and pesticides, are particularly relevant due to the potential impacts to
 6079 habitats such as mangroves, seagrasses, and coral reefs. In addition, sediments and other forms of
 6080 terrestrial runoff correspond with increased coral degradation and disease (Waddell, 2008). Sediments and
 6081 soils can be adversely impacted by actions that would erode, transport, bury, compact, or otherwise
 6082 disturb existing land surface or seafloor substrates. Terrestrial soils in the watershed are affected by
 6083 upland deforestation, agriculture, development, and subsequent stormwater runoff into downstream fresh,
 6084 coastal, and marine waters.

6085 While sediments and soils vary among U.S. coral reef jurisdictions due to variation in geology, climate,

6086 and other factors, the causes of, and impacts to, sediment and soil runoff are similar. Factors affecting
6087 stormwater runoff and nonpoint source pollution include rainfall intensity, preceding wet and dry days,
6088 pervious and impervious surfaces, land use, and drainage. Runoff from more developed and urban areas
6089 includes greater concentrations of soluble metals and fuel-related contaminants (Young et al., 2018).
6090 Runoff from agricultural areas is dominated by sediments but, like urban runoff, may also include
6091 pathogens, nutrients, pesticides, and metals. Remote areas in the American Pacific are less developed,
6092 with fewer roads and smaller extent of impervious surfaces, and more agricultural runoff. Development is
6093 more expansive in the Caribbean and along the Florida coast and the runoff is correspondingly greater,
6094 especially on steep slopes, and erosion of unpaved and degraded roads is a significant source of terrestrial
6095 sediment inputs into downstream water bodies. For example, sedimentation from unpaved roads can be
6096 300-900% higher than that of undisturbed watersheds in the USVI (Waddell, 2008) and most (83-95%) of
6097 the sediment yield reported for Saint Lucia in the Caribbean was attributable to unpaved and degraded
6098 roads (Bégin et al., 2014). Sediment runoff is also considered the leading land-based pollutant affecting
6099 reef community structure in the main Hawaiian Islands (Waddell, 2008).

6100 *4.3.1.1 No Action Alternative*

6101 CRCP activities including monitoring, mapping, research, coral restoration and intervention, watershed
6102 restoration and management, and activities to reduce physical disturbance to coral reefs (i.e., permanent
6103 boat mooring and marine debris removal; Table 2-1) have the potential to affect sediments and soils under
6104 the CRCP No Action Alternative.

6105 **Monitoring, mapping, and research.** Most terrestrial sediment loss is due to erosion in channels, gullies,
6106 and streams (Bartley et al., 2014). Monitoring and research activities in the watershed may include
6107 drilling into soil or sediment via auger, vibra-core, or hand probe to remove samples for analysis or
6108 geotechnical evaluations, and/or evaluating groundwater levels and elevations. Potential adverse impacts
6109 to sediments and soils from these activities would be direct, short-term, localized, and negligible to minor
6110 (NOAA, 2016b; OCS PEIS, 2013).

6111 Monitoring, mapping, and research activities under the No Action Alternative would result in short-term
6112 direct adverse impacts to marine sediments, such as stirring of bottom sediments due to interactions with
6113 vessel, equipment, sampling, and/or diver activities that may occur during these activities. Resuspended
6114 sediments, including any contained contaminants, may be redeposited on adjacent corals and may cause
6115 adverse effects to their health. Methods described in chapter 2 would ensure that turbidity and sediment
6116 resuspension would be minimized and that corals and other habitats would not be adversely impacted by
6117 associated activities. Adverse impacts would be limited to the duration of the activity and would be direct,
6118 short term, local, and negligible to minor. Major benefits to the understanding, sustainable use, and long-
6119 term conservation of coral reefs and coral reef ecosystems are anticipated due to data collected as a result
6120 of many of these activities (ONMS, 2018 [Section 4.1.1]; NCCOS PEA, 2016 [Section 4.1]; NOAA, 2013
6121 [Appendix 1]). Potential benefits of these activities were also analyzed in the NOAA RC PEIS 2015,
6122 which concluded that potential benefits would be indirect, long-term, local to large scale, and negligible
6123 to major (Section 4.5.1), depending on the location (sensitive vs. less sensitive sea floor) and type
6124 (mapping vs. sampling) of an activity.

6125 **Coral restoration and interventions.** Impacts to soils and sediments from coral restoration would be
6126 limited to disturbance of coastal and marine sediments during coral transplantation, *in-situ* nursery
6127 development and maintenance, and coral interventions (e.g., control of invasive species, corallivores, and

6128 disease). Potential adverse impacts and benefits to sediments would be the same as those described for
6129 vessel, equipment, and diver activities associated with monitoring, mapping, and research in coastal and
6130 marine waters. Construction of *in-situ* coral nurseries may require more vessel and diver activity than
6131 monitoring, mapping, and research due to the permanent installation of frames or other equipment used to
6132 anchor the nursery grown corals and the regular maintenance of the nurseries. Sediment disturbance may
6133 also occur during nursery construction (NAS, 2019). Resuspended sediments including contained
6134 contaminants may be redeposited on adjacent corals and may cause adverse effects to their health.
6135 Minimization and avoidance measures would ensure that turbidity and sediment resuspension were
6136 reduced during nursery construction, and that other corals and habitats were not adversely impacted by
6137 associated activities. Therefore, adverse impacts to coastal and marine sediments due to coral restoration
6138 and intervention activities are expected to be direct, short term, local, and negligible to minor.

6139 Benefits to seafloor sediments would be expected as a result of coral reef establishment and subsequent
6140 stabilization of sediments. Expected benefits would be direct, short-term, local, and negligible to minor
6141 due to small geographic nature of individual projects.

6142 **Watershed restoration and management.** Construction of watershed management projects such as
6143 culverts, baffle boxes, elevated boardwalks with pilings, and LID would result in larger-scale disturbances
6144 due to staging and cleaning areas, workers, and possibly heavy equipment to excavate or rearrange soils.
6145 Vegetation plantings would require some land clearing and possibly mechanical land clearing. Invasive
6146 species control activities may require existing vegetation to be mechanically cleared for invasive species
6147 treatment and replanting of desirable species. Construction activities would potentially impact
6148 sedimentation and soil erosion in areas where the slopes are steep and where the erosion potential is
6149 moderate to severe. Increased sedimentation in waterways may alter natural sediment transport processes
6150 and subsequently impair water and habitat quality and aquatic plants and animals. Potential construction
6151 BMPs are listed in Appendix A. BMPs, such as silt curtains, buffer zones, and water quality monitoring,
6152 would be used to minimize such effects. Although soil compaction has the potential for long-term
6153 impacts, BMPs would reduce the compaction so that plant roots and benthic infauna can inhabit the soil
6154 and create further improvements. Potential impacts caused by equipment staging, vehicle or foot traffic,
6155 and other construction-related activities would be avoided and minimized by applying BMPs related to
6156 construction activities and impacts would be negligible. When heavy equipment or motor vehicles are
6157 used for debris removal, BMPs for vehicle staging, fuel storage, erosion and pollution control, and species
6158 decontamination would prevent construction-related impacts to the extent possible

6159 Following restoration activities, revegetation would be relatively rapid (over weeks), and vegetation
6160 would be planted to ensure recovery. Some projects would result in the replacement of invasive species
6161 with native vegetation, while some would replace disturbed areas with projects such as swales or culverts
6162 and, in some cases, a stormwater pond may be constructed. The potential for the loss of topsoil due to soil
6163 mixing during proposed activities such as grading and/or excavation is present but would also be
6164 minimal. Construction activities would also potentially impact sediment and soil resources via
6165 compaction and rutting in susceptible soils. Overall, adverse impacts would be direct, short-term, local,
6166 and negligible to minor, depending on the level of activity, for example, hand planting a revegetation site
6167 vs. constructing a stormwater pond. NOAA has previously analyzed the impacts of similar activities for
6168 the NOAA RC PEIS (2015) and the NOAA PDARP/PEIS 2016 and concluded that no significant adverse
6169 impacts to sediments and soils anticipated from these activities. The activities proposed are similar to
6170 those analyzed in Section 4.5.2 of the NOAA RC PEIS and Section 6.4.1 of the NOAA PDARP/PEIS

6171 2016. Consequently, no significant adverse impacts to sediments and soils are anticipated as a result of
6172 these activities (NOAA PDARP/PEIS, 2016c; NOAA RC PEIS, 2015).

6173 Watershed restoration and management activities with the potential to result in discharge of dredged
6174 material or fill into U.S. waters would be regulated under [Section 404 of the CWA](#) and would require
6175 demonstration of avoidance and minimization of impacts to sediment and water quality contained in a
6176 project specific individual permit or an applicable general permit. Therefore, potential adverse impacts to
6177 coastal and marine sediments from watershed restoration and management activities are expected to be
6178 direct, short-term, local, and negligible to minor.

6179 Potential benefits to terrestrial (watershed) soils as a result of watershed restoration and management
6180 activities are anticipated. Many of these projects would redirect stormwater through vegetated areas (e.g.,
6181 swales, rain gardens, restored and planted landscapes) and stormwater ponds, reducing the potential for
6182 sediment erosion and downstream transport. For example, a sediment reduction project in Fouha Bay,
6183 Guam, installed tree seedlings and sediment filter “socks” in eroding hillsides above the bay, capturing
6184 more than 110 tons (100 metric tons) of sediment after 21 months (Shelton and Richmond, 2016). Results
6185 suggested that treating 0.05 km² (0.03 mi²) of eroding hillside would achieve the reduction needed to
6186 restore the bay to pre-sediment stress conditions (below 50 mg/cm²/day), providing conditions under
6187 which coral reefs are anticipated to recover. Benefits of stabilized soils include retention of mineral and
6188 organic soil components, nutrients, and microorganisms, improved water-holding capacity during
6189 drought, and increased aggregate soil stability that further reduces the susceptibility of soils to disturbance
6190 and erosion. Benefits would include reduced amounts of stormwater runoff and associated sediments and
6191 pollutants. Negligible to minor benefits to marine sediments may occur as a result of coral reef recovery
6192 that stabilizes sediments by filling in scoured or eroded areas, although these benefits would not be
6193 realized for years. Management efforts to reduce terrestrial runoff from watersheds have led to small but
6194 significant reductions in end-of-river sediment and nutrient loads on the Great Barrier Reef (Fabricius et
6195 al., 2016). Overall, benefits to soils and sediments under the No Action Alternative are expected to result
6196 in a range of impacts: direct and indirect, short- and long-term, local, and negligible to major (NOAA
6197 PDARP/PEIS 2016 [NOAA, 2016b]).

6198 **Reducing physical impacts to coral reef ecosystems.** Construction and installation of mooring buoys
6199 and other equipment, and community-based debris cleanups to reduce physical impacts to coral reefs
6200 could disturb sediments and cause temporary sediment plumes and increases in turbidity, but effects have
6201 been found to be negligible (Demers et al., 2012; Urban Harbors Institute, 2013). Permanent mooring
6202 buoys may attract more visitors and result in indirect increases in water quality and sediment disturbance
6203 due to anchorings rather than use of buoy moorings. However, permanent mooring buoys for vessels and
6204 instrumentation under the CRCP would reduce the numbers of temporary anchorings since boat users
6205 would attach to an existing mooring rather than multiple visitors dropping anchor multiple times,
6206 reducing impacts to sediments. Other benefits of mooring buoys include reduced scour and erosion that
6207 occurs when anchor chains scrape the seafloor as they are moved by tides, currents, and wind (Morrisey
6208 et al., 2018). Installation of mooring buoys would reduce losses of coral cover due to damage from
6209 anchors and chains because they would no longer be used. The NPS EIS 2015 analyzed the impacts of
6210 installing mooring buoys (e.g., Chapter 4 pages 214, 244, 262) and concluded that the installation of
6211 mooring buoys and volunteer debris cleanups would result in short-term, local, minor, and adverse
6212 impacts to submerged substrates, and mooring buoys would not be placed in corals, seagrass beds, or
6213 submerged cultural resources. Adverse impacts to sediments and soils are expected to be direct, short-

6214 term, local, and negligible to minor. Benefits of permanent mooring buoys, which would vary by location,
6215 would include continued protection of submerged sediments from unintentional vessel and anchor
6216 damage and would be direct, short-term, local, and negligible (e.g., sand bottom with few visitors) to
6217 moderate (sand bottom with frequent visitors).

6218 The removal of marine debris may involve operation of vessels in water and motor vehicles on land (e.g.,
6219 front-end tractor loaders, cranes, and light trucks), community-based volunteers, divers, and excavation to
6220 remove derelict equipment or vessels from sediments. The NOAA MDP 2013 presents an analysis of
6221 potential impacts of marine debris activities on the physical environment (Section 5.2.2) and reports that
6222 these activities may lead to direct, short-term, negligible to minor disturbance of substrates (NOAA MDP,
6223 2013), including resuspensions of sediment and sediment-bound contaminants. BMPs to reduce
6224 disturbance during these activities are included in the CRCP and would minimize disturbance to
6225 sediments and restore sediments to pre-disturbance conditions. Support teams responsible for
6226 implementing BMPs for safety, equipment, material handling, and use of air bags to lift heavy debris and
6227 vessels would reduce the potential for these short-term impacts to the seafloor. Direct, short-term, local,
6228 minor, adverse impacts are anticipated during removal of debris due to local disturbance. The removal of
6229 marine debris would reduce the millions of tons of debris added to coastal habitats each year via runoff
6230 from the watershed, wind, and currents (Browne et al., 2015) and would result in direct, short- and long-
6231 term, localized, and minor to moderate benefits to coastal and marine sediments.

6232 *4.3.1.2 Alternative 1*

6233 Under Alternative 1, current CRCP activities that support coral restoration and intervention and reduce
6234 physical disturbance to corals (e.g., permanent mooring buoy installation, marine debris removal) (Table
6235 2-1) would be eliminated.

6236 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to sediments and soils from
6237 monitoring, mapping, and research activities would be the same as described for the No Action
6238 Alternative.

6239 **Coral reef restoration and interventions.** Eliminating coral restoration and intervention activities would
6240 result in the continued deterioration of coral reefs and associated habitats (e.g., seagrasses and shorelines)
6241 and scouring and erosion of sediments that were formerly stabilized by the coral reef structure. Activities
6242 to address adverse impacts of coral-specific invasive species, disease, and predators would not be
6243 implemented, further reducing the potential for coral recovery and impacting coastal and marine
6244 sediments. Potential adverse impacts to sediments would be direct, long-term, local, and negligible to
6245 moderate. No benefits to sediments are expected.

6246 **Watershed restoration and management.** Potential adverse impacts and benefits to soils and sediments
6247 would be the same as described for the No Action Alternative.

6248 **Reducing physical impacts to coral reef ecosystems.** Eliminating the installation of permanent mooring
6249 buoys would increase the potential for direct damage to coastal and marine sediments as a result of
6250 recreational, scientific, and other vessel operators deploying and removing anchors on multiple occasions
6251 rather than attaching to an existing mooring line and having no impacts to sediments. This would increase
6252 the physical damage due to anchors that has been reduced under the No Action Alternative. The number
6253 of anchors and anchor chains scraping along the sea floor with changing currents and winds would
6254 increase the extent of sediment disturbance and alteration, sediment resuspension, and erosion,

6255 particularly in those areas with high visitor use. In the absence of debris removal activities implemented
6256 under the CRCP, derelict fishing gear, derelict vessels, and other debris that would otherwise be removed
6257 would continue to accumulate on the seafloor and along the shoreline, resulting in physical disturbance
6258 and potential contamination of sediments. Debris removal under NOAA's Marine Debris Program would
6259 continue to address this issue. Marine debris in coastal and marine waters can damage sediments via
6260 abrasion, shearing, scour, and burial and can result in accumulation of toxins, inhibit gas exchange, and
6261 alter nutrient cycles in the sediments (NOAA, 2016b). Derelict fishing gear can scour local sediments and
6262 fishing nets can trap sediments. Plastic pellets and fragments have been shown to alter sediment structure
6263 along Hawaiian beaches (Carson et al., 2011). Plastic pellets can adsorb contaminants such as PCBs,
6264 PAHs, and organochlorine pesticides, which may accumulate in sediments as the pellets degrade.
6265 Potential adverse impacts to sediments from continued anchoring and debris accumulation and damage
6266 would be direct, short- and long-term, local, and negligible (in small areas or where marine debris is not
6267 present) to moderate (where debris is present and causing in moderate scour). Ocean currents and
6268 sedimentation would continue to influence the overall nature of the sediments. No benefits to sediments
6269 are anticipated as a result of eliminating the installation of permanent mooring buoys and debris removal.

6270 Under Alternative 1, the benefits of monitoring, mapping, and research would continue to provide
6271 information critical to erosion management of soils and sediments and watershed restoration and
6272 management activities would continue to reduce sediment and other pollutant loads into downstream and
6273 coastal waters. However, the overall benefits to sediments would be reduced by the elimination of the
6274 components of the CRCP that directly address physical damage to, and loss of, sediments in coastal and
6275 marine waters. Therefore, overall potential benefits to sediments would be direct, short- to long-term,
6276 local, and negligible to minor.

6277 *4.3.1.3 Alternative 2*

6278 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs that are part of
6279 the current CRCP and may further reduce the potential for adverse impacts to sediments and soils from
6280 proposed activities. Implementation of DCMMs alone would have no adverse impacts to sediments and
6281 soils. Adverse impacts under Alternative 2 would be similar to the No Action Alternative but may have
6282 additional negligible impact reductions as a result of DCMMs, depending on the activity.

6283 DCMMs may include increasing the capacity for greater supervision over dive activities, BMPs to control
6284 turbidity and sediment, greater restrictions on instrument mooring, prioritizing the use of recreational
6285 mooring buoys or live boating, additional training to vessel operators, and stopping restoration work
6286 during or when a storm is approaching and during coral spawning periods. These activities would further
6287 reduce physical disturbance of sediments and soils in the watershed and in coastal and marine waters and,
6288 therefore, reduce the potential for release of sediments and sediment-bound contaminants into
6289 downstream freshwaters and coastal and marine waters. Potential benefits to sediments and soils would be
6290 similar to, but negligibly greater than, those described for the No Action Alternative.

6291 ***4.3.2 Terrestrial and Freshwater Habitats and Biota***

6292 Reducing land-based sources of pollution includes development of watershed management plans,
6293 implementation of projects such as water quality monitoring, upgrading wastewater treatment facilities,
6294 implementing BMPs to reduce sedimentation and runoff, partner coordination and technical assistance,
6295 and building capacity for each jurisdiction to take on and manage these activities (Table 2-1). These
6296 activities are intended to reduce the accumulation of sediments and other pollutants that enter coastal

6297 waters, subsequently affecting water and sediment quality that eventually impact coral reefs and
6298 associated habitats. This section focuses on impacts to the terrestrial habitats and associated biota
6299 throughout the watershed. Because of the programmatic level of this EIS, project types and locations to be
6300 implemented have not yet been determined and may range from water quality monitoring in state
6301 jurisdictions to water quality infrastructure in a south Pacific territory. Therefore, analysis of threatened
6302 and endangered (ESA-listed) terrestrial species critical habitat presented here is also very general and
6303 addressed here. As mentioned in Section 3.4.2, the CRCP is conducting programmatic Section 7
6304 consultations with NMFS and USFWS. Other ESA-listed species are addressed in Section 4.12.

6305 Potential impacts to ESA-listed species and designated critical habitat from activities similar or identical
6306 to those described in Section 2.3 were evaluated specifically in the NOAA RC PEIS 2015 (Section 4.7),
6307 NOAA PDARP/PEIS 2016 (Section 6.4), and the USFWS framework Biological Opinion/Conference
6308 Opinion (Section 6; [USFWS, 2016]); those analyses are incorporated by reference. Based on the results
6309 of these documents, minor to major adverse impacts to ESA-listed species or critical habitat are
6310 anticipated as a result of the proposed alternatives, though impacts are anticipated to be reduced through
6311 application of minimization measures. The discussion here is limited to potential general impacts to ESA-
6312 listed species.

6313 *4.3.2.1 No Action Alternative*

6314 CRCP activities under the No Action Alternative that were evaluated with respect to potential impacts to
6315 terrestrial habitats and biota include monitoring, mapping using drones, and watershed restoration and
6316 management activities. All other mapping and research activities are limited to the marine environment,
6317 specifically to coral reefs and adjacent areas. Activities that support coral restoration and intervention and
6318 reducing physical impacts to coral reefs would occur only in coastal and marine waters and would not
6319 adversely affect terrestrial habitats and biota.

6320 **Monitoring, mapping, and research.** Monitoring activities, mapping with drones, and the collection
6321 soils would be implemented in watershed areas. Data acquired from monitoring, mapping, soil collection,
6322 and water sampling would provide information to support assessments that may help prioritize areas for
6323 projects designed to reduce runoff into downstream and coastal waters. These data-acquisition activities
6324 would benefit terrestrial and freshwater fish and wildlife by providing information relevant to the
6325 management of soils and water quality and, therefore, fish and wildlife habitat. Adverse impacts to both
6326 animal and plant species would be negligible due to little or no ground disturbance during monitoring
6327 activities and the ability of animals to leave a disturbed area if necessary. Activities such as soil or water
6328 quality sampling, surveying areas for elevation or other landscape features, and identification of sensitive
6329 areas and surveys for ESA-listed species would result in little to no disturbance. The use of drones for
6330 mapping terrestrial areas may alter behavior of birds or other land species depending on the flight altitude.
6331 Potential adverse impacts to terrestrial habitats and biota would be direct, short-term, local, and negligible
6332 to minor. Potential benefits to terrestrial habitats and biota are expected to be direct, short-term, local,
6333 and negligible to moderate, primarily due to information available to support future conservation and
6334 management efforts.

6335 Monitoring, mapping, and research activities would provide water quality and soil erosion information
6336 that would be helpful in characterizing habitats and identifying potential water quality or erosion issues
6337 relevant to ESA-listed species (Appendix E). Sediment and water quality monitoring would have little to
6338 no impact on vegetation and animals, including ESA-listed species. Most listed animal species would

6339 avoid or move away from monitoring activities that may occur. Monitoring equipment would not be
6340 intrusive and would be carried by the survey team. Pedestrian surveys are not expected to have no impact
6341 on ESA-listed species with the exception of documenting their presence or potential presence. Activities
6342 would be limited to short-term and non-invasive disturbances that are not expected to adversely impact
6343 listed species. Similarly, activities would be limited to those that would not adversely impact critical
6344 habitat (e.g., vehicles confined to roads, pedestrian travel only in sensitive areas). Potential benefits to
6345 ESA-listed species and critical habitat would be direct, long-term, local, and negligible to moderate due to
6346 occurrence and habitat documentation and application of collected data in addressing potential water
6347 quality, sediment, and erosion information that may, in turn, affect ESA-listed species or critical habitat.

6348 **Watershed restoration and management.** Watershed restoration and management activities such as
6349 LID, stormwater control measures, road and trail stabilization, and erosion and sediment control practices
6350 may affect habitat and use of habitat by fish and wildlife. Depending on the activities implemented, short-
6351 term, minor adverse impacts to terrestrial habitats and biota may be anticipated during construction. For
6352 example, if construction includes earthmoving work, terrestrial vegetation and ground and tree nesting
6353 birds may be disturbed, and nests of mammals, birds, and/or reptiles damaged or destroyed. There could
6354 be adverse impacts to terrestrial and associated aquatic habitats and biota due to construction activities
6355 and subsequent disturbances to soils, hydrology, water quality, as described in Section 4.3.1 and 4.3.4),
6356 but adverse impacts would be minimized by implementing BMPs that reduce turbidity and sedimentation,
6357 avoid sensitive habitats, and are scheduled outside nesting seasons of sensitive biota. Biota such as birds,
6358 mammals, reptiles, amphibians, and fish would likely leave the area during construction, either
6359 permanently or temporarily, depending on habitats available. No loss of native habitats is anticipated as
6360 watershed restoration activities generally take place in previously disturbed areas, and sites are planted
6361 with native or naturalized plants. Herbicide applications would be consistent with labeled use to avoid
6362 potential impacts to ground or surface waters. Activities are not expected to interfere with foraging,
6363 reproduction, resting, migrating, or other factors affecting population levels. Changes to local population
6364 numbers, population structure, and other demographic factors are not anticipated because of the size of
6365 the restoration projects and sufficient habitat could persist at both the local and range-wide scales to
6366 maintain the viability of the species. Potential adverse impacts of these activities would be direct and
6367 indirect, short-term to long-term, and negligible to minor, and result from primarily temporary
6368 construction activities.

6369 Watershed restoration and management activities are expected to benefit habitat and biota by restoring
6370 sheet flows across the watershed that may have been altered with respect to volume, timing, duration, and
6371 quality. Reductions in stormwater runoff, sedimentation, and pollutant loadings would be anticipated
6372 throughout the watershed as a result of projects such as wetland treatment ponds, stormwater ponds, and
6373 rain gardens. These activities would reduce the potential impacts associated with impervious surface
6374 cover (e.g., roads, rooftops, parking lots, and driveways), which increases the volume and rate of
6375 stormwater runoff, erosion, and degradation of terrestrial habitats. EPA, together with the states and
6376 territories, regulates and permit certain pollutant sources; however, watershed activities that reduce runoff
6377 would provide further reductions in pollution to coastal waters. Watershed restoration and management
6378 activities would include a combination of stormwater control measures, erosion control practices,
6379 agriculture conservation practices, forestry management practices, and hydrologic restoration that are not
6380 mandated by the CWA.

6381 Benefits would accrue to terrestrial and aquatic biota under the No Action Alternative due to reduced

6382 contaminant loadings (e.g., pesticides and fuel contaminants), improved water and sediment quality,
6383 reduced runoff and associated habitat erosion and disturbance, and restored native vegetation. Long-term
6384 benefits to surface water and ground water would translate to improved terrestrial habitats in the
6385 watershed and corresponding benefits to biota that use these habitats. Expected benefits would be direct
6386 and indirect, short-term and long-term, local, and negligible to moderate.

6387 Disturbances to ESA-listed species and/or critical habitat during watershed restoration and management
6388 activities such as construction of road stabilization, stormwater swales, culverts, or stormwater detention
6389 ponds, would include soil and possibly vegetation excavation, sound, and temporary or permanent loss of
6390 habitat. Animals would leave the area if additional habitat is available and would return once proposed
6391 activities were completed. Benefits to ESA-listed species are expected due to improved habitat, control of
6392 invasive species, and restoration of native habitats. Potential adverse impacts to terrestrial ESA-listed
6393 species would be direct, short-term, local, and negligible to minor. Expected benefits would also be direct,
6394 short-term and long-term, and negligible to moderate.

6395 *4.3.2.2 Alternative 1*

6396 Under Alternative 1, the elimination of current CRCP activities that support coral restoration and
6397 intervention and reduce physical disturbance to corals would have no impacts on terrestrial habitats and
6398 biota due to the locations of those activities.

6399 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to terrestrial habitats and
6400 biota would be the same as described for the No Action Alternative. Potential adverse impacts would be
6401 direct, short-term, local, and negligible. Potential benefits would be direct and indirect, short-term, local,
6402 and negligible to minor, primarily due to information available to support water quality and soils
6403 management efforts.

6404 **Watershed restoration and management.** Potential adverse impacts and benefits to terrestrial habitats
6405 and biota would be the same as described for the No Action Alternative. Potential adverse impacts would
6406 be direct, short-term, local, and negligible to minor. Expected benefits would be direct, short-term and
6407 long-term, and negligible to moderate.

6408 *4.3.2.3 Alternative 2*

6409 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs that are part of
6410 the current CRCP. Implementation of DCMMs alone would have no adverse impacts to terrestrial habitat
6411 and biota. Adverse impacts under Alternative 2 would be similar to the No Action Alternative but may
6412 have additional, negligible reductions in impacts as a result of DCMMs are anticipated.

6413 DCMMs related to activities in the watershed may include additional BMPs to control turbidity and
6414 sediments; prohibition of collection of birds (live or dead), their eggs, nests, or parts (e.g., feathers); and
6415 necessary precautions to prevent injury to any birds or disturbance to any bird nests. These DCMMs
6416 would be applicable to all proposed activities undertaken in the watershed and would avoid potential
6417 adverse impacts to nesting birds and bird nests during monitoring and watershed restoration and
6418 management activities included in the current CRCP. Additional DCMMs may provide further, but likely
6419 negligible, benefits to terrestrial habitats and biota when compared with the No Action Alternative.

6420 **4.3.3 Wetlands and Floodplains**

6421 Wetlands may include freshwater streams, swamps, marshes, prairies, and other areas inundated for at

6422 least a portion of the year. Wetlands are critical to the life cycles of many species of fish and wildlife and
6423 are protected under the CWA as well as EO 11990, which is intended to minimize the destruction, loss, or
6424 degradation of wetlands and requires federal agencies, in planning their actions, to consider alternatives to
6425 wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. Within the
6426 watershed, wetlands often occur within a floodplain, which encompasses the area of potential flooding
6427 from a river, stream, or other waterbody. Because of the potential flooding in these areas, floodplain
6428 management is addressed under EO 11988, which requires federal agencies to avoid, to the extent
6429 possible, the long- and short-term adverse impacts associated with the occupancy and modification of
6430 floodplains and to avoid direct and indirect support of floodplain development wherever there is a
6431 practicable alternative.

6432 *4.3.3.1 No Action Alternative*

6433 CRCP activities under the No Action Alternative evaluated for potential impacts to wetlands and
6434 floodplains include monitoring, mapping, and research, and watershed restoration and management
6435 activities.

6436 **Monitoring, mapping, and research.** Monitoring, mapping, and research activities would be
6437 implemented in wetlands and floodplains. Potential impacts to wetlands and floodplains would be the
6438 same as those described for terrestrial habitats (Section 4.3.2). These activities would provide data to
6439 support management of wetlands and floodplains with respect to erosion, sedimentation, flooding, and
6440 other management efforts. Potential adverse impacts to wetlands and floodplains would be direct, short-
6441 term, local, and negligible due to pedestrian surveys limited to sediment and water quality sampling
6442 activities. Vegetation or wildlife sampling would not be included except for possible observation records.
6443 No activities that would disturb, alter, or otherwise affect hydrology, wildlife, or vegetation are
6444 anticipated. Benefits to wetlands and floodplains would occur due to the use of the information collected
6445 in addressing potential water quality, sedimentation, and erosion issues that may adversely affect
6446 wetlands and floodplains. Potential benefits wetlands and floodplains would be indirect, long-term, local
6447 to large scale, and negligible to moderate.

6448 **Watershed restoration and management.** The implementation of watershed restoration and
6449 management activities that include earthmoving work may disturb terrestrial vegetation and land surfaces.
6450 Impacts would be minimized by implementing BMPs that reduce turbidity and sedimentation and avoid
6451 sensitive habitats. The implementation of watershed restoration activities is likely to affect a small area
6452 and alter riparian, wetland, or upland vegetation and soils. No loss of native habitats is anticipated as
6453 restoration activities tend to be in previously disturbed area, and would be replanted with native or
6454 noninvasive vegetation. Herbicide applications would be consistent with labeled use to avoid potential
6455 impacts to ground or surface waters. Potential adverse impacts would be direct, short-term, local, and
6456 negligible to minor due to disturbances to land surfaces, soils (Section 4.3.1), and water quality (Section
6457 4.3.4).

6458 Watershed restoration and management activities such as LID, stormwater control measures, road and
6459 trail stabilization, and erosion and sediment control practices would reduce erosion and sedimentation in
6460 wetlands and floodplains, potentially restore the water-holding capacity of these areas and restore wetland
6461 habitat for fish and wildlife. Management of stormwater runoff would restore some of the natural
6462 hydrology of wetlands and floodplains, resulting in wetlands and floodplains that can accommodate
6463 floodwaters during peak rainfall periods, recharge aquifers, provide forage habitat for fisheries, reduce the

6464 spread of invasive species, and reduce flooding in uplands. Wetlands and floodplains would provide
6465 detention and passive treatment of stormwater by trapping debris, sediment, and pollutants (e.g.,
6466 chemicals, fertilizers, herbicides, insecticides, salts, oil, and bacteria and solids from livestock, pets, and
6467 faulty septic systems) from stormwater runoff and preventing their entry into downstream and coastal
6468 waters. Federal and state agencies regulate and permit certain pollutant sources; however, watershed
6469 activities that reduce runoff would provide further reductions in pollution to coastal waters.
6470 Implementation of these activities may include one or a combination of stormwater control measures,
6471 erosion control practices, agriculture conservation practices, forestry management practices, hydrologic
6472 restoration, and coastal and riparian conservation techniques that are not previously mandated by the
6473 CWA, resulting in a range of impacts. Potential benefits to wetlands and floodplains from these activities
6474 would be direct and indirect, short- and long-term, local, and negligible to moderate, depending on the
6475 project.

6476 *4.3.3.2 Alternative 1*

6477 Under Alternative 1, the elimination of current CRCP activities that support coral restoration and
6478 intervention and reduce physical disturbance to corals would have no impacts on terrestrial habitats and
6479 biota due to the locations of those activities in the marine environment.

6480 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to terrestrial habitats and
6481 biota would be the same as described for the No Action Alternative. Adverse impacts to wetlands and
6482 floodplains would be direct, short-term, local, and negligible to minor. Potential benefits would be
6483 indirect, long-term, local to large scale, and negligible to moderate, primarily due to information available
6484 to support water quality and sediment management efforts focused on stormwater runoff, as described for
6485 the No Action Alternative.

6486 **Watershed restoration and management.** Potential adverse impacts and benefits to terrestrial habitats
6487 and biota would be the same as described for the No Action Alternative. Adverse impacts to wetlands and
6488 floodplains would be direct, short-term, local, and negligible to minor. Benefits would be direct and
6489 indirect, short-term and long-term, local, and negligible to moderate, depending on the project.

6490 *4.3.3.3 Alternative 2*

6491 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs that are part of
6492 the current CRCP. Implementation of DCMMs alone would have no adverse impacts to wetlands and
6493 floodplains. Adverse impacts under Alternative 2 would be similar to the No Action Alternative but may
6494 have additional, negligible reductions in impacts as a result of DCMMs are anticipated. DCMMs may
6495 require the use of only native or naturalized vegetation, reductions in pesticides, and avoiding planting
6496 during storms. The addition of these would not be expected to result in adverse impacts to wetlands and
6497 floodplains.

6498 DCMMs related to activities in the watershed are focused on reducing water quality degradation and
6499 stormwater runoff. Additional DCMMs may provide further, but likely negligible, benefits to wetlands
6500 and floodplains when compared with the No Action Alternative.

6501 **4.3.4 Water Quality**

6502 Water quality is an issue for coral reefs around the world (Wear and Thurber, 2015). Nonpoint source
6503 runoff from agricultural, transportation, urban development, and urban sources and point source
6504 discharges, such as domestic and industrial wastewater discharges, are well known to affect local water

6505 quality. Effective pollutant reduction, typically at a local level, is critical to reducing these problems
6506 (NAS, 2019). The U.S. EPA (2019) reports sediments and nutrients from stormwater runoff and dredging
6507 for port development as concerns for Florida and Gulf of Mexico coral reefs. In 2010, the U.S. EPA
6508 increased funding to Pacific coral reef jurisdictions to a level comparable to the mainland to implement
6509 wastewater and drinking water infrastructure improvements in Guam, CNMI, and American Samoa
6510 (WWD, 2010).

6511 *4.3.4.1 No Action Alternative*

6512 CRCP activities that have the potential to impact water quality in U.S. coral reef jurisdictions include
6513 monitoring, research, sample collections, watershed restoration projects, coral restoration and
6514 intervention, and reduction in physical impacts to coral reefs (Table 2-1).

6515 **Monitoring, mapping, and research.** Activities that disturb soils or sediments (see Section 4.3.1) also
6516 have the potential to introduce and transport sediments and other pollutants to downstream, coastal, and
6517 marine waters. Impacts to water quality from marine activities such as vessel use involved in monitoring,
6518 sampling, transport of biologic and geologic samples, and SCUBA and snorkeling activities associated
6519 with benthic and water quality sampling would be limited to the duration of the activity. The temporary
6520 nature of these impacts would not be expected to alter the water quality of coastal and marine waters.
6521 Geotechnical evaluations and water quality sampling prior to construction would have no impact on water
6522 quality. Adverse impacts would be small and related to disturbances from equipment, vehicles, vessels,
6523 and divers engaged in the activities, as described for sediments and soils (Section 4.3.1). Adverse impacts
6524 to water quality in the watershed would be direct, short-term, local, and negligible (small project or little
6525 to no disturbance in the watershed) to minor (larger projects). Adverse impacts to coastal and marine
6526 waters may occur due to resuspension of bottom sediments or inadvertent release of fuels, lubricants used
6527 on instruments, or sealing epoxies to reinforce a loose stake; however, they are expected to be direct,
6528 short-term, local, and negligible to minor adverse impacts to water quality (NCCOS EA, 2016 [Section
6529 4.1.1]; NOAA, 2013 [Section 4.1.1]; CRED PEA 2010 [Sections 7.4 and 7.5]). Potential impacts to water
6530 quality from unintended fuel, lubricant, sewage and garbage spills, vessel operation, and other activities
6531 described here were also evaluated as part of the ONMS PEA 2018 and were found to have less than
6532 significant impacts on water quality (Section 4.1.1). Potential benefits to water quality would be indirect,
6533 long-term, local to large scale, and negligible for watershed monitoring (e.g., projects that sample water
6534 quality in a single stream reach) that captures data potentially critical to managing and improving water
6535 quality.

6536 **Coral restoration and intervention.** Sediment disturbance and resuspension into the water column due
6537 to vessels and other in-water activities during coral restoration and intervention activities would have
6538 relatively small adverse impacts, as described for sediment impacts (Section 4.3.1.1), while the
6539 development of coral nursery areas would result in greater disturbance due to the areal extent and
6540 potential duration of activities. Coral reefs require good water quality but do not directly affect water
6541 quality because they are not filter feeders. However, coral reefs buffer shorelines and shoreline habitats
6542 from erosion and sedimentation due to storms and other events, and restoration of corals would support
6543 subsequent increases in local water quality due to stabilization of sediments and reduced scour and
6544 erosion. Adverse impacts to water quality would be direct, short-term, local, and range from negligible to
6545 minor impacts (NOAA RC PEIS 2015 [Section 4.5.2.6]; NOAA PDARP/PEIS 2016 [Section 6.4.11]) due
6546 to implementation of restoration activities. However, benefits to water quality from coral restoration and

6547 intervention would be direct, short-and long-term, local, and negligible to minor due to potential
6548 stabilization of sediments following completion of projects.

6549 **Watershed restoration and management.** A nationwide assessment of streams in the U.S. found 42% of
6550 monitored stream segments in poor condition, primarily due to nitrogen, phosphorus, streambed
6551 sediments, and riparian disturbance (Paulsen et al., 2008). The poor conditions were attributable primarily
6552 to watershed development that results in changes in channel morphology, water quantity, and water
6553 quality (Richardson et al., 2011). Under the No Action Alternative, watershed activities, such as road
6554 stabilization, stormwater ponds, revegetation projects, and constructed wetlands projects, would be
6555 implemented to reduce the delivery of pollutants into nearshore waters where coral reefs are present.
6556 Potential impacts to water quality from these or similar activities were analyzed previously as part of the
6557 NOAA RC PEIS 2015 (Section 4.5.2.6) and the NOAA PDARP/PEIS 2016 (Section 6.4.1) and adverse
6558 impacts were not found to be significant.

6559 The construction of some watershed restoration projects may alter drainage patterns. For most runoff
6560 scenarios, BMPs would be used to reduce the runoff of sediments and other pollutants into downstream
6561 waters during construction and initial implementation. Construction activities have the potential for fuel
6562 leaks or other hazardous materials spills, and response measures would be taken to avoid spills and/or
6563 clean up after a spill to avoid hazardous materials seeping into the groundwater and/or flowing into
6564 downstream waters. BMPs such as silt fences, vegetation planting, temporarily stopping work during rain
6565 and approaching rain, and other BMPs (Appendix A) would reduce potential runoff from construction
6566 activities into downstream and coastal waters. Adverse impacts to water quality in the watershed from
6567 these activities would be direct, short-term, local, and negligible to minor.

6568 Adverse impacts to coastal and marine water quality are expected to be direct, short-term, local, and
6569 negligible to minor. Sediment from the watershed is primarily deposited in nearshore areas and
6570 subsequently resuspended by tide and wind events (Bartley et al., 2014), affecting nearshore water quality
6571 (Fabricius et al., 2014). Benefits of watershed restoration and management activities include reduced
6572 introduction of sediments, nutrients, and other pollutants into coastal waters due to reduced nonpoint
6573 source runoff and river discharges. Benefits to water quality from watershed restoration and management
6574 activities are anticipated to be direct and indirect, long-term, local, and negligible (e.g., a baffle box to
6575 capture debris from a single building) to moderate (e.g., a wetland treatment pond to capture and
6576 passively treat runoff from an entire basin) as a result of reduced pollutant loading to coastal and marine
6577 waters. These benefits would be important to improving the overall water quality by reducing nonpoint
6578 source runoff to coastal and marine environments.

6579 Reducing the amount of sediment and other pollutants added to downstream and coastal waters will not
6580 alter the legacy accumulations of sediments and other pollutants from point and nonpoint sources that
6581 have already accumulated and may continue to adversely impact water quality in coastal and marine
6582 waters. For example, Van Meter et al. (2018) demonstrated that even with no additional agricultural
6583 nitrogen loadings to the Gulf of Mexico, it would be decades before nitrogen reduction goals were
6584 reached in the Gulf because of the historic nitrogen loadings from the Mississippi River basin. Lags in
6585 water quality improvements may range from months to years for shorter-lived contaminants such as
6586 bacteria, and years to decades for excessive phosphorus levels in agricultural soils, and decades or more
6587 for sediment accumulated in river systems (Meals et al., 2010). The time delay between implementation
6588 of projects and measurable improvements in water quality may also delay the detection of improvements

6589 in water quality for years or even decades. Groundwater travel time may also delay detection of the
6590 benefits of agricultural BMPs on water quality. Furthermore, contamination from degraded microplastics
6591 may travel also in the water column or accumulate in sediments.

6592 Consequently, impacts of watershed project activities, while beneficial, are likely to be indirect and
6593 benefits are expected to accrue over the long-term rather than the short-term.

6594 **Reducing physical impacts to coral reef ecosystems.** Permanent mooring buoys would reduce the
6595 number of temporary anchorings and, therefore, the potential for entry of sediments and sediment-bound
6596 contaminants into the water column, resulting in improved water clarity and quality. Potential adverse
6597 impacts to water quality during mooring buoy installation may occur due to sediment disturbance and
6598 resuspension and would be direct, short-term, local, and negligible to minor. Potential benefits of
6599 permanent mooring buoys, which would vary by location, would be direct and indirect, short- and long-
6600 term, local, and negligible to minor, depending on the level of activity (i.e., number of boaters) in an area
6601 and the number of boaters using mooring buoys rather than anchoring in areas where they may contact
6602 and/or physically injure coral reefs or other habitats.

6603 Water quality can also be impacted by the removal, remobilization, and transport of debris. Creosote from
6604 pilings, fuel from abandoned vessels, chemicals from appliances, and other solid waste may be released or
6605 spread into the aquatic environment through removal activities. BMPs would minimize sediment
6606 disturbance, total suspended solids in the water column, and potential fuel releases. Removal of marine
6607 debris would directly reduce the physical impacts of the debris, as well as the potential contamination
6608 from fuel, microplastic contaminants, and other associated pollutants, as described in Section 4.3.1.1 and
6609 presented in Section 5.2.1 of the MDP PEA 2015. Potential adverse impacts of installing mooring buoys
6610 and removing debris would be expected to be direct, short-term, local, and negligible to minor.
6611 Significant adverse impacts to water quality are not anticipated (MDP PEA, 2015). Potential benefits of
6612 these activities on water quality would be direct and indirect, short- and long-term, local, and negligible to
6613 minor, depending on the amount and location of the debris being removed.

6614 *4.3.4.2 Alternative 1*

6615 Under Alternative 1, current CRCP activities that support coral restoration and intervention and reduce
6616 physical disturbance to corals (Table 2-1) would be eliminated.

6617 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to water quality from
6618 monitoring, mapping, and research activities would be the same as described for the No Action
6619 Alternative.

6620 **Coral reef restoration and interventions.** Eliminating coral restoration and intervention activities would
6621 result in the continued decline and loss of coral reefs and associated habitats (e.g., seagrasses, mangroves,
6622 and shorelines) and potential increases in resuspension of sediments into the water column that were
6623 formerly stabilized by the coral reef structure. Elimination of coral restoration and intervention activities
6624 would not significantly affect water quality, given the negligible to minor adverse impacts of these
6625 activities on water quality described for the No Action Alternative. Potential adverse impacts to water
6626 quality not in the absence of these activities.

6627 **Watershed restoration and management.** Potential adverse impacts and benefits to water quality would
6628 be the same as described for the No Action Alternative.

6629 **Reducing physical impacts to coral reef ecosystems.** Elimination of coral restoration activities,
6630 including installation of mooring buoys and debris removal, would not significantly affect water quality
6631 based on the negligible to minor impacts of these activities on water quality described for the No Action
6632 Alternative. Potential impacts to water quality due to these activities are primarily due to the potential
6633 introduction of sediments and sediment-bound contaminants (Section 4.3.1.1) into the water column.
6634 Increased and multiple anchorings, corresponding increases in disturbed sediments and resuspension of
6635 sediments, and continued accumulation and persistence of debris on the seafloor would, therefore, have
6636 potential adverse impacts on the water column. Potential adverse impacts to water quality from continued
6637 anchoring, debris accumulation, and other damage would be direct, short- and long-term, local, and
6638 negligible to minor. No benefits to water quality are anticipated.

6639 Adverse impacts to water quality under this alternative would be direct and indirect, short- and long-term,
6640 local, and negligible to minor due to continued resuspension of sediments and sediment-bound pollutants
6641 from anchoring and accumulation of marine debris, as described for sediments in Section 4.3.1.1. Benefits
6642 of monitoring, mapping, and research would continue to provide information critical to water quality
6643 improvement and management. Watershed restoration and management activities would continue to
6644 improve water quality. The overall benefits to water quality may be negligibly reduced by eliminating
6645 debris removal activities. Potential benefits to sediments would be direct, short- to long-term, local, and
6646 negligible to moderate.

6647 *4.3.4.3 Alternative 2*

6648 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs already
6649 implemented under the No Action Alternative. Implementation of DCMMs alone would have no adverse
6650 impacts to water quality. Adverse impacts under Alternative 2 would be similar to the No Action
6651 Alternative but may have additional, negligible reductions in impacts as a result of DCMMs are
6652 anticipated.

6653 DCMMs may include increasing the capacity for greater supervision over dive activities, BMPs to control
6654 turbidity and sediment, greater restrictions on instrument mooring, prioritizing the use of recreational
6655 mooring buoys or live boating, additional training to vessel operators, and stopping restoration work
6656 during or when a storm is approaching and during coral spawning periods. Additional reductions in
6657 sediment resuspension during in-water activities, stormwater runoff from the watershed, and turbidity and
6658 sediments during, for example, debris removal, as a result of additional DCMMs may provide further, but
6659 likely negligible, benefits to water quality when compared with the No Action Alternative. Potential
6660 benefits to water quality would be similar to, but negligibly greater than, those described under the No
6661 Action Alternative.

6662 **4.4 Biological Environment**

6663 *4.4.1 Seagrasses*

6664 Distribution patterns of seagrass meadows are influenced by physical (waves, tides, light availability,
6665 etc.), geological (sediment grain size), and geochemical factors (Koch, 2001). Turtle grass (*Thalassia*
6666 *testudinum*) and manatee grass (*Syringodium filiforme*) are the most common seagrasses in tropical waters
6667 off the coast of Florida and throughout the Caribbean and the Gulf of Mexico. Shoal grass (*Halodule*
6668 *wrightii*) is another seagrass common to the tropical Atlantic, but its distribution also includes Africa, the
6669 Indian Ocean, and the west coast of Mexico. Seven species of seagrasses are associated with clear waters

6670 and shallow reefs in the Atlantic, while the tropical Indo-Pacific has as many as fourteen species
6671 occurring together on reef flats and in deeper waters (Short et al., 2007). Seagrasses are typically
6672 characterized by greater variability in environmental parameters when compared to coral reefs and may
6673 provide sites for coral colonization (Lohr et al., 2017). Although requirements vary among species, all
6674 depend on appropriate sediment, salinity, light, water clarity, and nutrient conditions. The CRCP
6675 activities alter these physical conditions or directly disturb or damage substrates would also have the
6676 potential to adverse impact seagrasses by reducing light availability to seagrasses. Some species are
6677 slower growing and less resistant to perturbation, such as among Pacific species including *Enhalus*
6678 *acoroides*, the ephemeral species *Halodule uninervis*, *H. ovalis*, and *Cymodocea serrulata*, which may be
6679 associated with increased sediment accretion (Coles et al., 2011). Impacts presented here are consistent
6680 with those presented in the NOAA RC PEIS 2015 and NOAA PDARP/PEIS 2016. However, the CRCP
6681 activities could result in spreading of the invasive *Halophila stipulacea* under any alternative, which
6682 could be a potential long-term, minor adverse impact to coral reef and seagrass ecosystems.

6683 Johnson's seagrass (*Halophila johnsonii*) is the only marine plant species listed under the ESA. This
6684 seagrass species occurs in coastal waters off the east coast of Florida. Johnson's seagrass is listed as
6685 threatened due to its limited geographic range and habitat loss. Johnson's seagrass is adversely impacted
6686 by boating activities, habitat degradation, storm action and sedimentation, poor water quality, and
6687 excessive algal growth.

6688 4.4.1.1 No Action Alternative

6689 Proposed CRCP activities that would potentially affect seagrasses include monitoring, research and
6690 sample collections, watershed restoration, coral restoration and intervention, and reductions in physical
6691 impacts to coral reefs (Table 2-1).

6692 **Monitoring, mapping, and research.** Monitoring and research activities under the current CRCP may
6693 include stainless steel pin marker installation, moored sensor installation, SCUBA/snorkeling, sample
6694 collection, and vessel, ROV, and AUV use in (or in the vicinity of) seagrasses. These activities would
6695 result in minor sediment disturbance and resuspension into the water column and temporary, short-term
6696 reductions in water clarity and light availability (see Section 4.3.4) that would subside once activities
6697 were discontinued. Collection of seagrasses may occur, resulting in direct, short-term, minor, adverse loss
6698 of seagrasses because the seagrasses would grow back. Potential adverse impacts to seagrasses as a result
6699 of these activities would be direct, short-term, local, and negligible to minor (NOAA, 2013) (Sections
6700 5.1.2-5.1.3). The CRED PEA 2010 (Section 3.3.2) concluded that these activities would have at most
6701 minor, temporary (short-term) impacts to benthic cover (e.g., seagrasses) associated with coral reefs in the
6702 U.S.-affiliated Pacific Islands. Similarly, potential impacts to seagrasses and other benthic habitats in the
6703 National Marine Sanctuaries in the U.S. southeast Atlantic and Gulf of Mexico were considered
6704 temporary and negligible to minor as a result of monitoring activities that included vessel and equipment
6705 use, deployment of equipment and monitoring buoys, and sampling activities (ONMS, 2018 [Section
6706 4.1.1]). The similarity in our proposed activities and corresponding analyses to these previous studies
6707 support similar conclusions for the proposed activities. Under the proposed alternative, seagrasses are not
6708 directly monitored but may be included in benthic samples. Collection of sediment data would benefit
6709 seagrasses indirectly by supporting mapping that identifies sand bottom habitats safe for anchoring.
6710 Benefits would be indirect, long-term, local, and negligible to moderate benefits, based on the location
6711 and areal extent of seagrass beds with respect to the proposed activities.

6712 **Coral restoration and intervention.** Equipment impacts associated with coral restoration and
6713 intervention would be the same as those described above for the No Action Alternative monitoring
6714 activities. Coral proposed activities, such as transplanting, invasive and nuisance algae control/removal,
6715 and urchin outplanting, that require crossing or traversing seagrasses would potentially result in physical
6716 damage to seagrasses proximate to coral reefs where work is being performed. However, there are
6717 minimal coral restoration project types that would require direct contact with seagrasses. Regular
6718 maintenance of moorings and the monitoring of surrounding seagrass are required to ensure that these
6719 moorings are operating effectively. BMPs would reduce damage to seagrass habitat through activities
6720 such as anchoring work vessels or preventing unintentional introduction of non-native species. Recovery
6721 of corals would eventually increase protection of seagrasses from ocean waves and storms. Overall,
6722 potential adverse impacts of coral reef restoration activities on seagrasses are expected to be direct, short-
6723 term, local, and minor due primarily to physical disturbance during in-water activities (NOAA RC PEIS,
6724 2015[Section 4.5.2.6]; NOAA PDARP/PEIS, 2016c [Section 6.4.11]). Benefits to seagrasses from coral
6725 restoration include stabilized substrates and reduced erosion due to wave energy buffering effects of coral
6726 reefs. Benefits to seagrasses due to these activities are anticipated to be indirect, long-term, local, and
6727 negligible to moderate, depending on the extent of seagrasses and coral reefs to be affected.

6728 **Watershed restoration and management.** Construction of watershed management projects such as
6729 culverts, baffle boxes, elevated boardwalks with pilings, and LID would disturb and/or remove soils due
6730 to staging and cleaning areas, workers, and possibly heavy equipment used to excavate or rearrange soils.
6731 These activities could result in the subsequent delivery of sediments and other pollutants to downstream
6732 waters during construction, which may reduce water quality and clarity and adversely impact seagrass
6733 health. Construction BMPs (Appendix A) would reduce the potential release of sediments and other
6734 pollutants from the project site, and introduction into coastal and marine waters is unlikely, depending on
6735 the distance between the project area and coastal waters. In addition, without watershed restoration and
6736 management activities, declines in seagrasses are anticipated in areas where high nutrient and sediment
6737 loads occur. The rate and extent of coastal development would not be affected by continued
6738 implementation of the CRCP under the No Action Alternative and direct adverse impacts to seagrasses
6739 due to dredging and filling, coastal development, land reclamation, dock and jetty construction, and some
6740 fisheries and aquaculture practices, would continue (Gregg et al., 2013). Implementation of these
6741 activities is expected to result in short-term erosion and sedimentation, and potential adverse impacts to
6742 seagrasses would be direct, short-term, local, and negligible.

6743 Watershed restoration and management activities would reduce sediment and nutrient loads into coastal
6744 areas where seagrasses occur due to improved water clarity and light availability, as described for water
6745 quality (Section 4.3.4) and demonstrated for several projects. For example, regional-scale agricultural
6746 runoff from the mainland Everglades and local sewage discharges from the Florida Keys are significant
6747 nitrogen inputs that contribute to eutrophication and algal blooms in seagrass and coral reef communities
6748 in the Lower Florida Keys (Lapointe et al., 2004). Reduced stormwater runoff and freshwater flows
6749 would potentially reduce scour and erosion and shift the saltwater-freshwater interface. In Tampa Bay,
6750 Florida, point-source nutrient reductions over the past two decades reduced total nitrogen loads and water
6751 clarity by 50% and were followed by a recovery of 27 km² (17mi²) of seagrasses since 1982 (Tomasko et
6752 al., 2018). Benefits to seagrasses as a result of improved water quality are anticipated to be indirect, long-
6753 term, local, and negligible to moderate.

6754 **Reducing physical impacts to coral reef ecosystems.** Construction and installation of mooring buoys

6755 and removal of debris would disturb sediments and cause temporary sediment plumes and increases in
6756 turbidity; however, effects have been found to be negligible (see Section 4.3.1). During installation of
6757 mooring buoys, temporary adverse impacts to adjacent seagrasses may occur due to sediment
6758 resuspension that may occur due to installation activities and resulting sediment disturbances. Impacts
6759 may also occur due to more visitors, who may be attracted to an area due to the presence of mooring
6760 buoys, and subsequent vessel activity. Mooring buoys would not be placed in seagrass so that direct
6761 physical damage from mooring buoys would be avoided.

6762 Permanent mooring buoys would reduce the numbers of temporary anchorings and reduce the damage
6763 due to anchors and chains that are dropped into seagrasses and/or chains that scrape the seafloor as they
6764 are moved by tides, currents, and wind (Morrisey et al., 2018), thereby reducing potential future impacts
6765 to seagrasses. The NPS EIS 2015 concluded that the installation of mooring buoys and volunteer debris
6766 cleanups would result in short-term, local, minor, and adverse impacts to submerged substrates.
6767 Disturbance at a debris removal restoration site would occur during the debris removal process, generally
6768 several minutes to a few hours, but larger items may take potentially longer. Human and equipment
6769 access to a site for debris removal may cause minor damage to habitat and species through trampling,
6770 sound, displacement, and unintentional introduction of invasive species. BMPs for vehicle staging, fuel
6771 storage, erosion and pollutions control, and species decontamination would be used to minimize impacts
6772 of construction-related impacts to seagrasses (Section 4.4.1).

6773 Potential adverse impacts to seagrass habitat would be direct, short-term, local, and negligible to minor.
6774 Benefits to seagrasses from installation of permanent mooring buoys and removal of debris would include
6775 restored habitat, reduced potential for contamination, and reduced disturbance due to potential debris
6776 movement, resulting in potential direct and indirect, long-term, local, and negligible to moderate benefits
6777 due to the potential for sea floor, and therefore seagrass bed, stabilization.

6778 *4.4.1.2 Alternative 1*

6779 Under Alternative 1, current CRCP activities that support coral restoration and intervention and reduce
6780 physical disturbance to corals would be eliminated.

6781 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to seagrasses from
6782 monitoring, mapping, and research activities would be the same as described for the No Action
6783 Alternative.

6784 **Coral reef restoration and interventions.** Eliminating coral restoration and intervention activities would
6785 eliminate potential disturbances due to coral nursery development, transplanting, urchin propagation,
6786 invasive and nuisance algae control, and corallivore and disease control that may also impact proximate
6787 seagrass habitat. However, the potential reduction in adverse impacts to seagrasses, like the potential
6788 impacts themselves, would be negligible. Benefits to seagrasses from the potential recovery of corals,
6789 such as stabilized sediments and protection from high energy waves and erosion, would not occur under
6790 this Alternative. Potential adverse impacts to seagrasses would be direct, long-term, local, and negligible
6791 to moderate. No benefits to seagrasses are expected.

6792 **Watershed restoration and management.** Potential adverse impacts and benefits to seagrasses would be
6793 the same as described for the No Action Alternative.

6794 **Reducing physical impacts to coral reef ecosystems.** Under this alternative, sediment disturbances from

6795 continued and future anchoring would result in further damage and loss of seagrasses due to direct
6796 impacts from anchors, especially in areas with more development and/or high visitor use that would be
6797 more vulnerable to potential impacts of vessel anchoring. Corresponding sediment disturbances and
6798 resuspensions (described in Sections 4.3.1 and 4.3.4) that reduce water clarity and light availability to
6799 seagrasses, potentially leading to indirect damage and mortality among seagrasses, would also continue.
6800 Eliminating this portion of the CRCP would not affect debris removal that occurs under NOAA's
6801 extensive Marine Debris Program. However, for areas where debris removal does not occur, debris such
6802 as derelict fishing gear and vessels would remain on the seafloor, and the potential for continued physical
6803 damage to seagrasses from debris, as well as indirect loss due to degraded water quality and sediments
6804 from accumulated marine debris, would also persist. Potential adverse impacts to seagrasses from
6805 continued damage due to anchoring and debris accumulation would be direct, short- and long-term, local,
6806 and negligible to moderate. No benefits to seagrasses are anticipated as a result of eliminating the
6807 installation of permanent mooring buoys and debris removal since anchoring may still occur in seagrass
6808 beds in areas where mooring buoys are not present.

6809 Potential adverse impacts to seagrasses under this alternative would be direct, short- and long-term, local,
6810 and negligible to moderate due to continued damage from anchoring and accumulation of marine debris.
6811 Monitoring, mapping, and research activities would continue to provide information critical to
6812 conservation and management of seagrasses. Watershed restoration and management activities would
6813 continue to reduce sediment and other pollutant loads and improve water clarity in coastal waters and
6814 therefore benefit seagrasses. However, the overall benefits would be reduced due to the exclusion of the
6815 components of the CRCP that directly address impacts of anchoring and marine debris and coral reef
6816 restoration in coastal and marine waters. Therefore, overall potential benefits to seagrasses would be
6817 direct, short- to long-term, local, and negligible to minor.

6818 *4.4.1.3 Alternative 2*

6819 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs under the
6820 current CRCP. Implementation of DCMMs alone would have no adverse impacts to seagrasses. Adverse
6821 impacts under Alternative 2 would be the same as those for the No Action Alternative but may have
6822 additional, negligible reductions as a result of DCMMs, depending on the activity.

6823 DCMMs may include increasing the capacity for greater supervision over dive activities, BMPs to control
6824 turbidity and sediment, greater restrictions on instrument mooring, prioritizing the use of recreational
6825 mooring buoys or live boating, additional training to vessel operators, and stopping restoration work
6826 during or when a storm is approaching and during coral spawning periods. These activities would further
6827 reduce physical disturbance of soils and sediments in the watershed and in coastal and marine waters and,
6828 therefore, reduce the potential for impacts to seagrasses from reduced water quality. Additional reductions
6829 in sediment resuspension during in-water activities, stormwater runoff from the watershed, and turbidity
6830 and sediments during, for example, debris removal, as a result of additional DCMMs may provide further,
6831 but likely negligible, benefits to seagrasses when compared with the No Action Alternative. Potential
6832 benefits to seagrasses would be similar to, but negligibly greater than, those described under the No
6833 Action Alternative.

6834 *4.4.2 Mangroves*

6835 Mangroves are affected by freshwater inputs, water chemistry and salinity, sedimentation, and
6836 competition from other species such as saltmarsh cordgrass (*Spartina alterniflora*). Along shorelines,

6837 mangroves stabilize coastal sediments and habitats during non-storm conditions, while live corals and
6838 seagrasses buffer the impacts of storms (Guannel et al., 2016).

6839 Mangroves are important habitat in their native areas of distribution but are considered an invasive
6840 species in Hawaii where their introduction (circa 1912) adversely impacts habitat quality for water birds,
6841 cultural sites, and biological communities (DLNR, 2013). Other adverse impacts of invasive mangroves
6842 in Hawaii include colonization by introduced barnacles and other nonnative macrofauna (Demopolous
6843 and Smith, 2010); altered coastal hydrodynamics, nearshore sedimentation, and benthic community
6844 structure; and mangroves have replaced native habitats that support wetland birds, including the endemic
6845 Hawaiian stilt (*Himantopus mexicanus knudseni*), Hawaiian coot (*Fulica americana alai*) and Hawaiian
6846 duck (*Anas wyvilliana*). Potential impacts to mangroves are presented for the analysis of consequences for
6847 both watershed and coastal and marine activities due to their location at the interface of land and coastal
6848 waters. Potential adverse and beneficial impacts to mangroves are described here and are consistent with
6849 those described in NOAA RC PEIS 2015 and NOAA PDARP/PEIS 2016.

6850 *4.4.2.1 No Action Alternative*

6851 Proposed CRCP activities analyzed for potential impacts to mangroves under the No Action Alternative
6852 include monitoring, research and sample collections, watershed restoration, coral restoration and
6853 intervention, and activities to reduce physical impacts to corals (i.e., permanent boat mooring installation,
6854 and marine debris removal activities [Table 2-1]). Mangroves are considered native unless identified as
6855 invasive.

6856 **Monitoring, mapping, and research.** Mangroves are not typically monitored as part of the CRCP.
6857 However, monitoring, mapping, and research activities that occur in mangroves would have impacts
6858 similar to those described for soils and sediments (Section 4.3.1) due to small disturbances during
6859 activities such as diving/snorkeling, placement and retrieval of oceanographic instruments, sediment
6860 traps, or traps for collecting fish and invertebrates and associated disturbances of anchoring to sites that
6861 require boat access. Sediment sampling within mangroves may occur and therefore would temporarily
6862 disturb sediments in which mangroves grow. However, sampling would be limited in terms of numbers
6863 and volume of sediment and no adverse impacts to mangroves would be expected. Adverse impacts to
6864 sediments and soils, and thus mangroves, from these activities have been determined to be direct, short-
6865 term, localized, and negligible to minor, and not significant as a result of these activities. Benefits to
6866 mangroves from monitoring, mapping, and research activities include increased acquisition of data critical
6867 to management decisions regarding long-term conservation of these systems and would be indirect, long-
6868 term, local, and negligible to minor.

6869 **Coral restoration and intervention.** Coral reef restoration activities would occur seaward of mangrove
6870 forests, and vessel, SCUBA, and other in-water activities may result in negligible increases in wave
6871 energy due to vessel activity, but exposure would be no greater than fishing and other vessels that already
6872 occur nearby and no additional impacts are expected. Therefore, no adverse impacts to mangroves from
6873 coral restoration and intervention activities are anticipated. Potential benefits to mangroves from coral
6874 reef restoration include increased stabilization of coastal sediments and corals, reduced wave energy
6875 landward of coral reefs, and reduced potential for erosion of mangroves. For example, mangroves are
6876 buffered from storm impacts by coral reefs, while mangroves have been shown to intercept and reduce the
6877 sediment load to fringing reefs by 30% (e.g., Palau) (Victor et al., 2004). In Hawaii, the buffering effect
6878 of coral reefs protects invasive mangroves. While loss of coral reefs would potentially increase erosional

6879 stress on the invasive species, it would also adversely impact native shoreline species. Mangroves were
6880 absent from Hawaii due to geographic isolation, not wave energy, and their decline in the islands from
6881 erosion is unlikely. Potential benefits to mangroves due to erosion protection from sustained and/or
6882 recovered coral reefs would be direct and indirect, short- and long-term, local, and negligible to minor.

6883 **Watershed restoration and management.** In addition to small projects such as erosion control berms or
6884 swales, stormwater treatment wetlands may be constructed as part of the CRCP and may be vegetated as a
6885 marsh, mangrove, or other type of wetland, to collect and passively treat runoff from the watershed.
6886 However, these wetlands would not be constructed within a mangrove (or other wetland). Impacts to
6887 mangroves would most likely result from upstream activities that deposit sediment and other pollutant
6888 loads downstream, as described previously (Section 4.3.4). BMPs to reduce runoff from construction
6889 areas (Appendix A) would further reduce the potential for adverse impacts to mangroves (including
6890 invasive mangroves). Potential adverse impacts would be expected to be indirect, short-term, local, and
6891 negligible to minor due to the distance over which the runoff would have to be conveyed to have impacts.

6892 Without the proposed activities, mangroves would be likely to continue to be adversely impacted by
6893 sediment and other pollutants from uncontrolled stormwater runoff. Mangroves can be damaged by fine
6894 sediments that cover prop roots, excessive nutrient loading, and/or inundation for long periods (Gregg &
6895 Karazsia, 2013). Mangrove roots can become buried from sediment in watershed runoff, resulting in
6896 reduced root and soil gas exchange, altered biogeochemical cycles, reduced microbenthic diversity, and
6897 adverse impacts to adjacent reef fisheries and other habitats (Ellis et al., 2004; Caugati et al., 2018).
6898 Sedimentation rates in unimpacted mangroves range from less than 5 mm/year (0.2 in/year) to
6899 approximately 10 mm/year (0.4 in/year) (Ellison, 1998), and within a tolerable range of elevations, new
6900 plants can survive and expand with the sedimentation. However, long periods of root inundation can also
6901 result in mangrove death due to lack of oxygen. Watershed restoration that reduces erosion and
6902 stormwater runoff would detain or redirect stormwater across/through swales, rain gardens, restored and
6903 planted landscapes, further reducing the potential for downstream sediment and other pollutant loads that
6904 may otherwise result in burial and/or contamination of coastal areas where mangroves occur. Overall,
6905 benefits to mangroves (including invasive mangroves) are expected to be direct and indirect, long-term,
6906 local and larger scale, and negligible to moderate.

6907 **Reducing physical impacts to coral reef ecosystems.** Vessel activities associated with the installation of
6908 mooring buoys and debris removal in proximity to mangroves may result in temporary turbidity plumes,
6909 increased turbidity and wave action, and potential erosion of mangrove habitat, as well as possible
6910 inadvertent fuel or chemical spills or leaks. However, mangrove communities frequently absorb and
6911 dissipate wave energy from storm events greater than that anticipated from vessel activities. Increased
6912 mooring buoys may attract more visitors to areas where mangroves are present and result in physical
6913 impacts of vessels with mangroves. BMPs to reduce disturbance during these activities are included in the
6914 CRCP and would minimize potential erosion and accidental fuel spills by implementing BMPs. Potential
6915 adverse impacts to mangroves on the seaward side of the coast would be direct, short-term, local, and
6916 negligible to minor. Reducing the number of anchorings and the amount of accumulated marine debris
6917 would reduce the potential for adverse impacts to mangroves from physical disturbance of anchoring and
6918 marine debris and the potential for contamination (NPS EIS, 2015 [Section 5.1]; MDP PEA, 2013
6919 [Section 5.2.3]). Restored coral reefs would benefit mangroves by reducing the adverse impacts of storm-
6920 related waves and erosion to mangroves. Benefits to mangroves would be direct and indirect, short- and
6921 long-term, local, and negligible to minor depending on proximity to coral reef projects.

6922 *4.4.2.2 Alternative 1*

6923 Under Alternative 1, the current CRCP activities that support coral restoration and intervention and
6924 reduce physical disturbance to corals would be eliminated.

6925 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to mangroves from
6926 monitoring, mapping, and research activities would be the same as described for the No Action
6927 Alternative.

6928 **Coral reef restoration and interventions.** Eliminating coral restoration and intervention activities would
6929 result in declines in coral reefs and coral reef recovery (Section 4.4.3) and would subsequently affect
6930 coastal mangrove communities. Potential impacts to mangroves would include increasing erosion and
6931 scour associated with reduction in the buffering of wave energy that occurs due to coral reefs (Section
6932 4.4.3). Potential adverse impacts to mangroves would be indirect, long-term, local, and negligible to
6933 moderate. No benefits to mangroves are expected as a result of excluding these activities.

6934 **Watershed restoration and management.** Potential adverse impacts and benefits to mangroves would
6935 be the same as described for the No Action Alternative.

6936 **Reducing physical impacts to coral reef ecosystems.** Excluding the installation of permanent mooring
6937 buoys would result in continued multiple anchoring and subsequent physical damage to habitats in which
6938 the anchors are dropped. In addition to physical impacts, multiple anchoring would result in resuspension
6939 of sediments and possibly sediment-bound contaminants into the water column and/or into coastal
6940 habitats such as mangroves (NPS EIS, 2015; MDP PEA, 2013). In the absence of their removal, derelict
6941 fishing gear, vessels, and other debris would continue to accumulate in mangroves, resulting in
6942 subsequent physical disturbance and potential contamination due to fuels or other pollutants (see Section
6943 4.4). Eliminating this portion of the CRCP would not affect debris removal that occurs under NOAA's
6944 Marine Debris Program. However, without the installation of additional mooring buoys, chronic anchor
6945 damage to coral reefs, especially in highly visited areas, would not be addressed and further damage to
6946 the reef as debris such as vessels rock or are dragged across the sea floor due to wave or wind energy.
6947 Potential adverse impacts would be direct, short- to long-term, local, and negligible to minor. No benefits
6948 to mangroves would be expected.

6949 Overall, the reduction in CRCP activities under Alternative 1 would be expected to have direct and
6950 indirect, long-term, local, and negligible to moderate adverse impacts to mangroves due to physical
6951 disturbance, damage, and/or contamination from existing and future erosion, sediment deposition, and
6952 persistent and accumulating marine debris. Monitoring, mapping, and research activities would continue
6953 to provide information critical to conservation and management of corals. Watershed restoration and
6954 management activities would continue to reduce sediment and other pollutant loads and improve water
6955 clarity in coastal waters and benefit corals and associated benthos. However, the overall benefits of
6956 watershed restoration and monitoring, mapping, and research would be reduced due to the exclusion of
6957 the components of the CRCP that directly address the impacts of anchoring and debris removal on coral
6958 reefs and associated habitats. Therefore, overall potential benefits would be direct and indirect, short- to
6959 long-term, local, and negligible to minor.

6960 *4.4.2.3 Alternative 2*

6961 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs under the
6962 current CRCP. Implementation of DCMMs alone would have no adverse impacts on mangroves. Adverse

6963 impacts under Alternative 2 would be the same as those for the No Action Alternative but additional,
6964 negligible reductions in impacts as a result of DCMMs are anticipated.

6965 DCMMs may include increasing the capacity for greater supervision over dive activities, BMPs to control
6966 turbidity and sediment, greater restrictions on instrument mooring, prioritizing the use of recreational
6967 mooring buoys or live boating, additional training to vessel operators, and stopping restoration work
6968 during or when a storm is approaching and during coral spawning periods. These activities would further
6969 reduce physical disturbance of soils and sediments in the watershed and in coastal and marine waters and,
6970 therefore, reduce the potential for impacts to mangroves from reduced water quality. Additional
6971 reductions in sediment resuspension during in-water activities, stormwater runoff from the watershed, and
6972 turbidity and sediments during, for example, debris removal, as a result of additional DCMMs may
6973 provide further, but likely negligible, benefits to mangroves when compared with the No Action
6974 Alternative. Potential benefits to mangroves would be similar to, but negligibly greater than, those
6975 described under the No Action Alternative.

6976 ***4.4.3 Corals and Associated Invertebrates and Algae***

6977 Coral reef ecosystems include hard corals (scleractinians) as the primary reef-building corals, soft corals,
6978 algae, sponges and invertebrates, which in turn support numerous fish species. Invertebrate fauna
6979 associated with coral reefs include anthozoans such as sea anemones, mollusks such as giant clams and
6980 snails, echinoderms such as sea cucumbers, urchins, and the crown-of-thorns seastar (*Acanthaster planci*),
6981 and calcareans (sponges). Large, fleshy macroalgae colonize any uncolonized external portions of the reef
6982 and are grazed upon by herbivorous fish, which are in turn preyed upon by larger, predatory fish species.
6983 The reef matrix, formed from skeletal remains of organisms, supports a diverse community of organisms
6984 collectively known as cryptobiota. The number of invertebrate species that live in or around coral reefs is
6985 estimated to range from one to eight million (Reaka-Kudla, 1997). Consequently, activities that may
6986 impact corals or coral reefs may influence numerous other organisms.

6987 Macroalgae are conspicuous and naturally occurring on coral reefs and can provide shade to other sessile
6988 organisms and reduce bleaching impacts (Ceccarelli et al., 2018). However, high nutrients and turbidity,
6989 reduced grazing, and episodic disturbances such as hurricanes can shift reefs to dominance by macroalgae
6990 at the expense of corals. Low macroalgae cover appears necessary for coral propagule colonization and
6991 subsequent recovery of coral following large disturbances such as hurricanes or coral bleaching
6992 (Holbrook et al., 2016). On healthy oligotrophic coral reefs, even very low nutrient increases may shift
6993 relative dominance from corals to macroalgae (Holbrook et al., 2016).

6994 Loss of corals is attributed to the global threat of climate change impacts including increased water
6995 temperatures, ocean acidification, increased frequency and intensity of coastal storms, sea level rise, and
6996 localized threats such as increased sedimentation, altered water quality, and increased coral disease and
6997 predation. Of the 25 coral species protected under the ESA (79 FR 53851, 79 FR 53851, and 80 FR
6998 60560), 15 occur in the Indo-Pacific and seven in the Caribbean (no listed corals are presently known in
6999 Hawaii). Three corals are listed as endangered, which are not found in U.S. waters, and the remaining are
7000 listed as threatened. NMFS has designated critical habitat for staghorn coral (*Acropora cervicornis*) and
7001 elkhorn (*A. palmata*) (73 FR 72209), which includes water depths from the mean high water line to 30 m,
7002 to support successful larval settlement, recruitment, and reattachment of fragments around southern
7003 Florida, Puerto Rico, and the USVI. In 2015, NMFS released a [recovery plan](#) for elkhorn coral and
7004 staghorn coral (NOAA, 2015b), which includes several measures to increase abundance and protect

7005 genetic diversity while abating threats to corals, including research on coral biology (e.g., reproduction
7006 and recruitment, genetics, cellular processes, and host-symbiont relationships) increasing monitoring of
7007 disease and bleaching events, reducing local impacts of temperature stress (e.g., shading of reefs,
7008 pumping cooler waters onto reefs), researching the viability of land-based rearing and wild re-stocking of
7009 species, and testing approaches to culture resistant and/or resilient strains of corals (e.g., disease or
7010 biotoxin resistance, thermal or pH tolerance) (NOAA 2015b).

7011 The NMFS provides the current list of corals listed as threatened or endangered under the ESA and their
7012 critical habitat. A list of the ESA-listed coral species are in Chapter 3, Section 3.4.2. Because corals are
7013 the focus of the CRCP and ESA-listed corals may be impacted by some of the proposed activities,
7014 impacts to ESA-listed corals are considered in this section. In parallel with the preparation of this DPEIS,
7015 the CRCP has initiated formal consultation with NMFS Office of Protected Resources Interagency
7016 Coordination Division.

7017 *4.4.3.1 No Action Alternative*

7018 Proposed CRCP activities analyzed for potential impacts to coral and associated invertebrates and algae
7019 under the No Action Alternative include monitoring, research and sample collections, watershed
7020 restoration, coral restoration and intervention, and activities to reduce physical impacts to coral reef
7021 ecosystems (Table 2-1).

7022 **Monitoring, mapping, and research.** Adverse impacts to corals and associated invertebrates and algae
7023 may occur due to activities associated with monitoring, mapping, and research. The NOAA evaluated the
7024 impacts to corals, algae, fish, and invertebrates from monitoring, establishment of permanent transect
7025 markers, collection of coral samples and gametes, collection of reef fishes, towed diver surveys, algae
7026 collection, and mooring instruments to the seafloor concluded in the *Summary of Environmental*
7027 *Consequences* (CRED PEA 2010). These activities would result in “increased understanding of the
7028 science of fragile coral reefs and their ecosystems that will aid in the management of these important
7029 resources” and “Negative consequences, if any, are expected to be minimal with temporary impacts
7030 associated with field research (e.g., sample collection) and monitoring programs (e.g., installation of long-
7031 term markers).” The ONMS PEA 2018 also presented an analysis of these same and similar monitoring,
7032 mapping, and research activities on marine resources, including coral reefs, and concluded that no
7033 significant adverse impacts would be expected as a result of these activities (Section 4.1.2). Monitoring or
7034 research may result in direct contact with corals (e.g., transect tapes and calipers may have temporary
7035 contact with corals) or other reef-associated organisms or an activity may involve a direct take of coral
7036 cores, fragments, or gametes, or other invertebrates or algae.

7037 Direct coral sampling, collection of cores or fragments, is expected to have temporary effects on colony
7038 biomass as corals can recover through skeleton and tissue replacement and/or colony growth; however,
7039 recovery varies by coral species, and lesion size and shape (NMFS 2011, Bak and Steward-Van Es 1980,
7040 Meesters et al., 1997, and Oren et al. 1997). Alizarin Red S could cause stress due to long exposures (over
7041 eight hours) and high concentrations (over 10 ppm [10 mg/L]) (Dodge, 1984; Lamberts, 1973). CRCP
7042 BMPs require that coral sampling for research take less than 20% of a colony unless it can be determined
7043 that larger amount will not negatively impact the survival of the coral or impact the local population of
7044 that species. Typically, most coral sampling for research is less than 20% and is closer to 5% or less of
7045 colony. Gamete collection is not likely to affect coral populations given the low recruitment success and
7046 the low percentage of gametes collected compared to total amount released in a spawning event (NOAA,

7047 2009). Direct sampling may also include the collection of fragments or whole specimens of invertebrates
7048 or algae. As with hard corals, the collection of fragments or samples from certain invertebrates (e.g., soft
7049 corals or sponges) and algae is expected to have temporary effects on biomass, as these species can
7050 regenerate. For some activities, the collection of invertebrate or algal specimens may be required;
7051 however, the taking of a limited number of specimens is not expected to impact any population levels.
7052 Adverse impacts to corals and associated invertebrates and algae would be direct, short-term, local, and
7053 negligible to moderate. Temporary-to-short-term, minor, adverse effects may occur to ESA-listed corals
7054 and critical habitat due to localized disturbance and resuspended sediments from divers, installation of
7055 permanent transect makers, or by the placement of instruments on the seafloor. To the extent that adverse
7056 effects to ESA-listed coral species will rise to the level of take, avoidance and minimization measures
7057 developed through formal Section 7 consultations will be implemented. In addition, vessels typically
7058 anchor in areas with documented absence of coral reefs or in areas known to be devoid of corals, use
7059 mooring buoys, or avoid anchoring (live boating, manned vessel). Thus, negligible impacts to corals or
7060 associated invertebrates and algae from surveying or mapping vessels are anticipated. Potential adverse
7061 impacts to corals and associated invertebrates and algae from vessel transit, acoustic mapping, anchoring,
7062 AUVs, and other activities associated with monitoring, mapping, and research would be direct, short-
7063 term, local, and negligible to minor (NOAA, 2013 [Section 5.1]).

7064 Benefits to coral and associated invertebrates and algae from these activities include acquisition of data
7065 and information on coral reef ecosystems and endangered and threatened coral species, which is critical to
7066 their recovery and conservation. Benefits of monitoring, mapping, and research activities include the
7067 collection of data that would support future management of coral reef ecosystems and would therefore be
7068 indirect, long-term, local to large scale, and negligible (some coral reefs may not be monitored) to major
7069 (due to the value of the data for management and conservation efforts of corals and associated
7070 invertebrates and algae), as described above.

7071 **Coral restoration and interventions.** The CRCP supports on-the-ground restoration actions and research
7072 on intervention techniques (e.g., stress hardening and assisted gene flow) to support the creation of
7073 resilient, genetically diverse, and reproductively viable populations of key coral species. These
7074 intervention techniques are expected to facilitate the adaptation of coral reef ecosystems to evolving
7075 environmental conditions. Temporary, minor adverse effects of coral proposed activities themselves may
7076 occur due to disturbance and resuspended sediments, physical contact with corals, dispersion of adhesives
7077 used to plug the clipped coral or transplant injured corals onto the reef (although adhesives used in coral
7078 restoration are designed to have minimal dispersion and impact to the area), and other related activities.
7079 The National Academy of Sciences recently prepared a review of coral interventions (NAS, 2019) that
7080 evaluates genetic and reproductive, physiological, population and community, and environmental
7081 interventions with respect to coral reef persistence and resilience. The report provides evaluations,
7082 including methods, benefits, and potential risks, of the interventions. Many of the potential impacts
7083 described here are based on those presented in the report. Current restoration methods are not considered
7084 adequate to be “effective at larger scales needed to halt or reverse the decline in reef coral communities”
7085 (dela Cruz & Harrison, 2017). However, methods are continuously evolving and are needed to slow
7086 decline while adequate methods are developed.

7087 The NOAA RC PEIS 2015 evaluated potential impacts to coral reefs as a result of 26 proposed restoration
7088 approaches throughout NOAA’s jurisdictions. Many of the same restoration techniques evaluated in the
7089 NOAA RC PEIS 2015 are included in this DPEIS.

- 7090 ● Propagating a genetically and species-rich collection of coral fragments in nurseries, with an
7091 emphasis on threatened and endangered species.
- 7092 ● Transplanting (outplanting) coral fragments from nursery or an impacted location to appropriate
7093 targeted locations.
- 7094 ● Managing invasive species (invasive fish and algae) through removal and appropriate
7095 maintenance techniques (e.g., release of natural predators such as urchins or continued removal).
7096 For example, removal of invasive macroalgae by mechanical means (e.g., vacuum), followed by
7097 control with sea urchins has been successful at controlling algae in Kāneʻohe Bay, Hawaii
7098 (Neilson et al., 2018). This also includes the removal of nuisance species, such as corallivores,
7099 algae, or octocorals, to reduce predation on corals or to improve habitat quality.
- 7100 ● Re-attaching or moving broken corals or stabilizing rubble substrates in areas impacted by events
7101 such as vessel groundings or storms, sometimes in conjunction with proactively relocating corals
7102 to more appropriate locations, which may include a coral nursery.
- 7103 ● Improving infrastructure such as mooring buoys, navigation aids, or enhancements to piloting or
7104 salvage operational capabilities to prevent vessel groundings in coral habitats (discussed under
7105 activities for reducing physical impacts to corals).

7106 Stress hardening may be more likely under some conditions than others and can weaken the coral rather
7107 than strengthening it, possibly due to the over-expenditure of energy needed to respond (NAS, 2019).
7108 This approach is limited by the ability to scale up the restoration in space and time and is more likely to
7109 persist under the conditions the coral was exposed to for the stress-hardening.

7110 Transplanting wild coral fragments onto natural reefs and outplanting nursery grown corals into
7111 restoration areas are used for mitigating or enhancing damaged or depleted coral populations (see Young
7112 et al., 2012 for a review of restoration of the threatened *Acropora* corals in the Caribbean).

7113 Removal of nuisance species would result in death of those specimens but would not have any adverse
7114 effects at the population level. Instead, their removal, along with the removal of invasive species, would
7115 benefit the coral reef ecosystem.

7116 Risks of managed relocations include the introduction of nonnative pathogens, parasites, algae, microbes,
7117 commensal invertebrates, and corallivores (e.g., gastropods) that might overwhelm local controls on their
7118 abundance and the translocated type itself might become “invasive” or predominant if it is released from
7119 the pressure of a natural enemy or predator. Potential risks of transplanting coral also include damage to
7120 donor and recipient corals, loss of genetic diversity, and the introduction of disease and/or invasive
7121 species to recipient sites (dela Cruz & Harrison, 2017). However, recent studies (Zayasu et al., 2018)
7122 indicate that nursery grown *Acropora tenuis* have the same genetics as corals in the surrounding natural
7123 area, and restoration using farmed coral may be preferable to transplanting of wild colonies to avoid
7124 damaging donor corals. Nursery-grown corals grow quickly, do not damage donor and recipient corals,
7125 and the possibility of disease transmission and introduction of nonnative species are lower than for wild
7126 transplants, making them preferable for coral propagation and ecological reef restoration in the Caribbean
7127 and Western Atlantic (Young et al., 2012). Afiq-Roslia et al. (2017) documented three to five times faster
7128 growth in nursery-raised corals of *Pachyseris speciosa* and *Pocillopora damicornis* when compared with
7129 direct wild colony transplants. Young et al. (2012) report that fragment survival of transplants ranged
7130 between 43% and 95% during the first year, with increases in biomass of up to 250% for transplanted
7131 *Acropora* spp. Young et al. (2012) also reported on some studies that found more than 50% fragment

7132 mortality within the first year, typically due to fragment dislodgement or storm damage, and mortality
7133 often increased to 80-100% after five years. Monitoring is crucial to knowing what will be successful,
7134 however, and only two Caribbean studies of *Acropora* spp. transplantation and fragment stabilization
7135 have monitoring data over more than 10 years (Young et al., 2012).

7136 There is also potential for disease transmission from the laboratory (*ex-situ*) to the field, although no cases
7137 have been reported in the U.S. laboratory-grown corals must be certified as disease-free and require
7138 USDA veterinary certification prior to transplanting (Lirman & Schopmeyer, 2016), thereby reducing this
7139 risk. Additionally, regarding field work with diseased corals, the CRCP BMPs under the No Action
7140 Alternative require decontamination of equipment to reduce the potential for transmission the disease
7141 agents from one site to another.

7142 Application of antibiotics to corals as a means of disease prevention can destabilize the coral
7143 microorganism community (microbiome), resulting in greater susceptibility of other coral reef ecosystem
7144 species to disease. Impact assessment of applying antibiotics to coral ecosystems would be needed on a
7145 case-by-case basis to determine suitability of use. Concerns over antibiotic resistance and overuse in
7146 environmental settings indicate the need for additional research to make an informed decision. Site-
7147 specific NEPA analysis would be required before use of this technique in the field. Restoration would
7148 enhance coral cover and production on the reef, which would benefit reef fish and other organisms. Fish
7149 and invertebrates that rely on coral reefs for shelter also benefit from coral restoration activities.
7150 Enhancing natural recruitment of coral larvae by increasing available hard substrate would potentially
7151 lead to increased coral cover and habitat area for living coastal and marine resources (Ladd et al., 2019).
7152 Potential benefits to corals and associated invertebrates and algae as a result of these proposed activities
7153 would be expected to be direct and indirect, short- and long-term, local to large scale, and negligible to
7154 moderate.

7155 The implementation of coral restoration and innovation activities provides an opportunity to replenish
7156 important reef-building coral species and improve coral reef habitat. Adverse impacts to corals and
7157 associated invertebrates and algae, would be expected to be direct, short- or long-term, local, and
7158 negligible to moderate. Benefits to corals and associated invertebrates and algae would be direct and
7159 indirect, short- and long-term, local to large scale, and negligible to moderate.

7160 **Watershed restoration and management.** Stresses such as nutrient enrichment and physical disturbance
7161 can disrupt the balance of coral reef systems and result in injury or loss to small or large portions of the
7162 reef. For example, while in normal numbers, crown-of-thorns are not an issue, outbreaks of the large
7163 crown-of-thorns seastar, a corallivore, in the Indo-Pacific region have caused up to 90% mortality in
7164 localized areas of corals of the Great Barrier Reef, Guam, American Samoa, and Japan (Leray et al.,
7165 2012). Triggers for crown-of-thorns outbreaks are not fully understood, but are thought to be related to
7166 disturbances such as predator removal and nutrient discharges. Macroalgae dominance on reefs has been
7167 associated with nutrient increases in both subtropical and temperate zones, including the Florida Keys
7168 (Collado-Vides et al., 2007). In Kaneohe Bay, Hawaii, nitrogen limited nine of ten macroalgae species
7169 studied (Neilson et al., 2018). Reducing nutrient loadings to coastal waters would reduce the nutrients
7170 available to support increased growth by macroalgae and the potential for macroalgae to outcompete
7171 corals on the reefs. Sedimentation alone, particularly anthropogenic sedimentation, is considered the
7172 greatest impact on energy acquisition in corals because it impedes their feeding and ability to
7173 photosynthesize (Fourney & Figueiredo, 2017). A sedimentation rate of more than 10 mg/cm²/day is

7174 considered to be detrimental to the more sensitive species (Afiq-Roslia et al., 2017).

7175 Watershed restoration and implementation activities may result in the temporary discharge of sediments
7176 and other pollutants into coastal and marine waters, as described for sediments (Section 4.3.1) and water
7177 quality (Section 4.3.4). Potential adverse impacts of sediments to ESA-listed corals and non-listed corals
7178 include reduced light reaching symbiotic zooxanthellae of corals and subsequent reductions in energy
7179 availability to corals, as well as increased prevalence of coral disease and other indicators of poor coral
7180 health (Pollock et al., 2014). The turbidity and sediment BMPs (Appendix A), and others would reduce
7181 these potential impacts further. Potential adverse impacts to corals and associated invertebrates and algae
7182 from watershed restoration and management activities would be direct, short-term, local, and negligible to
7183 minor.

7184 Watershed restoration and management activities would benefit corals and associated invertebrates and
7185 algae through improved water quality due to reduced sediment, nutrient, and other pollutant loadings into
7186 coastal waters. Improved water quality would increase the availability of light and corals would benefit
7187 from increased photosynthesis by zooxanthellae and subsequent energy; increases in coral cover, density,
7188 and diversity through improved settlement habitat; improved three-dimensional structure to coral reefs;
7189 and greater possibility for recovery and conservation of coral reef ecosystems. Benefits would be
7190 expected to be indirect, long-term, localized, and minor to moderate as a result of watershed restoration
7191 and management activities that improve coastal water quality.

7192 **Reducing physical impacts to coral reef ecosystems.** Adverse impacts to coral reefs and associated
7193 invertebrates and algae due to installation of mooring buoys are anticipated to be minimal. One study
7194 predicted a 7-12% loss of coral cover due to anchors and anchor chains, and up to 2% loss due to
7195 recreational diver contact (Saphier & Hoffmann, 2005). The NPS EIS 2015 concluded that the use and
7196 maintenance of navigational markers and mooring buoys would be expected to protect corals from
7197 unintentional vessel groundings and anchor damage (see Section 4.3). Potential adverse impacts to corals
7198 and associated invertebrates and algae from the addition or relocation of mooring buoys and boundary
7199 markers may result in temporary adverse impacts due to temporary sediment resuspension that may
7200 reduce water clarity and adversely affect coral health, and drilling sounds that can alter the behavior of
7201 invertebrates. However, direct impacts would not be expected since mooring buoys would not be installed
7202 on or directly proximate to a coral reef. Potential adverse impacts to corals and benthic habitat would be
7203 direct, short-term, local, and minor due to underwater installations.

7204 Potential adverse impacts to corals and associated invertebrates and algae from debris removal may
7205 include sediment resuspension and accidental or direct intentional contact with or breaking of corals,
7206 sessile invertebrates, or algae by volunteers or professionals. Marine debris removal would primarily
7207 occur on a small scale, and local effects would be minor and short-term because such marine debris
7208 removal is done by hand (e.g., heavy items are typically lifted with airbag to the surface). Potential
7209 adverse impacts to corals and associated invertebrate and algae would be direct, short-term, local and
7210 negligible to minor, depending on the size and type of debris. Reductions in physical impacts to corals
7211 and associated invertebrate and algae would result in potential direct, long-term, local, negligible to
7212 moderate, benefits.

7213 *4.4.3.2 Alternative 1*

7214 Under Alternative 1, current CRCP activities that support coral restoration and intervention and reduce

7215 physical disturbance to corals would be eliminated.

7216 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to corals and associated
7217 invertebrates and algae from monitoring, mapping, and research activities would be the same as described
7218 for the No Action Alternative.

7219 **Coral reef restoration and interventions.** As described previously, natural recovery of coral
7220 communities is not expected in the foreseeable future without unprecedented, major global changes in
7221 climate, sea level, and species composition and abundance (Young et al., 2012). Burke et al. (2011)
7222 estimate that by 2050, 75% of remaining coral reefs will be under high to critical threat. Under
7223 Alternative 1, activities to address adverse impacts of coral-specific invasive species, disease, and
7224 predators would not be implemented, further reducing the potential for coral recovery. Therefore,
7225 implementation of Alternative 1 would be expected to result in a reduction in efforts to recover and/or
7226 conserve coral reefs with a commensurate decline in coral reef ecosystems for the foreseeable future
7227 relative to the No Action Alternative.

7228 Eliminating on-the-ground coral restoration and associated research related to enhancing coral resilience
7229 along with the application of intervention activities would reduce the information available to make
7230 decisions regarding management of this resource and eliminate the intervention actions needed to recover
7231 corals. Potential adverse impacts would be direct and indirect, long-term, local and large scale, moderate
7232 to major, adverse impacts to corals, and associated invertebrates and algae. Associated benthic
7233 communities would be expected to experience long-term adverse effects of the loss of reef structure and a
7234 subsequent loss of the complex and diverse community of benthic organisms, many of which are critical
7235 to the ecological integrity of the reef ecosystem.

7236 Eliminating coral restoration and intervention activities would also eliminate the temporary and negligible
7237 impacts of the activities associated with coral nursery development, transplanting, urchin propagation,
7238 invasive and nuisance species control, and disease mitigation activities and disturbances described under
7239 the No Action Alternative. However, the potential reduction in adverse impacts to corals and associated
7240 invertebrates and algae due to eliminating these restoration actions, like the potential impacts themselves,
7241 would be negligible. No benefits to corals and associated invertebrates are expected as a result of
7242 excluding these activities.

7243 **Watershed restoration and management.** Potential adverse impacts and benefits to corals and
7244 associated invertebrates and algae would be the same as described for the No Action Alternative.

7245 **Reducing physical impacts to coral reef ecosystems.** Under Alternative 1, the installation of permanent
7246 mooring buoys that presently occurs as part of the CRCP would be eliminated, increasing the potential for
7247 impacts physical damage to coral and associated invertebrates and algae from multiple anchorings and
7248 contact with marine debris. Eliminating this portion of the CRCP would not affect debris removal that
7249 occurs under NOAA's extensive Marine Debris Program. However, without the installation of additional
7250 mooring buoys, chronic anchor damage to coral reefs, especially in highly visited areas, would not be
7251 addressed and further damage to the reef as debris such as vessels rock or are dragged across the sea floor
7252 due to wave or wind energy. For example, a study of corals in highly and rarely anchored sites in the
7253 British Virgin Islands (Flynn, 2015) found that coral cover, density, and conditions were markedly lower
7254 in the highly anchored sites; cover of hard corals and sea fans were both reduced by about seven percent,
7255 hard corals were approximately 40% smaller in size and 60% less dense, and species richness was 60%

7256 lower at the highly anchored sites. The same highly anchored sites supported only 45% of the fish density
7257 as those rarely anchored, with some fish functional groups more affected than others.

7258 The exclusion of debris removal activities under Alternative 1 would result in a reduction in the removal
7259 of derelict fishing gear, vessels, plastics, and other debris on the sea floor and in benthic habitats, with the
7260 potential for continued physical damage to coral and associated invertebrates and algae, as well as indirect
7261 loss due to degraded water quality and sediments from accumulated marine debris. In a study of the
7262 adverse impacts of plastic debris on 159 Asia-Pacific coral reefs, Lamb et al. (2018) found that plastic
7263 debris increased the susceptibility of corals to disease, from 4 to 89%, possibly due to physical damage,
7264 conditions conducive to disease, and/or delivery of disease-causing microorganisms. Potential adverse
7265 impacts to corals and associated invertebrates and algae from continued anchoring and debris
7266 accumulation would be direct and indirect, short- and long-term, local, and negligible (e.g., little or no
7267 physical contact with debris) to major (e.g., accumulated plastic covering a portion of a reef), depending
7268 on the size of the project. No benefits to corals from the proposed elimination of these activities is
7269 anticipated.

7270 Monitoring, mapping, and research activities would continue to provide information critical to
7271 conservation and management of corals and associated invertebrates and algae. Watershed restoration and
7272 management activities would continue to reduce sediment and other pollutant loads and improve water
7273 clarity in coastal waters and benefit corals and associated invertebrates and algae. However, the overall
7274 benefits would be reduced due to the exclusion of the components of the CRCP that directly address coral
7275 restoration and physical impacts to corals. Therefore, overall potential benefits would be direct and
7276 indirect, short- to long-term, local, and negligible to minor.

7277 *4.4.3.3 Alternative 2*

7278 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs that are part of
7279 the current CRCP and may further reduce the potential for adverse impacts to corals and associated
7280 invertebrates and algae from proposed activities. Adverse impacts under Alternative 2 would be similar to
7281 the No Action Alternative but may have additional, negligible reductions in impacts as a result of
7282 DCMMs are anticipated.

7283 DCMMs may include increasing the capacity for greater supervision over dive activities, BMPs to control
7284 turbidity and sediment, greater restrictions on instrument mooring, guidance for anchoring with a priority
7285 for using mooring buoys or live boating, additional training to vessel operators, and stopping restoration
7286 work during or when a storm is approaching and during coral spawning periods. These activities may
7287 further reduce the potential for release of sediments and sediment-bound contaminants into coastal and
7288 marine waters and improve water quality (Section 4.3.4), thereby benefiting corals and associated
7289 invertebrates and algae.

7290 DCMMs may further reduce potential risks to corals and associated invertebrates and algae from physical
7291 damage during transplanting, potential for disease transmission and corallivore and invasive species
7292 introduction, and thereby increase the likelihood of coral survival and recovery from impacts of climate
7293 change, land-based sources of pollution, anchoring and debris accumulation, and over-fishing.

7294 Benefits due to additional reductions in impacts of stormwater runoff in the watershed and to coastal and
7295 marine waters would include increased coral survival, health, and increased potential success of coral
7296 transplants and reef recovery. Potential benefits to corals and associated invertebrates and algae would be

7297 similar to, but negligibly greater than, those described under the No Action Alternative.

7298 **4.4.4 Fish**

7299 Coral reefs support nearly two million marine species, amounting to more than one third of all marine
7300 species of fish (Holbrook et al., 2015). Of these species, tropical reef fishes are the most diverse marine
7301 vertebrate group, including over 6,300 species worldwide (Quimbayo et al., 2019). Tropical reef species
7302 include numerous commercially important fishes such as grouper, snapper, and lobster.

7303 Under the MSA, a 200-mile EEZ and eight regional Fishery Management Councils were created to
7304 manage U.S. marine fishery resources. FMPs are used to manage fish and shellfish such as reef fish,
7305 ground fish, crustaceans, pelagic fish, live coral and other fisheries for commercial, recreational, and
7306 subsistence fishing. FMPs provide stock assessments, fishery evaluations, regulation reviews, and other
7307 information for each fishery. Four of the eight Fishery Management Councils (i.e., South Atlantic,
7308 Caribbean, Gulf of Mexico, and Western Pacific Regional) have shallow-water coral reef ecosystems
7309 within their jurisdictions and the FMPs are available on each individual Council's website.

7310 Highly migratory species (HMS) of pelagic fishes such as tunas, billfish, swordfish, and sharks consume
7311 fish, crustaceans, cephalopods, and molluscs in the open ocean and are not reef-dependent but may occur
7312 at reefs. Some of these fish mix with juvenile individuals of other tuna species forming large schools
7313 along convergence zones, upwelling areas, and near thermal fronts, but not necessarily islands (Venegas
7314 et al., 2018) and spawn in warmer waters such as the Gulf of Mexico and the western Pacific. Large
7315 sharks such as hammerheads and bull sharks may visit a reef and consume fish there and are not critical to
7316 the function of the reef, although they are vulnerable to altered nutrient upwelling caused by warm waters
7317 (Goreau et al., 2005; Vanegas et al., 2018). These reef-associated shark species are, along with a diverse
7318 group of reef fish, predators of other reef fish (Roff et al., 2016; Goreau et al., 2005). These HMS fish are
7319 not expected to be impacted by the proposed monitoring, research, restoration activities, and reduce
7320 physical impacts activities and are not addressed further.

7321 The potential for impacts to threatened and endangered fish species was also examined. In the Pacific,
7322 species include the threatened giant manta ray (*Manta birostris*), oceanic whitetip shark (*Carcharhinus*
7323 *longimanus*), and the Central and Southwest Atlantic distinct population segments of endangered
7324 scalloped hammerhead shark (*Sphyma lewini*). In the Atlantic, species include the threatened giant manta
7325 ray, Nassau grouper (*Epinephelus striatus*), oceanic whitetip shark, scalloped hammerhead shark, and
7326 smalltooth sawfish (*Pristis pectinata*). Except for the Nassau grouper and smalltooth sawfish, these
7327 species are oceanic and impacted primarily by loss of non-coral habitat and overfishing. The Nassau
7328 grouper and the smalltooth sawfish have the potential to be affected by the proposed activities.

7329 For ESA-listed fish species, reef restoration would support the recovery of the Nassau grouper, which
7330 uses coral reefs, and the coastal smalltooth sawfish. The giant manta ray is more pelagic. Hammerhead
7331 sharks and oceanic whitetips are pelagic and may visit coastal waters and coral reefs but would not be
7332 expected to benefit directly from reef restoration activities. Overfishing and capture for their fins are the
7333 primary threat to both sharks. Benefits to ESA-listed fish species would be variable, but direct, long-term,
7334 local, and negligible to moderate. There may be direct adverse direct, short-term, minor-to-moderate
7335 impacts to ESA-listed fish through collection of fish for life history assessments, tagging, and/or
7336 monitoring of spawning aggregations. No adverse impacts to the other ESA-listed fish would be
7337 anticipated.

7338 No critical habitat is designated for Nassau grouper or smalltooth sawfish. The CRCP initiated an
7339 informal programmatic consultation with the NMFS Office of Protected Resources, Interagency
7340 Cooperation Division under the ESA for these species. This section of the PDEIS addresses reef-
7341 dependent and other marine fish. Freshwater fish are addressed under Section 4.3.2 Terrestrial and
7342 Freshwater Habitats and Biota.

7343 *4.4.4.1 No Action Alternative*

7344 CRCP activities that result in injury or loss of reef habitat or associated fish and invertebrates may
7345 adversely impact reef fish. For example, loss of the three-dimensional reef structure would reduce the
7346 abundance and diversity of fish communities (Holbrook et al., 2015). Loss of mature corals would result
7347 in the loss of corresponding source of reef organisms and a decrease in recruitment of fish and
7348 invertebrates due to the absence of suitable substrate or chemical stimulants for settling of larvae,
7349 reduction in coral habitat would reduce the food source available to other reef species, and loss of coral
7350 diversity could result in a greater risk of extinction for habitat-specific fish, especially in diversity
7351 “hotspots” where diversity and numbers of fish are high, such as in the Indo-Pacific region (Holbrook et
7352 al., 2015).

7353 The proposed CRCP activities analyzed for potential impacts to fish under the No Action Alternative
7354 include monitoring, research and sample collections, watershed restoration, coral restoration and
7355 intervention, and activities to reduce physical impacts to corals (Table 2-1).

7356 **Monitoring, mapping, and research.** Fish may be directly collected as part of research activities,
7357 resulting in direct loss of individual fish. However, the number of fish collected would be negligible and
7358 fish populations would not be expected to be affected. Fish tagging, such as coded wire tags (e.g., external
7359 spaghetti tags), elastomer T-bar anchor tags, dart identification tags, visible implanted fluorescent
7360 elastomer tags, and acoustic transmitters, could negligibly alter fish behavior, growth, and survivability
7361 (Hoey & McCormick, 2004; Berumen & Almany, 2009; Cote et al., 1999; Righton et al., 2006; Anglea et
7362 al., 2004). The physical presence of divers/snorkelers can alter fish behavior. Sediment disturbance and
7363 water turbidity from vessel and in-water activities may result in temporary indirect impacts to fish (see
7364 Section 4.3.4). Sounds in the high-frequency range (25-135 kHz) may also alter behavior, such as
7365 disrupting reproductive or feeding activity, in fish such as herrings, menhaden, and anchovies, (NOAA,
7366 2013 [Section 5.1.1.5]). Temporary displacement of prey species from in-water activities could affect
7367 feeding routines of predatory fishes and marine mammals. Sound sources from vessels are below levels
7368 that can cause temporary hearing loss or injury, but masking and short-term changes in behavior are
7369 possible. However, individual surveys would be temporary and spatially limited, and fish that are likely
7370 accustomed to other vessels would be expected to experience negligible or minor impacts. Adverse
7371 impacts to reef fish behavior from in-water and vessel activities are expected to be direct, short-term,
7372 local, and minor.

7373 The CRCP has identified a consistent need across the U.S. coral reef jurisdictions for better data on
7374 current stock status and vulnerability to fishing impacts to inform fisheries management actions. For
7375 example, data are scarce on historical Nassau grouper numbers because all grouper were combined for
7376 fisheries landings data, environmental conditions necessary for the fish are not well known, and it is
7377 threatened due to historical over-harvest. The Nassau grouper is now monitored by the Caribbean Fishery
7378 Management Council and Caribbean Coral Reef Institute. It is expected that monitoring, mapping, and
7379 research activities would benefit this species along with other fish species by providing information

7380 critical to management recommendations and regulations. Therefore, anticipated benefits to fish species
7381 and populations would be indirect, long-term, local to large scale, and negligible (data not collected in
7382 particular areas) to major (data acquired is critical to support to management and conservation of reef
7383 fish), depending on the species and the extent of monitoring.

7384 **Coral reef restoration and intervention.** Adverse impacts to fish from these activities may include
7385 temporary disturbances to individual fish from vessel and other in-water activities and would be the same
7386 as described above for monitoring, mapping, and research. The effects of *in-situ* antibiotic application to
7387 diseased corals on coral reef fish are unknown at this time. Site-specific NEPA analysis would be
7388 required before use of this technique in the field. Potential adverse impacts of other coral restoration and
7389 intervention activities would be direct, short-term, local, and negligible to minor. Potential benefits to reef
7390 fish from transplanting or outplanting corals, and other intervention activities would be anticipated,
7391 resulting from recovery of coral abundance, diversity, and structural complexity and subsequent
7392 restoration of habitat for reef-dependent organisms and species assemblages, as well as a source of fish
7393 recruitment. The extent of the benefits would depend on the fish species affected, whether a project was
7394 undertaken, and the success of a restoration project. Most coral species support distinctive fish
7395 communities, demonstrating the strong link between coral species and reef fish community structure
7396 (Komyakova et al., 2018). For example, new recruits of at least four damselfish species (*Chrysiptera*
7397 *parasema*, *Pomacentrus moluccensis*, *Dascyllus melanurus*, and *Chromis retrofasciatus*) showed a strong
7398 preference for a limited number of *Acropora* species (Komyakova et al., 2018) rather than total coral
7399 cover. In the Caribbean, coral proposed activities that used out-planting resulted in an increase in fish
7400 species richness within a week of outplanting *Acropora cervicornis*, compared with areas not planted
7401 (Opel et al., 2017). Potential benefits to reef fish from coral restoration would be direct and indirect,
7402 short- and long-term, local and larger scale, and negligible to major due to the need for or the extent of the
7403 restoration and success of the restored habitat with respect to improved habitat for foraging, refuge, and
7404 spawning.

7405 **Watershed restoration and management.** During construction of watershed restoration projects such as
7406 stormwater treatment wetlands, road and trail stabilization, LID, and culverts, stormwater runoff and
7407 associated sediment and other pollutant loading into downstream and coastal waters may occur,
7408 potentially degrading water quality and adversely impacting reef fish and nursery habitat. BMPs for
7409 turbidity and sediment control would be implemented during construction activities, and areas would be
7410 planted with vegetation to stabilize soils following completion of these activities, reducing the potential
7411 for the introduction of sediments and other pollutants into downstream and coastal waters. Potential
7412 adverse impacts to reef fish and nursery habitat from watershed restoration and management activities
7413 would be direct, short-term, local, and negligible to minor. Watershed restoration and management
7414 activities are intended to reduce stormwater runoff and sediment and other pollutant loadings into coastal
7415 and marine waters, resulting in improved water and sediment quality (Sections 4.3.4 and 4.4.1).
7416 Reductions in land-based pollutants into coastal waters would improve water and sediment quality
7417 conditions for reef fish nursery habitat. Benefits of improved water quality may accrue to reef fish and
7418 nursery habitat and would be direct and indirect, short- and long-term, local and larger scale, and
7419 negligible to moderate.

7420 The listed smalltooth sawfish occurs in a variety of coastal habitats depending on life stage, including
7421 mangrove habitats as juveniles and deep-water reefs for adults. The smalltooth sawfish would benefit
7422 from these activities due to potential increases in sediment quality and reduced sediment loads. The

7423 Nassau grouper would benefit indirectly due to improved water quality and subsequent potential
7424 improvements in coral reef habitat. Benefits to listed species would be the same as those for non-listed
7425 species: direct and indirect, short- and long-term, local and larger scale, and negligible to moderate.

7426 **Reducing physical impacts to coral reef ecosystems.** Adverse impacts to reef and other fish may occur
7427 during installation of mooring buoys and removal of marine debris but would be temporary and minimal.
7428 Fish may be disturbed by in-water activities of vessels and divers and leave the area but would return
7429 once activities were completed. Potential adverse impacts to fish from these activities may occur due to
7430 installation and associated activities (see monitoring, mapping, and research). The use and maintenance of
7431 mooring buoys would be expected to protect coral reefs and therefore provide habitat for reef fish.

7432 Adverse impacts to reef fish from debris removal and associated sediment disturbance and resuspension
7433 and possible fragmentation of corals by divers, equipment, and vessels may occur during removal,
7434 especially for debris such as derelict vessels, if removal occurs near a coral reef (described in Section
7435 4.4.3). Accidental fuel spills that may occur as a result of these activities would likely be floating oils are
7436 unlikely to impact the seafloor but may directly impact an organism due to toxicity. Application of BMPs
7437 and implementation of terms and conditions of programmatic and project-specific consultations and
7438 permits (MDP PEA, 2013) would further reduce potential adverse impacts.

7439 Removal of marine debris would directly reduce further physical impacts of marine debris and associated
7440 potential contamination from fuel, microplastics, and other pollutants, as well as potential impacts of
7441 “ghost fishing” (uncollected or lost fishing traps that continue to trap and result in the death of fish and
7442 shellfish), and physical habitat disturbance (MDP PEA, 2013). Marine debris, including derelict nets,
7443 ropes, and fishing gear, may also entangle fish and wildlife. For example, the listed smalltooth sawfish
7444 continues to be adversely impacted due to bycatch, especially in gillnets, as well as fishing line and other
7445 debris. A study of the species from 1998-2005 found smalltooth sawfish entangled in PVC pipe,
7446 monofilament line, elastic bands, and netting in Florida (Seitz & Poulakis, 2006). In addition, removal of
7447 derelict vessels would remove potential source of contamination and physical impacts to coastal and
7448 marine habitats that support listed fish species.

7449 Potential benefits to reef fish and ESA-listed fish species as a result of installing permanent mooring
7450 buoys and removing marine debris would be direct and indirect, short- and long-term, local, and
7451 negligible to moderate. Potential adverse impacts to fish during implementation of these projects would
7452 be direct, short-term, local and negligible to minor, depending on the amount, size, and type of debris
7453 removed and the habitat from which the debris is removed.

7454 *4.4.4.2 Alternative 1*

7455 Under Alternative 1, current CRCP activities that support coral restoration and intervention and reduce
7456 physical disturbance to corals would be eliminated.

7457 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to fish from monitoring,
7458 mapping, and research activities would be the same as described for the No Action Alternative.

7459 **Coral reef restoration and interventions.** Decline in coral cover has been shown to result in a parallel
7460 decline in fish biodiversity both in marine reserves and in areas open to fishing (Jones et al., 2004).
7461 Therefore, if coral reef cover continues to decline, a corresponding decline diversity, and potentially
7462 abundance of reef dependent fish is anticipated under Alternative 1. Activities to address adverse impacts

7463 of invasive species, disease, and predators would not be implemented, further reducing the potential for
7464 coral reef ecosystem recovery. Potential adverse impacts to fish as a result of excluding these activities
7465 would be direct and indirect, long-term, local, and negligible to moderate. No benefits to fish as a result of
7466 excluding these activities are anticipated.

7467 **Watershed restoration and management.** Potential adverse impacts and benefits to fish would be the
7468 same as described for the No Action Alternative.

7469 **Reducing physical impacts to coral reef ecosystems.** Eliminating the installation of permanent mooring
7470 buoys and eliminating removal of marine debris under the CRCP would result in continued chronic
7471 damage and loss of reef habitats and fisheries, as described for coral reefs (Section 4.4.3). Corresponding
7472 sediment disturbances and resuspensions (Section 4.3.1) due to wave and wind induced movement of
7473 debris would reduce water quality, subsequent impacts to coral reefs, and corresponding adverse impacts
7474 to fish. Persistent debris such as derelict fishing gear and vessels would remain on the seafloor, and the
7475 potential for physical damage to reef fish habitat, ghost-fishing, and entanglements would persist. Loss of
7476 reef fish habitat due to physical damage from plastics, conditions conducive to disease, and/or delivery of
7477 disease-causing microorganisms would also persist under this alternative. Potential adverse impacts to
7478 fish would be direct, short- and long-term, local, and negligible to moderate. No benefits to fish are
7479 anticipated.

7480 Overall, monitoring, mapping, and research activities would continue to provide information critical to
7481 conservation and management of fisheries. Watershed restoration and management activities would
7482 continue to reduce sediment and other pollutant loads and improve water clarity in coastal waters,
7483 benefiting fish habitat and fish. However, the overall benefits would be reduced due to the exclusion of
7484 the components of the CRCP that directly address impacts of coral reef habitat loss and anchoring and
7485 marine debris in coastal and marine waters. Therefore, overall potential benefits to fish would be direct,
7486 short- to long-term, local, and negligible to minor.

7487 *4.4.4.3 Alternative 2*

7488 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs that are part of
7489 the current CRCP. Adverse impacts under Alternative 2 would be similar to the No Action Alternative but
7490 may have additional, negligible reductions in impacts as a result of DCMMs are anticipated.

7491 Additional training with vessels and equipment, additional limitations and precautions for mooring buoy
7492 and equipment installation, and guidance for anchoring would be expected to further reduce the negligible
7493 adverse impacts to reef fish due to monitoring, research, coral restoration, vessel operation and buoy
7494 installation, debris removal, and other in-water activities described under the No Action Alternative
7495 (NOAA, 2013). No adverse effects of DCMMs on fish are expected. Benefits of DCMMs that reduce the
7496 risks associated with coral restoration and intervention would also benefit fish due to the increased
7497 likelihood of coral reef habitat persistence. Potential benefits to fish would be similar to, but negligibly
7498 greater than, those described under the No Action Alternative.

7499 *4.4.5 Invasive Species*

7500 Executive Order 13112 addressing invasive species includes requirements to identify federal actions that
7501 may affect the status of invasive species and that federal agencies “do not authorize, fund, or carry out
7502 actions that it believes are likely to cause or promote the introduction or spread of invasive species in the
7503 U.S. or elsewhere, unless such actions clearly outweigh the potential harm caused by invasive species”

7504 (EO 13112 - 2. Federal Agency Duties). Although not a resource to be protected, the management of
7505 invasive species is critical to the conservation of coral reefs and associated biota. Therefore, potential
7506 impacts of invasive species and their management relevant to the CRCP are addressed here. Impacts of
7507 invasive species and invasive species control to previously examined resources are presented here.

7508 The CRCP activities are intended to remove, reduce, and control invasive species in both the watershed
7509 and in coastal and marine environments. Invasive species are a significant issue because they can impact
7510 native species through predation, competition for food and space, and hybridization, as well as the
7511 introduction of pathogens and parasites. Normal ecosystem functions such as hydrology, nutrient cycling,
7512 or productivity may also be altered by biological invasion. Invasive species control measures and BMPs
7513 to avoid and minimize potential impacts to non-target species are detailed in the NOAA RC PEIS 2015.
7514 The CRCP activities that result in land disturbance or clearing and in-water activities that include
7515 equipment or transit across land or water are potential mechanisms for the introduction and spread of
7516 invasive species. Potential impacts of the CRCP activities on invasive species control and, by inference,
7517 on native species, are presented for both the watershed and coastal and marine waters.

7518 The National Academies of Sciences, Engineering, and Medicine (NAS, 2019) reports that invasive
7519 seaweed species have become established in a variety of locations including Florida, Hawaii, and the
7520 eastern Caribbean. Several species of invasive corals, such as *Tubastrea* spp., occur in the Atlantic and
7521 the globally distributed, temperature-hardy micro-algae coral symbiont (*Durusdinium trenchii*) appears to
7522 be present in the Caribbean. Terrestrial invaders such as rats, which consume eggs from nests of seabirds,
7523 have been shown to harm coral reefs by reducing the numbers of seabirds, thereby reducing nutrient
7524 inputs in the ocean and resulting in less algae initially, fewer algae-consuming fish, and later an increase
7525 in algae at the expense of coral (Graham et al., 2018). Once established, invasive species are extremely
7526 difficult to eradicate, and management efforts often rely on volunteer efforts, are labor intensive and
7527 expensive, and require constant management.

7528 *4.4.5.1 No Action Alternative*

7529 CRCP activities included in the No Action Alternative that may affect invasive species include
7530 monitoring, research, coral nursery and interventions, watershed restoration and management activities,
7531 and outreach and education. Under the No Action Alternative, invasive species control would be
7532 implemented as part of both watershed restoration and coral restoration and intervention activities and is
7533 intended to control invasive species and enhance or support the recovery of native species and habitats.

7534 **Monitoring, mapping, and research.** In-water activities supporting monitoring, mapping, and research
7535 activities have the potential to introduce invasive species to coral reefs and other habitats if equipment
7536 and vessels are not adequately decontaminated following work in previous areas. While the majority of
7537 marine invasive species are from ballast water and aquaculture release, the majority of tropical marine
7538 invasive species are from aquaria releases (Padilla and Williams, 2004). Potential adverse impacts to
7539 native species and habitat from invasive species would be direct and indirect, long-term, local to large
7540 scale, and negligible to moderate. Data collected and analyzed would support control and management of
7541 invasive species and the conservation and recovery of native species. Benefits of monitoring, mapping,
7542 and research would be indirect, long-term, local to large scale, and negligible to major benefits due to the
7543 information collected and compiled for invasive species.

7544 **Coral restoration and interventions.** Transplanting and coral interventions may lead to introduction and

7545 spread of invasive species to the detriment of native corals and other coastal and marine habitats, as
7546 described in Section 4.4.3.1. Coral transplants and research activities that involve coral or coral fragment
7547 relocation also have the potential to introduce invasive species into the target area. Introduction of non-
7548 native pathogens, parasites, algae, microbes, commensal invertebrates, and corallivores poses a risk to
7549 both the translocated species and the entire recipient community. The CRCP specifically targets invasive
7550 and nuisance species removal, including removal of algae, seagrass, and fish, and corallivore control, as
7551 part of coral interventions. Potential adverse impacts of invasive species removal are direct and indirect,
7552 short- and long-term, local with the potential to be larger scale, and negligible to moderate. However,
7553 adverse impacts to invasive and nuisance species would benefit coral reef ecosystems.

7554 Benefits to coral reef ecosystems are anticipated as a result of the removal of invasive and nuisance
7555 species such as algae, lionfish, and crown-of-thorns. Removal of these and other invasive species would
7556 reduce threats to coral reef habitats. NOAA's recovery plan for elkhorn and staghorn coral (NMFS, 2015)
7557 identifies the lionfish (native to the Indo-Pacific) as a contributor to the shift to macroalgae dominance in
7558 some coral reefs in the Bahamas because it feeds on herbivorous fish (e.g., parrotfish) that control the
7559 growth of macroalgae on elkhorn and staghorn corals in the Bahamas. Removal of this species would
7560 restore macroalgae control by grazers and improve reef conditions. Removal of nuisance or invasive
7561 species from reef habitat would restore coral reef habitat and function, natural species composition and
7562 diversity, and enhance recreational opportunities. Benefits anticipated would be direct and indirect, long-
7563 term, local and large-scale, and negligible to moderate.

7564 **Watershed restoration and management.** Adverse impacts to native species as a result of invasive
7565 species control may occur in the watershed as a result of land clearing and creation of gaps in which
7566 invasive species may become established and spread. Adverse impacts to native species and habitats may
7567 also occur due to herbicide drift or poor application that results in harm to non-targeted native species.
7568 Adverse impacts to native species from herbicides and surfactants (used to enhance the intended effects of
7569 the herbicide on the plant) would potentially occur due to contamination of soils or water the plants use.
7570 However, herbicide use is restricted to activities conducted in accordance with approved application
7571 methods and BMPs are designed to prevent exposure to non-target areas and organisms, reducing
7572 herbicide drift, and reduced use of surfactants. Therefore, potential adverse impacts of invasive species
7573 would likely be direct, short-term, local to large-scale, and negligible to moderate.

7574 Using native plants to restore the landscape can help to reverse the trend of species loss by improving the
7575 viability of native habitats (Dorner, 2002). Native species will, in most cases, eventually become self-
7576 sustaining due to adaptations to weather, disease, and herbivores in the native area. Establishment of
7577 vegetation on bare soils or revegetation of an area is important to reducing soil erosion and runoff on its
7578 own or following other proposed activities that disturb an area. Following construction activities,
7579 vegetation would be planted that would be consistent with the habitat created. In areas reclaimed from
7580 previous agriculture, for example, establishing ground cover such as using native species or naturalized
7581 vetiver grass (a nonnative but noninvasive species) would be used to reduce erosion.

7582 Controlling invasive species would benefit most living resources, especially threatened and endangered
7583 species that are typically at greater risk from these impacts. Potential impacts to aquatic and terrestrial
7584 biota would be avoided and minimized by implementing BMPs, including the use of the least toxic
7585 herbicides, surfactants, and spray pattern indicators available. Benefits are anticipated to be direct and
7586 indirect, short- and long-term, local to large-scale, and negligible to minor.

7587 **Reducing physical impacts to coral reef ecosystems.** Potential adverse impacts to resources may
7588 include introduction of invasive species as a result of mooring buoy installation and marine debris
7589 removal would occur due to contaminated vessels or equipment. Therefore, potential adverse impacts of
7590 mooring buoys and debris removal on resources are the same as those described for monitoring, mapping,
7591 and research activities. Potential adverse impacts to native species and habitat from invasive species
7592 introduced during these proposed activities would be direct and indirect, long-term, local to large scale,
7593 and negligible to moderate. Benefits to resources may occur due to reduced disturbances and subsequent
7594 fewer opportunities for invasive species to become established. Potential benefits would be direct, long-
7595 term, local, and negligible to minor.

7596 *4.4.5.2 Alternative 1*

7597 Under Alternative 1, current CRCP activities that support coral restoration and interventions and reduce
7598 physical disturbance to corals would be eliminated.

7599 **Monitoring mapping and research.** Potential adverse impacts and benefits to native habitats and species
7600 from monitoring, mapping, and research activities would be the same as described for the No Action
7601 Alternative. Potential adverse impacts to native species and habitat from invasive species would be direct
7602 and indirect, long-term, local to large scale, and negligible to moderate. Benefits of monitoring, mapping,
7603 and research would be indirect, long-term, local to large scale, and negligible to major benefits due to the
7604 information collected and compiled for invasive species.

7605 **Coral reef restoration and interventions.** Under Alternative 1, proposed activities that include invasive
7606 species removal and/or control as a means of restoring coral and coral reefs would be eliminated and coral
7607 reef degradation would continue. While invasive species control alone may not be adequate for recovery
7608 of corals, it is critical to recovery of coral reefs and associated native habitats. In the absence of coral
7609 research, restoration, and intervention techniques, invasive species control would be limited to
7610 decontamination of equipment and vessels. The removal and/or biological and chemical control of
7611 invasive species such as algae, seagrass, and fish would not occur, and these invasive species would
7612 continue to establish and spread to the detriment of native corals and other coastal and marine habitats. As
7613 described in Section 4.4.3, recovery of coral reefs would not be expected in the foreseeable future without
7614 intervention. Invasive species are already considered a significant threat to coral reefs. Potential adverse
7615 impacts of invasive species removals are direct and indirect, short- and long-term, local with the potential
7616 to be larger scale, and negligible to moderate.

7617 Eliminating coral restoration and intervention activities would also eliminate potential adverse impacts of
7618 coral restoration and intervention activities (Section 4.4.3). However, the potential reduction in adverse
7619 impacts to corals, like the potential impacts themselves, would be negligible. No benefits to native
7620 habitats and species are expected as a result of excluding coral reef restoration and intervention activities
7621 because this would exclude invasive species control.

7622 **Watershed restoration and management.** Potential adverse impacts and benefits to corals and
7623 associated benthos would be the same as described for the No Action Alternative.

7624 **Reducing physical impacts to coral reef ecosystems.** Eliminating the installation of permanent mooring
7625 buoys and the removal of marine debris would result in continued damage and loss of coral reefs and
7626 other native habitats. Disturbances and debris would provide potential opportunities for invasive species
7627 introduction and establishment by removing or stressing native species and/or serving as a carrier for the

7628 introduction of invasive species and further loss of native habitats. Potential adverse impacts to native
7629 species and habitat from invasive species introduced during these proposed activities would be direct and
7630 indirect, long-term, local to large scale, and negligible to moderate. No benefits to native resources with
7631 respect to invasive species are expected under this alternative.

7632 Potential adverse impacts to native habitats and species due to the introduction and expansion of invasive
7633 species would be direct and indirect, short- and long-term, local and large scale, and minor to moderate
7634 due to the persistence of invasive species and the continued introduction of others. Monitoring, mapping,
7635 and research activities would continue to provide information critical to conservation and management of
7636 invasive species. Watershed restoration and management activities would support healthier native habitats
7637 and reduce opportunities for invasive species establishment. However, the overall benefits would be
7638 reduced due to the exclusion of the components of the CRCP that directly address invasive species
7639 impacts. Therefore, overall potential benefits would be direct and indirect, short- to long-term, local, and
7640 negligible to minor.

7641 *4.4.5.3 Alternative 2*

7642 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs that are part of
7643 the current CRCP. Implementation of DCMMs alone would have no adverse impacts to natural resources.
7644 Adverse impacts under Alternative 2 would be similar to the No Action Alternative but may have
7645 additional, negligible reductions in impacts as a result of DCMMs are anticipated.

7646 DCMMs would be expected to further reduce the opportunities for invasive species introduction and
7647 establishment due to additional protocols for decontamination of vessels, equipment, coral transplant
7648 materials, and other activities. Watershed restoration and management activities would also reduce
7649 opportunities for invasive species introduction and establishment by using only native vegetation during
7650 revegetation projects. Benefits of the additional DCMMs to native habitats and species under Alternative
7651 2 would be direct and indirect, short- and long-term, local, negligible to major, and No Action
7652 Alternative.

7653 **4.5 Regulatory Environment**

7654 ***4.5.1 Essential Fish Habitat (EFH)***

7655 The MSA recognizes the importance EFH as areas where fish spawn, breed, feed, or grow to maturity;
7656 EFH includes aquatic habitats such as wetlands, coral reefs, seagrasses, and rivers. NOAA Fisheries
7657 protects more than 800 million acres (~324 million km²) of habitat under EFH, which supports a \$200
7658 billion U.S. fishing industry (NOAA Fisheries, 2019a). EFH for every life stage of each federally
7659 managed species has been identified in FMPs that are prepared by the Fishery Management Councils and
7660 implemented by NMFS. Descriptions, geographic boundaries, and links to additional information about
7661 EFH are available through the NOAA *Essential Fish Habitat Mapper*, which provides visual spatial
7662 representations of fish species, their life stages, and important habitats (NOAA Fisheries, 2019b). The
7663 protection and restoration of EFH is critical to supporting fisheries, rebuilding depleted fish stocks, and
7664 aiding in coral reef recovery in the U.S.

7665 This DPEIS focuses on demersal habitats (including hard bottom and soft bottom) from the shoreline to
7666 the open ocean in the throughout U.S. coral reef jurisdictions and priority international areas. Adverse
7667 effects to EFH are defined as any reduction in quantity or quality of EFH and may include direct or

7668 indirect physical, chemical, or biological alterations of the water or substrate and loss of, or injury to,
7669 benthic organisms, prey species and their habitat, and other ecosystem components. In parallel with the
7670 preparation of this DPEIS, the CRCP has initiated early coordination for potential impacts to EFH and
7671 intends to complete a programmatic consultation with NMFS Office of Habitat Conservation. HAPCs, a
7672 subset of EFH, are considered high priority areas for conservation, management, or research because they
7673 are rare, sensitive, stressed by development, or important to ecosystem function by NOAA. Examples of
7674 coral reef HAPCs are East and West Flower Garden Banks and the Dry Tortuga Ecological Reserve. The
7675 HAPC designation does not necessarily confer additional protections or restrictions upon an area but can
7676 help to prioritize and focus conservation efforts. Because they are a subset of EFH, HAPCs are within the
7677 regulatory protection of EFH.

7678 *4.5.1.1 No Action Alternative*

7679 CRCP activities with the potential to impact EFH under the No Action Alternative may include vessel
7680 and in-water activities, mapping with echosounder, introduction of sediments or other pollutants into
7681 coastal and marine waters from construction activities, sea floor disturbance, accidental spills, and
7682 introductions of invasive species or disease during transplanting or outplanting.

7683 **Monitoring, mapping, and research.** Potential adverse impacts to EFH from echosounder, aircraft
7684 activity, vessel transit, surveys, anchoring, sea bottom sampling, and other monitoring, mapping, and
7685 research activities were evaluated under the OCS PEA 2013 and the MDP PEA 2018. Preferred anchor
7686 sites do not include coral reefs, seagrass beds, and other sensitive areas and the footprint of anchoring
7687 would be small enough that it would be unlikely to alter water column habitat for managed fish species.
7688 Although sensitive areas such as coral reefs are avoided, many areas remain uncharted. In such cases,
7689 vessels will typically anchor in areas with documented absence of coral reefs or in areas known to be
7690 devoid of corals, use mooring buoys, or avoid anchoring (live boating, manned vessel). Coral reef
7691 ecosystem assessment, monitoring, and sampling may result in direct contact and negligible to minor
7692 adverse impacts to EFH if sampling gear makes physical contact with the seafloor or coral reefs.
7693 Instruments temporarily moored to the seafloor may alter EFH by shading areas and modifying habitat
7694 structure. NOAA's OCS PEA 2013 concluded that none of the proposed activities are expected to reduce
7695 the quantity or quality of EFH and, therefore, would not adversely impact EFH, either individually or
7696 cumulatively (Section 5.1.1-5.1.3). The ONMS PEA (2018) (Section 5.1.1) also evaluated the potential
7697 impacts of these same activities (e.g., vessels, instrument and vehicle deployment, SCUBA and snorkel,
7698 and other sampling activities) and concluded that the adverse effects on EFH from these activities would
7699 be minimal due to the relatively low number of events, divers, and equipment deployments, in addition to
7700 the BMPs and training protocols in place. Therefore, potential adverse impacts to EFH are anticipated to
7701 be negligible. If any CRCP project -specific activities are found to have the potential to adversely impact
7702 EFH that are not considered in the CRCP's programmatic EFH consultation, NOAA would contact the
7703 Office of Habitat Conservation to reevaluate the impacts to EFH and potentially initiate EFH consultation
7704 under 50 C.F.R. §§ 600.905-930.

7705 Some in-water activities may disturb the seafloor, alter habitat structure, and can have localized impacts
7706 to demersal fishes and EFH. The area affected during installation of permanent transect markers,
7707 temporary placement of instruments, and sampling is insignificant relative to the total benthic habitat in
7708 the U.S. coral reef jurisdictions (NOAA, 2013). The National Coral Reef Monitoring Plan includes the
7709 collection of coral cores once every 10 years and the infrequent sampling and small sample size.

7710 Additionally, research activities may involve the collection of coral fragments and cores. Multiple
7711 samples are generally collected from different donor colonies throughout a coral reef ecosystem. The
7712 collection of coral samples may have minor, temporary, localized adverse impacts to EFH. Additionally,
7713 instruments temporarily moored to the seafloor may alter EFH by shading nearby areas and modifying
7714 habitat locally, which could cause minor, temporary, localized adverse impacts. Finally, floating oils from
7715 accidental spills are unlikely to impact the seafloor, but may impact organisms such as corals and
7716 seagrasses due to toxicity. Pollutant discharge or hazardous materials release from vessels may also
7717 adversely affect pelagic habitat in the water column, as described in Section 4.3.4. However, most
7718 activities planned for coral reefs in coastal waters are conducted from small vessels so that adverse
7719 impacts from an oil spill are expected to be negligible to minor if they occur.

7720 Consequently, adverse impacts to EFH from these activities would be direct, short-term, local, and
7721 negligible to minor. Benefits to EFH would include data relevant to EFH in the water column and on the
7722 seafloor that would be critical to EFH conservation and management efforts (NOAA, 2013). Benefits to
7723 EFH would be expected to be indirect, long-term, local to large scale, and negligible to major benefits.

7724 **Coral restoration and intervention.** Activities such as vessel transit, collection, diving, and nursery
7725 development may disturb EFH due to travel or work in the area or in adjacent areas and impacts would be
7726 the same as those described for the monitoring, mapping, and research activities described above. Coral
7727 nurseries may be developed on or adjacent to healthy reefs and could disturb existing coral reefs
7728 designated as EFH. Transplanting wild colonies or nursery-reared corals back onto damaged coral reefs
7729 could result in temporary damage to EFH if those colonies are injured, making them susceptible to
7730 disease and possible death. There are associated risks such as introduction of invasive species and
7731 predators (Section 4.4.3). Indirect benefits would include sediment stabilization and reduced wave energy
7732 that would benefit EFH such as mangroves (Section 4.4.2), seagrasses (Section 4.4.1), and the water
7733 column. Adverse impacts to EFH from coral reef proposed activities are expected to be direct, short-term,
7734 local, and negligible to minor. Coral restoration and intervention activities are expected to result in direct
7735 and indirect, long-term, local, and negligible to moderate benefits to EFH as a result of directly restoring
7736 EFH such as coral reefs.

7737 **Watershed restoration and management activities.** Adverse impacts to EFH from these activities may
7738 occur if activities result in erosion and runoff of sediments and other pollutants into downstream and
7739 coastal waters, resulting in temporary degradation of water column and other EFH as described
7740 previously (Section 4.3.4). However, results of these activities would be temporary and local to the
7741 activities, and BMPs (Appendix A) would avoid and minimize sediment runoff and water column
7742 turbidity. Adverse impacts to EFH from these activities are expected to be direct, short-term, local, and
7743 negligible to minor. Potential benefits to EFH from proposed activities include improved water quality
7744 and subsequent direct benefits to coral reefs, mangroves, seagrasses, the water column, and other EFH.
7745 Benefits would be direct and indirect, long-term, local, and negligible to moderate.

7746 **Reducing physical impacts to coral reef ecosystems.** Potential adverse impacts to EFH from disturbed
7747 substrates may occur during activities to reduce physical impacts, e.g., mooring buoy installation and
7748 marine debris removal, and would be direct, short-term, local, and minor due to disturbance and potential
7749 resuspension of submerged substrates (Section 4.3.1). Adverse impacts to EFH from debris removal and
7750 associated sediment disturbance and resuspension during removal, especially for larger derelict vessels,
7751 would be anticipated if the removal required work in or near EFH. Debris removal may temporarily

7752 increase turbidity and reduce water clarity, which may reduce the quality of EFH. Direct, short-term,
7753 local, and negligible to minor adverse impacts would be expected but would be minimized with the
7754 application of BMPs. In addition, potential impacts to ESA-listed coral species would require ESA
7755 consultation and would include implementation of terms and conditions of project-specific consultations
7756 and permits (MDP PEA, 2013).

7757 Installation of mooring buoys and removal of marine debris would directly reduce the amount of vessel
7758 anchoring, many of which may be EFH, and therefore reduce the potential for further physical impacts
7759 from these activities. Debris removal would remove trash and other debris that could otherwise result in
7760 physical impacts to EFH from plastic materials that may smother coral, derelict vessels that may be
7761 carried by waves into seagrass beds) and potential contamination of sediments and water column EFH
7762 from fuel that may be released during derelict vessel removal or microplastics and other associated
7763 pollutants that occur as part of the debris (MDP PEA, 2013 [Section 5.2.2]). Potential benefits to EFH
7764 from marine debris removal would be direct and indirect, short- and long-term, local, and negligible to
7765 moderate.

7766 *4.5.1.2 Alternative 1*

7767 Under Alternative 1, current CRCP activities that support coral restoration and intervention and reduce
7768 physical disturbance to corals would be eliminated.

7769 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to EFH from monitoring,
7770 mapping, and research activities would be the same as described for the No Action Alternative.

7771 **Coral reef restoration and interventions.** As described earlier (Section 4.4.3), recovery of coral reefs
7772 would not be expected in the foreseeable future without unprecedented, major global changes in climate,
7773 sea level, and community composition and species abundance (Young et al., 2012). Activities to address
7774 adverse impacts of invasive species, disease, and predators would not be implemented, further reducing
7775 the potential for coral recovery. Therefore, the continued direct loss of coral reef EFH is anticipated under
7776 Alternative 1. The subsequent reduction in coral reef EFH may result in further sediment and shoreline
7777 erosion due to increased wave energy along shorelines, resulting in adverse impacts to other EFH such as
7778 mangroves, seagrass, other benthic habitats, and the water column. Potential adverse impacts to EFH
7779 under Alternative 1 would be expected to be direct and indirect, short- and long-term, local and large
7780 scale, and minor to moderate.

7781 Eliminating coral restoration and intervention activities would also eliminate potential adverse impacts of
7782 coral restoration and intervention activities (Section 4.4.3). However, the potential reduction in adverse
7783 impacts to corals, like the potential impacts themselves, would be negligible. No benefits to EFH are
7784 expected as a result of excluding coral reef restoration and intervention activities.

7785 **Watershed restoration and management.** Potential adverse impacts and benefits EFH would be the
7786 same as described for the No Action Alternative.

7787 **Reducing physical impacts to coral reef ecosystems.** Eliminating the installation of permanent mooring
7788 buoys and the removal of marine debris from the current CRCP would result in increases in damage and
7789 loss of EFH, especially coral reef habitat, due to increased sediment resuspensions, wave and wind
7790 induced movement of anchors and debris, and subsequent adverse impacts of physical damage and
7791 contamination (MDP PEA, 2013). The exclusion of debris removal activities would result in continued

7792 accumulation of derelict fishing gear, vessels, plastics, and other debris on the seafloor and in benthic
7793 habitats, with the potential for continued physical damage to EFH, as described for coral reefs (Section
7794 4.4.3) and mangroves (Section 4.4.2). Physical damage, in turn, can create conditions conducive to
7795 disease, and/or delivery of disease-causing microorganisms (Lamb et al., 2018). Potential adverse impacts
7796 to EFH from continued anchoring and debris accumulation would be direct, short- and long-term, local,
7797 and negligible to moderate. No Benefits to EFH are anticipated from the elimination of these activities.

7798 Monitoring, mapping, and research activities would continue to provide information critical to
7799 conservation and management of EFH. Watershed restoration and management activities would continue
7800 to reduce sediment and other pollutant loads and improve water clarity in coastal waters and benefit corals
7801 and EFH. However, the overall benefits would be reduced due to the exclusion of the components of the
7802 CRCP that directly address coral restoration and physical impacts to corals. Therefore, overall potential
7803 benefits would be direct and indirect, short- to long-term, local, and negligible to minor.

7804 *4.5.1.3 Alternative 2*

7805 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs that are part of
7806 the current CRCP. Implementation of DCMMs alone would have no adverse impacts to EFH. Adverse
7807 impacts under Alternative 2 would be similar to the No Action Alternative but may have additional,
7808 negligible reductions in impacts as a result of DCMMs are anticipated.

7809 Additional training with vessels and equipment, additional limitations and precautions for mooring buoy
7810 and equipment installation, and reduced anchoring due by prioritizing mooring buoy use or live boating
7811 would be expected to further reduce the negligible adverse impacts to EFH due to monitoring, collection,
7812 vessel operation and buoy installation, debris removal, and other in-water activities described under the
7813 No Action Alternative (NOAA, 2013). No adverse impacts of implementing DCMMs on EFH are
7814 expected. Benefits of DCMMs that reduce the risks associated with coral restoration and intervention
7815 would also benefit EFH due to the increased likelihood of coral reef habitat persistence. Potential benefits
7816 to EFH would be similar to, but negligibly greater than, those described under the No Action Alternative.

7817 *4.5.2 Protected Species*

7818 This section describes the impacts to other federally threatened and endangered species (referred to as
7819 ESA-listed species) and designated critical habitat described in Chapter 3 that were not described in
7820 previous sections. ESA-listed seagrasses (Section 4.4.1), corals (4.4.3), fish (Section 4.4.4), terrestrial
7821 (Section 4.3.2), and wetland and floodplain (Section 4.3.3) species have been discussed in their respective
7822 sections. ESA-listed species are federally protected under the ESA, with all marine mammals being
7823 protected under the MMPA whether they are ESA listed or not. Similarly, the Migratory Bird Treaty Act
7824 and the Bald and Golden Eagle Protection Act provide federal protection to many bird species that are not
7825 protected by the ESA. For protected species that might occur within or near areas of proposed activities, a
7826 comprehensive table of NOAA ESA-listed species is in Section 3.4.2, a list of USFWS ESA-listed
7827 species anticipated is presented in Appendix E, and a list of all marine mammals is in Appendix F.

7828 ESA-listed species that may be impacted, adversely or beneficially, by the CRCP activities inhabit
7829 marine, coastal, riparian, and terrestrial habitats. Many of the marine and coastal species reside or
7830 temporarily migrate through areas where proposed activities may occur. The ESA provides for the
7831 conservation of species in danger of extinction throughout all or a significant portion of their range,
7832 presently or in the foreseeable future, as well as designation of critical habitat for these species.

7833 Potential impacts to these other ESA-listed species from activities similar or identical to those in the
7834 current CRCP activities (Section 2.3) have been evaluated in previous EISs and EAs, specifically NOAA
7835 RC PEIS 2015 (Section 4.7), OCS PEA 2013 (Section 4.2.2), NOAA PDARP/PEIS 2016 (Section 6.9.1),
7836 the programmatic Biological Opinion (Opinion) on the Preferred Alternative within the Deepwater
7837 Horizon Oil Spill Programmatic Damage Assessment and Restoration Plan and Programmatic
7838 Environmental Impact Statement (NOAA PBO 2016 [Section 6.12]), ONMS PEA 2018 (Section 5.3),
7839 CRED PEA 2010 (Section 7.2), MDP PEA 2013 (Section 5.2.3), NCCOS EA 2016 (Section 4.1), and the
7840 USFWS framework Biological Opinion/Conference Opinion (Section 6.0; [USFWS, 2016]). These
7841 documents outlined levels above which adverse impacts would require further individual consultation and
7842 can be referred to for such documentation. Based on the results of these documents, no significant adverse
7843 impacts to ESA-listed sea turtles, marine mammals, or birds are anticipated as a result of the activities
7844 included in any of the three alternatives. Potential impacts to ESA-listed sea turtles, marine mammals, and
7845 birds in or near areas of interest to this DPEIS are summarized here based on the results of these previous
7846 evaluations and as related to proposed activities.

7847 Sea turtles, marine mammals, and protected birds are distributed across U.S. coral reef jurisdictions with
7848 some species such as the sperm whale (*Physeter microcephalus*) potentially occupying all jurisdictions,
7849 and other species, such as the Hawaiian monk seal (*Neomonachus schauinslandi*) being limited to one
7850 jurisdiction. There are a few differences among jurisdictions in ESA-listed species and critical habitat, as
7851 described in Chapter 3, Section 3.4.2. For example, the Pacific Islands jurisdictions (Hawaii, American
7852 Samoa, Guam, and the CNMI) are typically more species-rich and diverse than the Caribbean (i.e.,
7853 Florida, Puerto Rico, and the USVI) and Gulf of Mexico jurisdictions, and U.S. Remote Pacific Island
7854 Areas have fewer development impacts when compared with the Florida coast or the MHIs. All the CRCP
7855 jurisdictions have ESA-listed sea turtles, marine mammals, and birds, including designated critical habitat
7856 for many species, and are impacted by CRCP activities in the same manner regardless of jurisdiction for
7857 this analysis.

7858 While there is the potential for incidental take of ESA-listed sea turtles, marine mammals, and birds as the
7859 CRCP activities are implemented, NOAA does not anticipate the activities and potential impacts
7860 discussed below to result in adverse impacts to any of these ESA-listed species or result in the destruction
7861 or adverse modification of designated critical habitat. Because of the programmatic nature of this DPEIS,
7862 individual projects would likely require a project-specific consultation with NOAA NMFS or USFWS if
7863 the programmatic consultations do not consider all effects of an individual project. Adherence to any
7864 project modifications or avoidance and minimization measures would be identified through additional
7865 ESA Section 7 consultations, as appropriate.

7866 Management and conservation efforts similar or the same as those implemented under the CRCP (e.g.,
7867 monitoring, research, watershed restoration, coral restoration, and marine debris removal activities) were
7868 evaluated in the NOAA PDARP/PEIS 2016 and also addressed in the corresponding NOAA PBO (2016)
7869 with respect to potential adverse impacts to all of the listed species addressed in this section. These
7870 documents are referenced as appropriate in the following sections. The Programmatic Biological Opinion
7871 (Opinion) on the Preferred Alternative within the Deepwater Horizon Oil Spill Programmatic Damage
7872 Assessment and Restoration Plan and Programmatic Environmental Impact Statement (NOAA PBO,
7873 2016) concluded that restoration activities proposed under the NOAA PDARP/PEIS 2016 are “not likely
7874 to jeopardize the continued existence of any listed endangered or threatened species under the jurisdiction
7875 of NMFS and not likely to destroy or adversely modify any designated critical habitat” (Section 11).

7876 *4.5.2.1 No Action Alternative*

7877 The CRCP activities included in the No Action Alternative that have the potential to affect these other
7878 protected species are related to monitoring, mapping, and research; coral restoration and intervention;
7879 watershed and management activities; and reduction of physical impacts to coral reefs. Each of these
7880 activity groups includes a component that has been known to impact protected coral, fish, terrestrial and
7881 marine mammals, birds, amphibians, reptiles, invertebrates, and/or plant species through habitat loss,
7882 habitat degradation, water quality degradation including turbidity and contamination, handling and direct
7883 contact, displacement, and sound and reverberations (NOAA RC PEIS, 2015). Adverse impacts can be
7884 indirect: for example, an activity might cause disruption in behavioral patterns or loss of the availability
7885 of habitat; or an adverse impact may be direct: for example, an activity such as a vessel strike, may
7886 incidentally result in harm or injury to a species. When one or more individual's fitness to breed and
7887 reproduce as a result of these direct or indirect adverse effects is reduced, an adverse effect can occur at a
7888 population level. Minimization and avoidance efforts for particular impacts, such as vessel strikes or
7889 disturbance due to construction activities, can be implemented to reduce the likelihood of interaction with
7890 ESA-listed marine turtles, marine mammals, and birds performing essential behavioral functions such as
7891 migration, breeding, and nesting. The NOAA RC PEIS 2015 described mitigation measures that could be
7892 implemented during marine debris removal in riverine and coastal habitat restoration projects. For
7893 example, mitigation measures include using experienced personnel and type of equipment during debris
7894 removal activities, avoid direct interactions with ESA-listed species, schedule debris removal during
7895 appropriate tide cycles to avoid unnecessary water quality impacts, and implement BMPs related to
7896 construction activities to avoid impacts during equipment staging, vehicle or foot traffic.

7897 Because impacts to protected corals, fish, plants are discussed above, the following analysis of other
7898 protected species includes three categories: sea turtles, marine mammals, and protected birds. Though all
7899 sea turtles and some marine mammals are ESA-listed species, because of their specialized characteristics
7900 and habitat, regulatory protection, and similarity of impacts within each activity group, they are presented
7901 separately from other listed species.

7902 **Monitoring, mapping, research.** Adverse impacts to sea turtles, marine mammals, and protected birds
7903 would be direct, indirect, short- and long-term, local, and negligible to minor, based on the proposed
7904 activities and the type of habitat in which the activity occurs. Potential adverse impacts of monitoring,
7905 mapping, and research activities may include activities associated with the use of in-water vessels and
7906 land-based surveys related to vessel transit, sea floor mapping using echosounder, benthic sampling, and
7907 deployment of equipment, and drones. Subsequent impacts to sea turtles, marine mammals, and protected
7908 birds that may be in the path or vicinity of vessels may include physical interactions due to accidental
7909 strikes or groundings, behavioral changes or physiological impacts due to sounds from vessels,
7910 echosounder, and potential entanglement or harmful contact with sampling, anchors, or other equipment.
7911 Chemical releases (primarily oils) from vessels, improperly sanitized dive equipment, and contaminated
7912 sampling equipment could result in temporary, short-term, minor impacts to sea turtles, marine mammals,
7913 and protected birds if there is contact with the chemical. Research and mapping activities may also affect
7914 behavior through the physical presence of divers and snorkelers, and sound. Impacts may range from
7915 negligible due to absence of a species in an area and/or no increase in vessel transit or activities, to minor,
7916 due to the presence of ESA-listed species.

7917 The OCS PEA 2013 (Section 5.1) and the ONMS PEA 2018 (Section 4.1-4.4) include analyses for the

7918 potential impacts to sea turtles, marine mammals, and birds (Sections 5.1.1 and 5.1.3) from monitoring,
7919 mapping, and research activities, including vessel activities, similar to or the same as activities included in
7920 the CRCP. The NOAA RC PEIS 2015 (Section 4.5.13) concluded that adverse impacts to ESA-listed
7921 species may include effects of monitoring from handling, sound, turbidity, displacement, and mortality.
7922 The OCS PEA 2013 and FONSI concluded that adverse impacts to the environment would be temporary,
7923 non-significant, and low impact. Examples of these effects include avoidance behavior of whales in the
7924 presence of a survey vessel or disturbance of wildlife while drilling during tide gauge installation, which
7925 produces sound levels lower or similar to mooring buoy installation and drilling coral cores. The ONMS
7926 PEA 2018 indicates less than significant adverse physical impacts to ESA-listed sea turtles, marine
7927 mammals, and birds as a consequence of monitoring, mapping and research activities (does not address
7928 overall benefits to management and conservation).

7929 ● **Sea turtles.** Sea turtles use the pelagic zone either permanently or transitionally, are highly
7930 migratory, and do not rely directly on coral reefs. Sea turtles can use coral reefs for food, such as
7931 the hawksbill sea turtle, which consumes sponges on coral reefs, but they are not confined to a
7932 coral reef and spend most of their life stages away from coral reefs. Food sources range from
7933 seagrasses and algae for the green sea turtle, to squid, shrimp, crabs, and jellyfish for the
7934 leatherback sea turtle. Adverse impacts to sea turtles and associated critical habitat due to
7935 monitoring, mapping, and research activities such as vessel use, sound, anchoring, turbidity, and
7936 bottom sampling are described in the OCS PEA 2013 (Section 5.1). Sea turtles that spend time in
7937 coastal habitats can be impacted by increased vessel traffic associated with monitoring activities;
7938 however, those impacts are temporary, localized, and short-term. Similar to other NOAA
7939 programs, the CRCP implements BMPs to prevent vessel collisions and sound impacts to sea
7940 turtles, which include restricting vessel speeds and direction, placing vessels in neutral in the
7941 presence of animals, and moving away when animals are observed within specific distances of
7942 the vessel; Appendix A (NMFS, 2008; NOAA, 2013). The nesting beaches of sea turtles would
7943 largely be unaffected by the proposed activities, which will occur during daylight hours. The
7944 research that is being conducted could have long-term beneficial impacts to species management,
7945 BMP development, habitat protection, vessel restrictions, or conservation areas by gathering data
7946 to inform future habitat management decisions to benefit species as described in NOAA RC PEIS
7947 2015 (Section 4.5.2).

7948
7949 ● **Marine Mammals.** Monitoring, mapping, and research activities have the potential to impact
7950 marine mammals in a manner similar to those described for sea turtles in the marine environment.
7951 Many marine mammals are migratory, including humpback whales, fin whales, sei whales, and
7952 sperm whales, which spend the winter months in proximity to temperate, subtropical or tropical
7953 locations and summer months in cooler locations. Dolphins are much more frequent visitors to
7954 coral reefs but do not rely directly on coral reefs. Hawaiian Monk seals use coral reef and other
7955 areas as foraging and breeding habitat. The transitory nature of marine mammals can increase the
7956 potential for vessel strikes and sound impacts since the exact location of these species is unknown
7957 and activities can be conducted in any open waterbody. Most of the CRCP activities are
7958 conducted within coral reef ecosystems where many marine mammals may feed and/or breed
7959 during part of their lives.

7960
7961 Active echosounders result in sound in the water column that creates the potential to behaviorally

7962 disturb certain marine mammals. Disturbance depends on whether the functional hearing range of
7963 the marine mammal overlaps with the acoustic range of the hydroacoustic survey sources
7964 employed. Many marine mammal species can occur in the CRCP's action area (see Appendix F).
7965 The OCS PEA 2013 evaluated the potential impacts of hydrographic surveys, including
7966 bathymetric surveys using side scan echosounder and multibeam echosounders similar to those
7967 employed by CRCP. NMFS's Northeast, Pacific Islands, Southeast Fisheries Science Center
7968 PEAs and accompanying MMPA analyses assessed the potential impacts of hydroacoustic
7969 surveys for fish aggregation (NMFS, 2019; NMFS, 2016; NEFSC, 2016; PIFSC, 2015; SEFSC,
7970 2016). Sound from these units analyzed ranges from 50-500 kHz, and single beam echosounders
7971 range from 12-100 kHz. Single-beam echosounders can operate as low as 12 kHz, but due to the
7972 narrow, downward facing orientation of the beam, the beams are narrowly dispersed, providing
7973 opportunity for mammals to avoid impacts. Mysticete cetaceans (baleen whales) typically hear in
7974 the range of 7 Hz-25 kHz, while otariids (eared seals and manatees) hear in the 75 Hz-30 kHz
7975 range underwater. The hearing of odontocetes (e.g., toothed whales, sperm whales, and dolphins)
7976 have a hearing range of 150Hz-160 kHz, and some porpoises and dolphins hear frequencies up to
7977 180 kHz. Therefore, baleen whales, eared seals, and manatees cannot typically hear in the 50-500
7978 kHz frequency range underwater and are not at risk for acoustic harassment from side scan
7979 echosounder and multibeam echosounders. Phocids (true seals), including the Hawaiian monk
7980 seal, can hear in frequencies greater than 50 kHz and may exhibit avoidance behavior in the
7981 presence of high frequency sound from side scan echosounder and multibeam echosounders
7982 (NOAA, 2013). Many of the activities covered under this DPEIS are focused on coral reefs, not
7983 deep-water environments where many of the more sensitive marine mammal species, such as
7984 beaked whales, are often found and it is unlikely that proposed activities will overlap with ESA-
7985 listed whales.

7986 Adverse effects are anticipated to be limited to temporary, minor behavioral disturbances. As
7987 analyzed by NOAA, the most likely response to these sound sources is behavioral disturbance,
7988 which may include a variety of effects, including subtle or minor changes in behavior (e.g., minor
7989 or brief avoidance of an area or changes in vocalizations). CRCP does not anticipate more
7990 sustained and/or potentially severe reactions, such as displacement from or abandonment of high-
7991 quality habitat. Because the survey vessel is itself moving and because of the directional nature of
7992 the sources considered here, repeated exposures are unlikely, and behavioral reactions are
7993 expected to be of short duration and low severity. As such, we conclude that the impacts to
7994 marine mammals from hydroacoustic survey activities would be temporary and negligible to
7995 minor. For these reasons, NOAA has determined that no incidental take authorization is required
7996 for the proposed programmatic action. CRCP will review future specific hydrographic survey
7997 proposals to determine whether effects might occur that would require additional NEPA review,
7998 and MMPA and ESA compliance.

7999 The CRCP supported in-water research and monitoring activities do not directly target marine
8000 mammals; however, the implementation of these activities may alter behavior due the presence of
8001 SCUBA divers in the water or sounds associated with installing moored instruments or drilling
8002 coral cores. Transect tapes that are temporarily laid across coral reefs and associated ecosystems
8003 are removed once the divers collected need information and are not likely to pose an
8004 entanglement threat. Additionally, the CRCPs BMPs requires observers for protected species, and

8005 if a protected species moves into the area, the work stop until the animal leaves on its own. The
8006 adverse impacts of the in-water monitoring and restoration activities would be negligible to
8007 minor, local, and short-term.

8008 The temporary use of echosounder, the limited probability of species co-occurrence with these
8009 activities, implementation of BMPs and mitigation measures, and the ability of the marine
8010 mammal to avoid the survey area limits adverse impacts for mapping, monitoring and research
8011 activities. These activities would benefit marine mammals by providing information critical to
8012 management recommendations and regulations related to fishery management, coral health and
8013 restoration, and water quality. Though research from the proposed activities does not specifically
8014 address marine mammals, data collected related to water quality, sediment, and fish can be
8015 applied to marine mammal management and habitat protection.

8016
8017 ● **Birds.** Monitoring, mapping, and research activities may include temporary disturbance to marine
8018 seabirds during increased vessel activity and drone use for mapping coral reef ecosystems and
8019 terrestrial habitats. However, these species are likely to temporarily disperse during these
8020 activities. The OCS PEA 2013 evaluated impacts of hydrographic surveys on various biological
8021 resources and found that activities associated with survey, including vessel activity, would have
8022 no significant adverse impact on seabirds, ESA-listed species, and other birds. The OCS PEA
8023 2013 states there is no scientific evidence supporting a disturbance of nesting or breeding seabirds
8024 in the presence of vessels surveying in nearshore waters.

8025
8026 **Coral restoration and intervention.** In-water coral restoration and intervention techniques could stress,
8027 injure, or harm sea turtles, marine mammals, and protected birds. Chemical releases (primarily oils) from
8028 vessels, improperly sanitized dive equipment, and contaminated sampling equipment could result in
8029 temporary, short-term, minor impacts to sea turtles, marine mammals, and birds if there is contact with
8030 the chemical. Lines used in nurseries may pose entanglement hazards for sea turtles and marine mammals
8031 that may result in injury or harm to these species. Similarly, entanglement could occur when lines become
8032 detached during storms and other disturbances. Sound caused by installation of anchors (e.g., duckbill
8033 anchors, helix ground anchors, rebar, anchor screws, heavy weights, or eye bolts cemented into hard-
8034 bottom) to hold nursery systems in place may temporarily alter the behavior of sea turtles or marine
8035 mammals near the area of installation. The use of BMPs to reduce or minimize impacts to protected
8036 species during vessel operations would reduce potential adverse impacts to sea turtles and marine
8037 mammals.

8038 Antibiotics used to treat disease corals may leach into the water and become bioavailable to other species.
8039 There are concerns about the rise in antibiotic resistance bacteria and how this will not only impact
8040 human health, but also other species. Using antibiotics on corals may add to antibiotic background level
8041 currently in the system from other sources such as sewage, waste-water disposal, fish aquaculture, and
8042 animal horticulture (Gaw et al., 2014). Antibiotic resistant bacteria have been found in several marine
8043 species including sea turtles, sharks, fish, and marine mammals (Al-Bahry et al., 2009, Ahasana et al.,
8044 2017, Blackburn et al., 2010 and Stewart et al. 2014.). The compound that is used to mix the antibiotics to
8045 treat corals is silicone based and slowly leaches the antibiotics into the corals and likely into the water.
8046 Potential impacts to sea turtles, marine mammals and birds of antibiotic application in the field are
8047 unknown at this time. Site-specific NEPA analysis would be required before use of this technique in the

8048 field.

8049 With the exception of the unknown impacts from antibiotics in the field, potential adverse impacts to sea
8050 turtles, marine mammals, and birds would be direct or indirect, short-term, local, and negligible to
8051 moderate. Benefits to these species would be direct and indirect, short-and long-term, local to large scale,
8052 and negligible to major.

8053 • **Sea turtles.** The CRCP proposed restoration and intervention activities may result in temporary
8054 disturbances to sea turtles due to vessel and other in-water activities, as described above, and
8055 there is potential for entanglement in coral nurseries that could lead to injury or harm. Benefits of
8056 coral reef restoration and intervention activities that would likely result in indirect benefits by
8057 improving sea turtle habitat and food resources.

8058 • **Marine mammals.** Potential impacts to marine mammals due to coral restoration and
8059 interventions would be increased vessel activity, interactions with lines in coral nurseries, and
8060 minor disturbance from SCUBA and snorkel activities. Consequently, potential adverse and
8061 beneficial impacts would be similar to those described above for sea turtles.

8062 • **Birds.** The impacts to birds would be similar to those listed for vessel impacts under monitoring,
8063 mapping, and research. Beneficial impacts are anticipated as a result of coral reef restoration and
8064 intervention techniques that would likely lead to increases in abundance and composition of reef
8065 and fish assemblages, increasing the food supply, and improved water quality.

8066 **Watershed restoration and management.** Watershed restoration and management such as monitoring,
8067 trail and road stabilization, stormwater control activities, and associated vegetation plantings could
8068 potentially result in adverse impacts to sea turtles, marine mammals, and protected birds as a result of
8069 disturbance, burial, sound, displacement, turbidity, and habitat loss. Adverse impacts of these activities
8070 would be limited to the duration of implementation of restoration projects, and BMPs would reduce any
8071 potential adverse impacts of water quality on species. Other projects, such as creation of stormwater
8072 treatment wetlands, clearing and revegetating large areas of invasive species, and bank erosion control,
8073 may involve the use of heavy machinery for excavation, land clearing, herbicide applications, and
8074 hydrologic alterations, and would potentially result in loss of terrestrial habitat due to excavation,
8075 contamination due to herbicide use, flooding or drying due to water diversions, and potential mortality of
8076 terrestrial species due to physical impacts. Potential adverse impacts to sea turtles, marine mammals, and
8077 protected birds as a result of these activities would be indirect, short- and long-term, local, and negligible
8078 due to the majority of the work being conducted in terrestrial and wetland habitats.

8079 Benefits to sea turtles, marine mammals, and birds from these watershed restoration and management
8080 activities would be direct and indirect, long-term, local to large scale, negligible to moderate. Benefits
8081 include restored native terrestrial and aquatic habitat due to erosion reduction and removal of invasive
8082 species, greater biodiversity due to removal of invasive species, planting of native species, improved
8083 water quality due to reduced sediment and other pollutant runoff, and reduced physical disturbance due to
8084 stabilized stream flows.

8085 • **Sea turtles.** Watershed restoration and management activities may result in discharge of
8086 sediments and other pollutants into coastal and marine waters, as described for sediments (Section
8087 4.3.1) and water quality (Section 4.3.4). Potential adverse impacts of watershed restoration and

8088 management activities include construction along sea turtle nesting beaches that would involve
8089 sediment disturbance, temporary sound, and light pollution that could affect emerging juvenile
8090 sea turtles in the unlikely event that night operations were utilized. Nest loss or reduced nesting
8091 could have long-term impacts on sea turtle populations. The adverse impacts could result in
8092 direct, short-term, local, negligible to moderate impacts to sea turtles. BMPs, including stopping
8093 work on nesting beaches during the nesting season, daylight operations only, turbidity and
8094 sediment control measures (Section 4.3.4), would reduce these impacts. Overall, there would be
8095 benefits to sea turtles from watershed restoration and management activities by reducing erosion
8096 and sedimentation of a watershed and improving water quality in adjacent coastal and marine
8097 waters.

8098
8099 ● **Marine mammals.** Potential impacts to marine mammals due to watershed-related activities
8100 would also be related to sediment and other pollutants discharging into coastal and marine waters,
8101 similar to those for sea turtles, as described above. However, due to the location of most
8102 watershed restoration projects on land, most marine mammals will not likely be affected
8103 adversely. Marine mammals may benefit by long-term reduction of erosion, improved water
8104 quality, reduced pollutant runoff, and increased research to improve watershed management.

8105
8106 ● **Birds.** Potential impacts to birds due to watershed-related activities are related to construction
8107 activities that could potentially disturb, displace, or harm nesting birds or disrupt normal
8108 behaviors, such as foraging or mating. Terrestrial, wading, and shore birds that nest in shrubs and
8109 trees within wetlands, riparian habitats, and coastal forest could be displaced during construction
8110 of stormwater control measures. Adverse effects would be local, short-term to long-term, direct
8111 and indirect, negligible to moderate. Benefits to birds would be through improved habitat and
8112 water quality, and increased research to improve watershed management.

8113 **Reducing physical impacts to coral reef ecosystems.** Adverse impacts due to mooring buoy installation
8114 and marine debris removal activities would be temporary and minimal. As described in Section 4.6.1, the
8115 use and maintenance of navigation markers and mooring buoys are expected to protect coral reef and
8116 benthic habitats from unintentional vessel and anchor damage (NPS EIS, 2015). Sea turtles, marine
8117 mammals, and birds may be disturbed by in-water activities (i.e., temporary increase in vessel traffic and
8118 sound), but they are less likely to be impacted due to the mobility of these species. Debris removal
8119 reduces exposure potential and susceptibility of entanglement, ingestion to ESA-listed marine species or
8120 damage to coral reef habitats (CRED PEA, 2010 [Section 7.1]).

8121 Potential adverse impacts due to the installation of mooring buoys and removal of marine debris to sea
8122 turtles, marine mammals, and protected birds would be direct, short-term, local, and negligible to minor.
8123 The fixed lines associated with mooring buoys are highly unlikely to pose an entanglement threat to sea
8124 turtles and marine mammals because it is a single, taut line. During the installation of mooring buoys,
8125 sound can alter animal behaviors and disrupt normal activities.

8126 Adverse impacts to sea turtles, marine mammals, and protected birds from marine debris removal are
8127 related to operation of vessels and divers, and potential sediment resuspension during the activity. These
8128 disturbances, however, would primarily be local, and the effects would be minor and short-term.
8129 However, leaving large debris results in further damage to the reef as debris can re-mobilize further

8130 impacting reefs by moving back and forth in place, move across a reef by wave or wind energy or break
8131 apart thus spreading debris to a broader area (MDP PEA, 2013 [Section 5.2]). Furthermore, not removing
8132 marine debris can be an entanglement hazard to ESA-listed species and other marine life. Therefore,
8133 reducing the potential entanglement hazards by removing marine debris and damage to benthic habitats
8134 from anchors and grounding, the potential benefits to sea turtles, marine mammals, and protected birds
8135 would be direct and indirect, short- and long-term, local, and negligible to major.

- 8136 ● **Sea turtles.** Sea turtles could be impacted by increased vessel and equipment use for installation
8137 of mooring buoys and/or debris removal contributing to unintentional vessel strikes. However,
8138 those instances would be localized, and short-term and would be mitigated by the implementation
8139 of the CRCP's BMPs. Sounds from buoy installation or removal of marine debris can alter
8140 behavior (e.g., disrupt foraging) if a sea turtle is in the area during installation or removal
8141 activities. Removing marine debris also reduces potential entanglement and ingestion hazards to
8142 sea turtles. For example, rope, chain, nets, or other loose material can trap sea turtles to a point
8143 that their movement is restricted, and they cannot surface for air, search for food, or avoid
8144 predators.
- 8145 ● **Marine mammals.** Potential adverse and beneficial impacts to marine mammals due to mooring
8146 buoy installation and marine debris removal are consistent with potential impacts to sea turtles
8147 described above, including the benefit to reduce potential entanglement hazards to species such as
8148 the Hawaiian monk seal.
- 8149 ● **Birds.** Adverse impacts to listed birds due to mooring buoy installation and marine debris
8150 removal would be negligible due to implementation of the BMPs and their ability to move away
8151 from in-water construction activity. Benefits to reducing marine debris would be direct, short-
8152 term, local, and negligible to major due to the reduction in entanglement hazards, contamination,
8153 and decreased potential to ingest marine debris.

8154 *4.5.2.2 Alternative 1*

8155 Under Alternative 1, current CRCP activities that support coral restoration and intervention and reduce
8156 physical disturbance to corals would be eliminated.

8157 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to sea turtles, marine
8158 mammals, and protected birds from monitoring, mapping, and research activities would be the same as
8159 described for the No Action Alternative.

8160 **Coral reef restoration and interventions.** The continued direct loss of coral reef habitat is expected
8161 under Alternative 1 due to elimination of coral proposed activities and activities that reduce the impacts of
8162 coral-specific invasive species, disease, and predators (Section 4.4.3). Potential adverse impacts to sea
8163 turtles, marine mammals, and protected birds under this alternative would be direct and indirect, short-
8164 and long-term, local and large scale, and minor to moderate due to the continued loss of coral reefs. No
8165 benefits to sea turtles, marine mammals, or protected birds are expected as a result of excluding coral reef
8166 restoration and intervention activities.

8167 **Watershed restoration and management.** Potential adverse impacts and benefits to sea turtles, marine
8168 mammals, and protected birds would be the same as described for the No Action Alternative.

8169 **Reducing physical impacts to coral reef ecosystems.** Eliminating the installation of mooring buoys and
8170 components of the marine debris removal currently conducted by the CRCP could result in continued

8171 damage and injury to sea turtles, marine mammals, and birds. Eliminating this portion of the CRCP would
8172 not affect debris removal that occurs under NOAA’s extensive Marine Debris Program and would only
8173 eliminate debris removal in a relatively small number of the CRCP project areas. Increased anchoring,
8174 without a mooring buoy, can lead to increased sediment disturbances, resuspension of debris, and direct
8175 injury to listed species. Results include continued impacts of marine debris on sea turtles, marine
8176 mammals, and protected birds in marine and coastal habitats. These species can be impacted by debris,
8177 including plastics, in the marine environment through entanglement and ingestion (Wilcox, 2018).
8178 Entanglement of sea turtles, marine mammals, and birds in marine debris, at sea or on beaches, can
8179 reduce the movement of an animal, restricting its access to air and food. Ingestion of plastics can cause
8180 mortality in juvenile and adult sea turtles, marine mammals, and birds if the object cannot pass through
8181 the digestive tract (Wilcox, 2018). According to the United Nations Environmental Programme, more
8182 than 260 species of animals worldwide—including marine mammals, birds, turtles, crustaceans, and
8183 fish—have been reported entangled in marine debris or have ingested it (Kershaw et al., 2011). In the
8184 U.S., at least 115 different marine species have become entangled in plastic marine debris (MDP PEA,
8185 2013). In particular, fishing line and nets, plastic ribbons on balloons, and similar types of trash can easily
8186 entangle animals. Derelict fishing gear is an important threat to endangered species, such as the Hawaiian
8187 monk seal, and causes significant mortality for other marine mammals, seabirds and invertebrates. Ghost
8188 fishing, which traps marine biota in derelict fishing gear, is a chronic stressor for fisheries, with direct
8189 economic losses through target and non-target species mortality (MDP PEA, 2013). Potential adverse
8190 impacts would be direct and indirect, short- and long-term, local, negligible to moderate. No benefits to
8191 sea turtles, marine mammals, or protected birds are anticipated as a result of eliminating these activities.

8192 Monitoring, mapping, and research activities would continue to provide information critical to
8193 conservation and management of listed species. Watershed restoration and management activities would
8194 continue to reduce sediment and other pollutant loads and improve water clarity in coastal waters and
8195 benefit listed species. However, the overall benefits would be reduced due to the exclusion of the
8196 components of the CRCP that directly address coral restoration and physical impacts to coral reefs.
8197 Therefore, overall potential benefits would be direct and indirect, short- to long-term, local, and negligible
8198 to minor.

8199 *4.5.2.3 Alternative 2*

8200 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to the BMPs that are part
8201 of the current CRCP and may further reduce the potential for adverse impacts to sea turtles, marine
8202 mammals, and protected birds from proposed activities. Implementation of DCMMs alone would have no
8203 adverse impacts to these protected species. Adverse impacts under Alternative 2 would be similar to the
8204 No Action Alternative but may have additional, negligible reductions as a result of DCMMs, depending
8205 on the activity.

8206 Additional training with vessels and equipment, additional limitations and precautions for mooring buoy
8207 and equipment installation, and reduced anchoring due to use of permanent mooring buoys would be
8208 expected to further reduce the negligible adverse impacts to sea turtles, marine mammals, and birds due to
8209 monitoring, collection, vessel operation and buoy installation, debris removal, and other in-water
8210 activities described under the No Action Alternative (NOAA, 2013). Benefits of DCMMs that reduce the
8211 risks associated with coral restoration and intervention would also benefit coral reef habitats and their
8212 potential value to sea turtles and marine mammals. Additional DCMMs may provide further, but likely

8213 negligible, benefits to wetlands and floodplains when compared with the No Action Alternative.

8214 **4.6 Socioeconomic Environment**

8215 ***4.6.1 Cultural Resources***

8216 Cultural resources include a variety of physical resources protected by Federal statute and Executive
8217 Orders and include archaeological resources, antiquities, shipwrecks, historic properties and resources of
8218 importance to federally recognized tribes and NHOs. Activities conducted under the CRCP would
8219 continue to comply with applicable statutes, Executive orders and NOAA policies addressing cultural
8220 resources as those activities are proposed, planned and implemented. Of primary importance to the CRCP
8221 is the NHPA, which provides a legal framework for identifying the foregoing resources, to the extent they
8222 meet certain criteria; predicting effects; and in consultation with specified stakeholders, resolving adverse
8223 effects. The NHPA defines a historic property as “any prehistoric or historic district, site, building,
8224 structure, or object included in, or eligible for inclusion on the National Register [of Historic Places].”
8225 Also included are any artifacts, records, and remains (surface or subsurface) that are related to and located
8226 within historic properties and any properties of traditional religious and cultural importance to Tribes or
8227 NHOs. These resources may be above ground, below grade, or submerged in waterways and include
8228 resources listed in, or eligible for listing in the NRHP.

8229 Examples of terrestrial cultural resources may include buildings, structures, sites, and objects. Examples
8230 of marine cultural resources may include shipwrecks, navigation landmarks, traditional fishing areas, and
8231 relic weapons and ammunition. Effects to cultural resources that are considered adverse, including those
8232 under the NHPA, include physical destruction, damage, or alteration, including moving the property or
8233 cultural resource from its historic location; isolation from, or alteration of, the setting; and introduction of
8234 intrusive elements. Proposed activities could have direct, permanent, minor to moderate adverse impacts
8235 to cultural resources during restoration or other on-the-ground activities. While they are derived from
8236 impacts to the characteristics that may qualify the site for inclusion in the National Register based on the
8237 following definitions (adapted from NOAA RC PEIS 2015), we apply them to all cultural resources. For
8238 this DPEIS, the intensity of adverse impacts to cultural resources are described below.

- 8239 ● Minor: the effect is detectable but small and effects are limited to the area of a site, structure, or
8240 group of sites or structures. Impacts to any of the characteristics that qualify the site(s) for
8241 inclusion in the National Register may diminish the integrity of the site(s). For purposes of
8242 Section 106, the determination of effect would be adverse impact.
- 8243 ● Moderate: the effect is measurable and detectable and may alter one or more of the characteristics
8244 that qualify the site(s) or structure(s) for inclusion in the National Register and diminishes the
8245 integrity of the site(s) but does not jeopardize its National Register eligibility. For purposes of
8246 Section 106, the determination of effect would be adverse effect.
- 8247 ● Major: the impact to the site or structure, or group of sites or structures, is substantial, noticeable,
8248 and permanent, alters one or more characteristics that qualify the site(s) for inclusion in the
8249 National Register, diminishing the integrity of the site(s) or structure(s) to such an extent that it is
8250 no longer eligible for listing in the National Register. For purposes of Section 106, the
8251 determination of effect would be adverse effect.

8252 Given the nature of cultural resources, adverse impacts are generally considered permanent, except when

8253 impacts are restricted to proposed activities that temporarily prevent the use of a site for culturally
8254 important practices or impair a viewshed. When there is a potential for impact to archeological or
8255 historical resources, NOAA consults with the appropriate state and local officials, federally recognized
8256 tribes, NHO, and potentially the Advisory Council on Historic Preservation and considers their views on
8257 effects to cultural resources and resolves adverse effects prior to making a final project implementation
8258 decision. The proposed action and alternatives analyzed in this DPEIS are programmatic in nature and,
8259 therefore, do not trigger any specific NHPA Section 106 compliance requirements. However, any CRCP
8260 activities that might affect cultural resources would undergo project-specific NHPA Section 106
8261 consultations in the future. Such consultation frequently results in a letter from (SHPO) or Tribal Historic
8262 Preservation Officer (THPO) with a determination of “no historic properties affected” or with stipulations
8263 to reduce the adverse impacts such as the following:

- 8264 ● Archival quality photographs of structures prior to removal and documentation on appropriate
8265 state-designated forms,
- 8266 ● Immediate notification of SHPO/THPO if previously undocumented historic properties or sites
8267 are discovered during the project;
- 8268 ● Interpretive signs,
- 8269 ● Development and implementation of unanticipated discovery plans,
- 8270 ● Installation or remediation of structures in accordance with the Secretary of the Interior’s
8271 Standards for Rehabilitation, and
- 8272 ● Monitoring of excavations and site disturbance by a historian or archaeologist who meets the
8273 Secretary of the Interior’s Professional Qualification Standards.

8274 *4.6.1.1 No Action Alternative*

8275 Cultural resources have the potential to be affected by any ground-disturbing activities or other activities
8276 that may diminish the integrity of the structure or site. Impacts to cultural resources resulting from the
8277 implementation of CRCP activities are dependent on site-specific conditions.

8278 **Monitoring, mapping, and research activities.** Monitoring, mapping, and research activities have the
8279 potential to impact cultural resources due to disturbances due to soil or sediment sampling in the marine
8280 and terrestrial environments. However, sediments samples would be small and would be located as to not
8281 impact known cultural resources. Adverse impacts to marine cultural resources from anchoring,
8282 monitoring and sampling equipment, and diving activities may also occur due to disturbances by vessels
8283 and other in-water activities. Potential adverse impacts are expected to be direct, short-term, local, and
8284 negligible to minor. Discovery or recovery of cultural or historic resources would allow their future
8285 protection. Benefits of these activities include reduced erosion of soils covering archaeological sites, or
8286 increased use of the site for culturally important practices, such as subsistence harvest, and data to support
8287 greater protection for cultural resources. Potential benefits would be indirect, long-term, local to large
8288 scale, and negligible to minor due to the potential for identifying cultural resources during surveys for
8289 other resources.

8290 **Coral restoration and interventions.** Potential impacts to cultural resources due to coral restoration and
8291 interventions would be limited to associated vessel activity, equipment use, and SCUBA and snorkel
8292 activities. Consequently, potential impacts would be the same as those described for monitoring,
8293 mapping, and research, activities, described above.

8294 **Watershed restoration and management.** Construction activities associated with watershed restoration
8295 and management activities may impact cultural resources due to land surface disturbance, excavation, and
8296 construction of stormwater management projects. Consultation with the appropriate SHPO/THPO and
8297 other consulting parties prior to project construction would minimize or preclude the likelihood of
8298 disturbance or damage to a known cultural or historic site or structure. If an undocumented cultural or
8299 historic structure or site is discovered, construction activities would cease, the local SHPO/THPO office
8300 would be notified, and consultation would proceed as appropriate. In this case, there is potential for initial
8301 damage to the integrity of a site or structure, but it is likely that the disturbance would result in adverse
8302 effects of an intensity that would preclude it from eligibility for listing in the National Register due to a
8303 loss of integrity. Consequently, potential adverse impacts to cultural resources from these activities would
8304 be direct and indirect, long-term, local, and negligible to minor. Benefits would be direct, long-term,
8305 local, and negligible to moderate, due to the potential for identifying and preserving cultural resources.

8306 **Reducing physical impacts to coral reef ecosystems.** Potential impacts to cultural resources due to
8307 mooring buoys and debris removal would also be limited to associated vessel activity, equipment use, and
8308 SCUBA and snorkel activities. Therefore, potential impacts would be the same as those described for
8309 monitoring, mapping, and research activities, described above.

8310 *4.6.1.2 Alternative 1*

8311 Under Alternative 1, current CRCP activities that support coral restoration and intervention and reduce
8312 physical disturbance to corals would be eliminated.

8313 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to cultural resources from
8314 monitoring, mapping, and research activities would be the same as described for the No Action
8315 Alternative.

8316 **Coral reef restoration and interventions.** Eliminating coral restoration and intervention activities under
8317 Alternative 1 would also eliminate the potential for adverse impacts to cultural resources that may occur
8318 as a result of these activities. For example, eliminating coral reef intervention activities may also
8319 eliminate some opportunities to visit these reefs and observe sites that may have the potential to be a site
8320 of historical or cultural significance. Adverse impacts may result from the loss of coral reefs and
8321 subsequent reductions in coastal resource protection (including cultural resources) from wave and storm
8322 energy, and the potential damage. Potential adverse impacts to cultural resources would be expected to be
8323 direct, short- to long-term, local, and negligible. Benefits to cultural resources may occur due to reduced
8324 disturbance under this alternative, but the potential reductions would be negligible. In addition, recovery
8325 and preservation of such coastal resources may be reduced as a result of reduced coastal activities that
8326 may include the documentation of cultural resources encountered during their implementation. Potential
8327 benefits would be indirect, long-term, local, and negligible.

8328 **Watershed restoration and management.** Potential adverse impacts and benefits to cultural resources
8329 would be the same as described for the No Action Alternative.

8330 **Reducing physical impacts to coral reef ecosystems.** Eliminating the installation of permanent mooring
8331 buoys under the No Action Alternative would have the potential for direct damage to cultural resources
8332 from continued multiple anchorings and anchors dragging along the sea floor where resources may occur.
8333 Without removal of marine debris, derelict fishing gear, vessels, and other debris would continue to
8334 accumulate and/or move across the sea bottom with currents and waves, resulting in physical disturbance

8335 to cultural resources that may be present, as well as potential contamination due to fuels or other
8336 pollutants (Section 4.3.4). Adverse impacts to cultural resources would be direct, short- to long-term, and
8337 negligible to major. However, in the absence of debris removal, the potential for disturbing, or recovering,
8338 any potentially present cultural resources is also eliminated, as is the potential for the identification of the
8339 same resource. Benefits to cultural resources as a result of Alternative 1 would be indirect, long-term,
8340 local, and negligible to minor.

8341 *4.6.1.3 Alternative 2*

8342 Under Alternative 2, there are no DCMMs (Appendix B) that directly address cultural resources.
8343 However, additional DCMMs under Alternative 2 that have the potential to affect cultural resources
8344 include addition controls to reduce turbidity and sediment, management plans to ensure activities are
8345 completed and equipment removed when no longer in use, greater restrictions on instrument mooring,
8346 prioritizing the use of recreational mooring buoys or live boating, and additional training for vessel
8347 operators. These activities would further reduce erosion and runoff into coastal and marine waters that
8348 may bury or damage cultural resources. No adverse impacts are anticipated as a result of these additional
8349 DCMMs. Adverse impacts would be the same as for the No Action Alternative.

8350 Overall, additional activities included under Alternative 2 would further contribute to the reductions in
8351 adverse impacts to cultural resources that may occur under the No Action Alternative. Benefits due to
8352 additional reductions in stormwater runoff and in-water activities anticipated as a result of additional
8353 DCMMs would be negligible under the No Action Alternative.

8354 **4.6.2 Public Health and Safety**

8355 Potential impacts to human health and safety associated with implementation of activities under the
8356 proposed alternatives may include exposure to or increased likelihood of oil and hazardous materials,
8357 occupational hazards, flooding, and/or shoreline damage, as well as physical injury due to heavy
8358 machinery or vessels. Workers are protected under the federal Occupational Safety and Health
8359 Administration, which mandates that employers protect their employees from occupational hazards that
8360 may result in injury and are therefore not addressed here.

8361 *4.6.2.1 No Action Alternative*

8362 Under the No Action Alternative, projects that involve the use of vessels, diving, and other in-water
8363 activities, as well as the use of heavy machinery in the watershed have the potential to result in accidents
8364 and injury.

8365 **Monitoring, mapping, and research.** Under the No Action Alternative, areas proposed for monitoring,
8366 mapping, and research would remain open to visitors during work to implement proposed activities.
8367 Boater safety practices and signs/markings to indicate work areas would reduce the risks of injury and/or
8368 vessel groundings. Possible introduction of invasive species or coral diseases into new areas may also
8369 adversely impact public health and safety by reducing the potential recovery among coral reefs, which
8370 could reduce shoreline protection. However, the CRCP's BMPs (Appendix A) include decontamination
8371 protocols to reduce the likelihood of spreading coral diseases. Pollutant spills from boats or other vehicles
8372 (e.g., paint, fuel) may travel offsite and expose visitors to the pollutants. Risks would be mitigated by the
8373 use of BMPs that reduce opportunities for trespass into work areas and reduce the possibility of pollutant
8374 release. Potential adverse impacts to public health and safety would be direct, short- to long-term, local,
8375 and negligible.

8376 Benefits of these activities include acquisition and information to improve public health and safety. For
8377 example, data collected in coastal and marine waters would support fishing and other recreation
8378 management and help identify areas that may be impacted by flooding due to surface water runoff, sea
8379 level rise, or storm-related risks. Potential benefits to public health and safety would be indirect, long-
8380 term, local to large scale, and negligible to moderate.

8381 **Coral restoration and intervention.** Potential adverse impacts to public health and safety due to coral
8382 restoration and intervention activities would include those described for monitoring, mapping, and
8383 research. The potential for introduction of invasive species, disease, or corallivores into new areas may
8384 also adversely impact public health and safety by reducing the potential recovery among coral reefs,
8385 subsequently reducing shoreline protection due to coral reefs. However, the CRCP's BMPs (Appendix A)
8386 include decontamination protocols to reduce the likelihood of spreading coral diseases. Adverse impacts
8387 would be direct, short-term, local, and negligible to minor. Benefits to the public from coral restoration
8388 and intervention include recovery of coral reefs, associated fisheries, and shoreline protection. There
8389 would likely be a benefit to public health and safety due to natural storm protection to surrounding
8390 communities from persistent or recovering coral reefs. Benefits to public health and safety would be
8391 direct and indirect, long-term, local, and negligible to minor.

8392 **Watershed restoration and management.** Watershed restoration and management activities may result
8393 in mobilization of contaminants from machinery, fuels, or other materials associated with excavation or
8394 construction of stormwater treatment wetlands, LID, road stabilization, and other activities. Exposure of
8395 humans or other sensitive receptors such as plants and wildlife to contaminant levels could result in health
8396 effects. Herbicide applications for invasive species, if not implemented correctly, may pollute surface or
8397 groundwater or soils and may travel offsite, although herbicides would be applied by a licensed applicator
8398 according to the label and established protocols for the locality. Excavation or land-clearing activities
8399 could disturb soils and mobilize legacy contaminants. However, assessment of historic or potential
8400 environmental contamination and/or documented environmental issues would provide information to
8401 prepare for the potential presence of, for example, soil or groundwater contamination, unsafe ground
8402 conditions, erosive soils, or other conditions with the potential to compromise public health and safety.
8403 Construction BMPs (Appendix A) would reduce the likelihood of surface water moving offsite.
8404 Volunteers would be trained to follow BMPs and other safety protocols to ensure public health or safety
8405 issues. Potential adverse impacts to public health and safety due to watershed restoration and management
8406 activities would be direct and indirect, short- to long-term, local, and negligible to minor.

8407 Benefits to public health and safety from these activities include reduced risk of potential hazards to
8408 visitors, residents, and workers due to improved shoreline and flood protection and improved water
8409 quality in downstream and coastal waters. Subsequent benefits to fisheries from improved water quality
8410 would improve the number and quality of fish available for recreational and subsistence fishing. Restored
8411 native habitats may reduce the spread of invasive species and subsequent impacts to local agriculture and
8412 gardens. Potential benefits would be direct and indirect, short- and long-term, local and larger scale, and
8413 negligible to minor.

8414 **Reducing physical impacts to coral reef ecosystems.** The addition of mooring buoys would benefit
8415 public health and safety by providing safe sites for visitors to stop for recreation and/or fishing and
8416 reducing vessel crowding by installing buoys in safe locations. As a result, the potential for vessel
8417 groundings and interactions with other vessels and anchors would be reduced. Debris removal activities

8418 would have the same impacts described for monitoring, mapping, and research activities, above, due to
8419 in-water activities involving vessels, equipment, and divers. Large derelict shipwrecks may offer dive
8420 exploration opportunities but may also be a safety issue. Potential adverse impacts of contamination from
8421 debris due to inadvertent fuel spills or other chemicals and subsequent water degradation that may result
8422 in beach advisories for beach goers (see Section 4.3.4) or physical harm to visitors due to persistent debris
8423 such as derelict fishing gear or remains of derelict gear or vessels and the potential for contact with the
8424 debris may also adversely impact public health and safety. Adverse impacts from debris removal would
8425 be direct, short-term, local, and negligible to minor. Marine debris removal activities would improve
8426 public health safety by removing and preventing the accumulation of marine debris by improving
8427 navigation safety. In addition, these projects can create new recreational opportunities and waterfront
8428 revitalization, provide sediment to nourish beaches, and decrease safety and liability concerns. No adverse
8429 impacts to public health or safety concerns are likely to result from debris removal activities (NOAA
8430 MDP, 2013). Benefits would be direct, long-term, local, and negligible to minor.

8431 *4.6.2.2 Alternative 1*

8432 Under Alternative 1, current CRCP activities that support coral restoration and intervention and reduce
8433 physical disturbance to corals would be eliminated.

8434 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to public health and safety
8435 from monitoring, mapping, and research activities would be the same as described for the No Action
8436 Alternative.

8437 **Coral reef restoration and interventions.** Eliminating coral restoration and intervention activities under
8438 Alternative 1 would also eliminate the potential for adverse impacts that may occur under the No Action
8439 Alternative, such as temporary water quality degradation or sediment disturbance. Under Alternative 1,
8440 adverse impacts to public health and safety would be expected due to the subsequent loss of coral reefs in
8441 the absence of restoration efforts. Adverse impacts would include increases wave energy reaching the
8442 coastline and subsequent shoreline damage and greater potential for flooding. Potential adverse impacts to
8443 public health and safety would be expected to be direct and indirect, short- to long-term, local, and
8444 negligible to moderate. No benefits to public health and safety under Alternative 1 are anticipated.

8445 **Watershed restoration and management.** Potential adverse impacts and benefits to public health and
8446 safety would be the same as described for the No Action Alternative.

8447 **Reducing physical impacts to coral reef ecosystems.** Mooring buoys reduce the potential for anchor
8448 damage to coral reefs and other habitats and reduce the number of anchors on the sea bottom. Eliminating
8449 the installation of permanent mooring buoys under the No Action Alternative would result in further
8450 crowding and anchoring in areas most frequented or favored by boaters and would result in potential
8451 safety issues due to larger numbers of boats, anchors, and visitors in an area. Without mooring buoys,
8452 visitors may be unable to find safe anchoring locations, which could result in further safety issues related
8453 to vessel groundings or other boating accidents. Without moorings, in the potential interactions among
8454 anchors from different boats, and subsequent safety issues would persist. No benefits to public health and
8455 safety are anticipated as a result of eliminating installation of additional permanent mooring buoys. If the
8456 CRCP does not participate in debris removal, some debris removal may be delayed, but NOAA's Marine
8457 Debris Program and other organizations would continue to work to remove such debris. Therefore, if the
8458 CRCP were not to implement debris removal activities, the adverse effects would not be detectable.

8459 Potential adverse impacts to public health and safety under Alternative 1 would be direct, short-term, and
8460 negligible to moderate. No benefits to public health and safety are anticipated as a result of eliminating
8461 these activities.

8462 Monitoring, mapping, and research activities would continue to provide information for managing coastal
8463 and marine resources with respect to public health and safety. Watershed restoration and management
8464 activities would continue to reduce sediment and other pollutant loads and improve water quality in
8465 coastal waters. However, the overall benefits would be reduced due to the exclusion of the components of
8466 the CRCP that directly address the potential impacts of mooring buoy installation, marine debris, and
8467 coral restoration to public health and safety. Therefore, overall potential benefits would be direct and
8468 indirect, short- to long-term, local, and negligible to minor.

8469 *4.6.2.3 Alternative 2*

8470 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs that are part of
8471 the current CRCP and may further reduce the potential for adverse impacts to public health and safety
8472 during proposed activities. Implementation of DCMMs alone would have no adverse impacts to public
8473 health and safety. Adverse impacts under Alternative 2 would be similar to the No Action Alternative but
8474 may have additional, negligible reductions in impacts as a result of DCMMs are anticipated.

8475 DCMMs that may affect public health and safety include BMPs to control turbidity and sediment,
8476 management plans to ensure activities are completed and equipment removed when no longer in use,
8477 greater restrictions on instrument mooring, prioritizing the use of recreational mooring buoys or live
8478 boating, and additional training for vessel operators. These activities further enhance the public health and
8479 safety by reducing erosion and runoff in the watershed, improving water quality in coastal and marine
8480 waters, and reducing the potential impacts of accumulating marine debris on the seafloor.

8481 **4.6.3 Economic Environment**

8482 Healthy coral reefs and associated habitats in U.S. coral reef jurisdictions support tourism, recreation, and
8483 economic opportunities. In the U.S., approximately half of all federally managed fisheries, both
8484 commercial and recreational, depend on coral reefs and associated habitats for at least a portion of their
8485 life cycles (NOAA, 2018b). These fish are a significant food source for more than one billion people
8486 worldwide, and U.S. reef-related fisheries are valued at more than \$100 million (NOAA Fisheries,
8487 2019a), accounting for a large part of the overall commercial industry. Global reef fisheries are
8488 considered unsustainable based on several studies (McClanahan et al., 2011; Teh et al., 2013, Newton et
8489 al., 2007).

8490 In 2010, more than 163 million people (approximately 52% of the U.S. population) lived in coastal
8491 counties, and this number is expected to increase to 178 million by the year 2020 (NOAA, 2013).
8492 Approximately eight million individuals participated in coastal recreational fishing along the Atlantic and
8493 Gulf of Mexico coasts each year between 2009 and 2014 (NOAA, 2019b). The most recent NOAA data
8494 indicate the commercial fishing industry employs around 1 million people (about 1,029,000 in 2009) and
8495 contributes \$116 billion to the nation's economy. Recreational fishing industries supported about 327,000
8496 full- and part-time jobs, contributing \$50 billion to the nation's economy (NMFS, 2011). A recent study
8497 estimated that U.S. coral reefs provide more than \$1.8 billion in shoreline protection (Storlazzi, 2019).

8498 The CRCP funded and summarized coral reef valuation studies for each of the sevel U.S. coral
8499 jurisdictions. This summary (NOAA CRCP, 2013) presents a valuation of goods and services (e.g.,

8500 tourism and recreation, fisheries, coastal protection, cultural resources, and biodiversity) provided by
 8501 coral reefs under U.S. jurisdiction. In order to compare the studies across jurisdictions the annual values
 8502 were converted to 2012 dollars and are presented in Table 4-2 (NOAA CRCP, 2013).

8503 *Table 4-2. Annual economic values of U.S. coral reefs based on the CRCP supported valuation studies.*

Location	Study Year	2012 Value (\$Million/year)
Florida	2001	324
Hawaii	2002	455
American Samoa	2004	11
CNMI	2006	68
Guam	2007	150
Puerto Rico	2008	1,161
USVI	2011	210

8504 Source: NOAA Summary Report: The Economic Value of U.S. Coral Reefs (NOAA CRCP, 2013)

8505 The values presented in Table 4-2 are lower than earlier citations (\$8.5 billion) for economic activity
 8506 linked to coral reefs because economic values (benefits) are inherently different from economic impacts
 8507 (activity). Economic value resides in the contributions that ecosystem functions make to human well-
 8508 being, while economic impact describes localized economic effects on local businesses and communities
 8509 (sales, employment, income, and taxes). Economic impacts do not measure benefits to resource users. The
 8510 table only highlights the mostly non-market economic values for coral reefs in these jurisdictions.

8511 The impacts to coastal resources from human activities such as agriculture, transportation, port
 8512 development, and urban development in general have been presented in previous sections (e.g., Section
 8513 4.3.4 and Chapter 3) and include degraded water quality and sediments and losses of coastal and marine
 8514 habitats. Indirect adverse impacts could occur during construction through limits on recreational activities
 8515 near the construction area to protect public safety, temporary increases in road traffic due to movement of
 8516 construction vehicles, and adverse effects on aesthetics due to the presence of construction equipment,
 8517 new breakwaters, or other changes to the surrounding environment (NOAA PDARP/PEIS, 2016).

8518 *4.6.3.1 No Action Alternative*

8519 Under the No Action Alternative, benefits to economies due to improved opportunities for recreation and
 8520 tourism are expected due to improved health of coral reefs and associated habitats and subsequent
 8521 increases in fisheries sustainability and other ecosystem services (e.g., coastal protection, biodiversity).
 8522 Socioeconomic activities would also be affected by area closures that may occur due to logistics and
 8523 safety reasons during some of the proposed CRCP activities under the No Action Alternative.

8524 **Monitoring, mapping, and research.** Under the No Action Alternative, areas proposed for monitoring,
 8525 mapping, and research would remain open to visitors during work to implement proposed activities.
 8526 Boater safety practices and signs/markings to indicate work areas would reduce the risks of injury and/or
 8527 vessel groundings. Adverse impacts of closures would be direct, short-term, local, and negligible.
 8528 Benefits of mapping monitoring and research activities may include improved knowledge and

8529 management of coral ecosystems and their services and would be indirect, short-term to long-term, local,
8530 and negligible to moderate.

8531 **Coral reef restoration and interventions.** Visitors are not required to be excluded from coral nursery
8532 areas during restoration and intervention. Because of the locations and small number of coral nursery sites
8533 around the globe, adverse impacts to tourism, recreation, or socioeconomics in general are not anticipated.
8534 Potential adverse impacts to socioeconomics would be direct and indirect, short- to long-term, local, and
8535 negligible to minor. Benefits to socioeconomics from coral reef restoration and intervention would be
8536 direct and indirect, long-term, local, and negligible to moderate.

8537 **Watershed restoration and management.** Area closures to protect public safety during construction
8538 may result in short-term limitations on tourism and recreational uses. If these closures occur in areas
8539 where hunting, fishing, and tourist activities are high, users may choose to pursue these activities
8540 elsewhere or not at all. Potential adverse impacts to tourism and recreation resulting from potential
8541 closures would be expected to be direct, short-term, local, and negligible to moderate. Long-term benefits
8542 to the public are anticipated as a result of activities to reduce runoff, land loss, and restore native habitats.
8543 Implementation of watershed restoration and management activities that include upgrades or maintenance
8544 of infrastructure could result in minor, short- and long-term economic impacts related to funding of these
8545 efforts. Depending on the projects implemented, short-term benefits to the local economy could accrue
8546 through an increase in employment and associated spending in the project area during construction
8547 activities. Projects that are anticipated to enhance stormwater infrastructure would be expected to result in
8548 improved public health and safety as a result of improved runoff controls and reduced stormwater
8549 flooding that may otherwise flood streets and interfere with utilities, including storm sewers and
8550 wastewater facilities. Potential benefits would be direct and indirect, short- and long-term, local, and
8551 negligible to minor.

8552 **Reducing physical impacts to coral reef ecosystems.** The installation of mooring buoys and removal of
8553 debris may require temporary closures in action areas for logistics and safety reasons in specific research
8554 areas, otherwise closures are not anticipated. No changes to fishing, boating, or other practices are
8555 anticipated as a result of these activities. Potential adverse impacts to socioeconomics would be the same
8556 as those for monitoring, mapping, and research. None of the alternatives and proposed activities are
8557 anticipated to adversely impact recreation opportunities. Benefits would include easier and safer
8558 anchoring, snorkeling, and SCUBA activities and would be direct, long-term, local, and negligible to
8559 moderate.

8560 *4.6.3.2 Alternative 1*

8561 Under Alternative 1, current CRCP activities that support coral restoration and intervention and reduce
8562 physical disturbance to corals would be eliminated.

8563 **Monitoring, mapping, and research.** Potential adverse impacts and benefits to socioeconomics from
8564 monitoring, mapping, and research activities would be the same as described for the No Action
8565 Alternative.

8566 **Coral reef restoration and interventions.** Potential adverse impacts to socioeconomics would be
8567 expected due to the continued decline and loss of coral reefs in the absence of restoration and intervention
8568 efforts. Adverse impacts would include associated loss of fish habitat, as well as increases wave energy
8569 reaching the coastline and subsequent shoreline damage and greater potential for flooding. Potential

8570 adverse impacts to socioeconomics would be expected to be direct and indirect, short- to long-term, local
8571 and large scale, and negligible to major. No benefits to socioeconomics under Alternative 1 during
8572 proposed activities would be expected.

8573 **Watershed restoration and management.** Potential adverse impacts and benefits to socioeconomics
8574 would be the same as described for the No Action Alternative.

8575 **Reducing physical impacts to coral reef ecosystems.** Eliminating the installation of permanent mooring
8576 buoys under the No Action Alternative may reduce water quality and benthic habitat damage due to
8577 continued multiple anchor deployments and anchors dragging along the seafloor in areas used by boaters.
8578 Without debris removal, derelict fishing gear, vessels, and other debris would continue to accumulate
8579 and/or move across the sea bottom with currents and waves, reducing the recreational, tourism, and
8580 socioeconomic opportunities associated with coastal and marine resources. Potential adverse impacts to
8581 socioeconomics under Alternative 1 would be direct, short- to long-term, local to large scale, and
8582 negligible to moderate. Benefits as a result of Alternative 1 would be direct, short-term, local, and
8583 negligible to minor.

8584 Monitoring, mapping, and research activities would continue to provide information for managing coastal
8585 and marine resources with respect to socioeconomics. Watershed restoration and management activities
8586 would continue to reduce sediment and other pollutant loads and improve water clarity in coastal waters
8587 and socioeconomics. However, the overall benefits would be reduced due to the exclusion of the
8588 components of the CRCP that address the socioeconomic benefits of coastal and marine resources (i.e.,
8589 tourism, recreation, coastal protection, fisheries sustainability, biodiversity). Overall potential benefits
8590 would be direct and indirect, short- to long-term, local, and negligible to minor.

8591 *4.6.3.3 Alternative 2*

8592 Under Alternative 2, DCMMs (Appendix B) would be implemented in addition to BMPs that are part of
8593 the current CRCP. Regarding DCMMs for projects that might negatively affect certain groups of people,
8594 efforts need to be made to educate user groups about the importance of and need for implementing the
8595 activities that support monitoring, mapping, and research; restore viable coral populations; restore and
8596 manage watersheds; and reduce physical impacts. Implementation of DCMMs alone would have no
8597 adverse impacts to socioeconomics. Adverse impacts under Alternative 2 would be similar to the No
8598 Action Alternative and may have additional, negligible reductions in impacts as a result of DCMMs.
8599 Additional DCMMs that may affect socioeconomics include BMPs that may further reduce adverse
8600 impacts to water quality and coastal marine habitats and, therefore, further improve the socioeconomic
8601 values for those who use these resources.

8602 **4.7 Cumulative Impacts**

8603 In accordance with NEPA and to the extent reasonable and practical, this DPEIS considers the combined
8604 incremental programmatic effects of the No Action Alternative, Alternative 1, and Alternative 2 with the
8605 effects of other past, present, and reasonably foreseeable actions to common resources identified,
8606 regardless of what agency (federal or nonfederal) undertakes such other actions. Cumulative impacts can
8607 result from individually minor, but collectively significant impacts from actions taking place over time.
8608 Cumulative impacts are an important consideration for programmatic analyses because of the potential for
8609 additive effects from individual projects that may result in a cumulative effect to a resource in the project

8610 area. Analyzing cumulative effects at a programmatic level is also challenging, primarily because of the
8611 large geographic extent of the CRCP programs, the long timeframes considered, and the future of
8612 program decisions.

8613 The scope of the cumulative impact analysis for the CRCP proposed action and alternatives involves both
8614 the geographic extent of the effects and the timeframe in which the effects could be expected to occur, as
8615 well as the resources potentially cumulatively affected. When applying the concept of cumulative impacts
8616 to a programmatic analysis, additional consideration must be given to uncertainty associated with
8617 selection of specific future project locations. The design, construction, and operation of the CRCP
8618 activities would occur throughout U.S. coral reef jurisdictions and all specific project sites have not yet
8619 been identified. Furthermore, there is currently a wide range of existing, new, and developing
8620 technologies that NOAA and/or its partners may use to implement the CRCP. As such, it is not possible
8621 to quantify the cumulative effects of these projects when combined with other potential projects.
8622 Therefore, cumulative impacts are assessed qualitatively. Affected resources, program boundaries, and
8623 potential (past, present, and reasonably foreseeable) cumulative actions considered for this analysis are
8624 presented below. Cumulative impacts of individual projects conducted under the CRCP, as noted, will be
8625 conducted as necessary through project level review.

8626 ***4.7.1 Resources Affected***

8627 Resources retained for analyses are considered here. None of the alternatives would result in potentially
8628 significant cumulative impacts at the programmatic level based on the impact significance criteria and
8629 analysis presented in this DPEIS. Impacts could occur as a result of other past and ongoing projects, but
8630 when combined with the potential impacts associated with the proposed action under any alternative,
8631 incremental impacts to the natural and human environment are not expected to be significant at the
8632 programmatic level. The project types that involve new construction and/or ground-disturbing activities
8633 would tend to be limited by their nature in the extent and duration of their effects, and these projects
8634 would include appropriate BMPs and/or mitigation measures to further reduce the already limited
8635 potential impacts. As reflected in previously prepared PEISs and PEAs and described in Section 4.2.3, no
8636 significant cumulative adverse impacts to resources are anticipated as a result of implementing the
8637 proposed activities.

8638 Cumulatively, effects associated with project operations are not expected to be significant at the
8639 programmatic level. Taken together, these projects are not expected to result in significant adverse
8640 incremental cumulative impacts to either human health or the environment, because the long-term
8641 benefits essentially reflect increased sustainability and quality of coastal and marine habitats and fauna.
8642 The key factor to cumulative assessment is identifying any potential temporally and/or spatially
8643 overlapping or successive effects that may significantly affect resources occurring in the analysis areas
8644 (CEQ, 1997; EPA, 1999).

8645 ***4.7.2 Geographic Boundaries and Timeframes***

8646 The spatial boundary includes those areas where CRCP activities described in each alternative are likely
8647 to occur, which is within U.S. coral reef jurisdictions and priority international areas. Although species
8648 such as highly migratory fish and wildlife may use areas beyond the jurisdictions, an analysis of potential
8649 cumulative impacts beyond these boundaries would be speculative and uninformative. Moreover, as
8650 explained, CRCP activities affect near-shore coastal resources and we anticipate little to no effect in the
8651 open ocean environment. Cumulative impact analyses in any subsequent tiered environmental reviews

8652 will address this potential at that more appropriate scale.

8653 The duration of project implementation and useful project life, which can vary substantial depending on
8654 the specific details for each project, also contribute to an assessment of cumulative impacts. Although
8655 most CRCP projects last one to three years, over 75% of NOAA Restoration Center projects supported
8656 between 1992 and 2015 were short-term in duration and had design and construction durations less than
8657 five years (NOAA RC PEIS, 2015). Of those, many had an active construction window of only weeks or
8658 one to two seasons. Most (short-term) adverse impacts from restoration occur during the construction
8659 phase. NOAA has supported parts of longer-term, larger-scale projects that have taken longer than five
8660 years to design and implement or has continually supported the same restoration work in a given area for
8661 more than five years. These projects may have a higher likelihood of resulting in a cumulative impact
8662 from other construction activities happening at the same time or location. Similarly, the effects of one
8663 project may persist during implementation of another project, leading to a cumulative effect. This is
8664 usually, but not always, likely to occur in watersheds where large numbers of acres have been restored.

8665 ***4.7.3 Past, Present, and Reasonably Foreseeable Future Actions***

8666 Actions or groups of actions within the established geographic and timeframe boundaries that are also
8667 programmatic in nature were considered. There may be additional small-scale activities not currently
8668 identified; however, these descriptions of actions provide the necessary information to fully understand
8669 the cumulative impacts to resources that may occur. The *CEQ Memorandum Guidance on Consideration*
8670 *of Past Actions in Cumulative Effects Analysis* (CEQ, 2005) states that consideration of past actions is
8671 only necessary insofar as it informs agency decision-making and that “[a]gencies are not required to list
8672 or analyze the effects of individual past actions unless such information is necessary to describe the
8673 cumulative effect of all past actions” (CEQ, 2005). Agencies may aggregate the effects of past actions
8674 without delving into the historical details of individual past actions. Chapter 3 presented a discussion of
8675 past activities that have influenced the current condition of many resources and identified impacts of
8676 those activities that are likely to persist (e.g., activities resulting in long-term climate change). In addition,
8677 to establish the context for the direct and indirect impacts analyses in Chapter 4 we included a brief
8678 description of past actions that have influenced the current condition of specific resources. Those
8679 discussions, while relevant, are not repeated here for efficiency.

8680 Various impacts from other physical activities may occur at or near project sites, which may also have an
8681 additive effect on a proposed action. The present analysis considered the alternatives discussed in Chapter
8682 2 and other programmatic-scale actions because analysis of specific actions for every potential project site
8683 or location neither practical nor informative. Cumulative effects analysis of individual projects and other
8684 past, present, and reasonably foreseeable future actions relevant at the local level can be addressed as part
8685 of future project-specific NEPA reviews, if needed. Project-specific analysis may be required depending
8686 on the site conditions, the type of deployment, or any other permits or permissions necessary to perform
8687 the work. Types of reasonably foreseeable future actions that may contribute negatively or positively to a
8688 cumulative effect to the natural or human environment in or proximate to a project site are briefly
8689 described below.

- 8690 ● **NOAA restoration projects.** The NOAA Restoration Center has restored 3,900 to 9,800 habitat
8691 acres per year since 2003. In 2016, the NOAA Restoration Center restored almost 200,000 acres
8692 (809 km²) of habitat and expects to restore about 6,600 acres (27 km²) per year in the future. A
8693 list of approved coral--reef--related projects based on the NOAA RC PEIS 2015 is provided in

8694 Appendix D. The number of NOAA Restoration Center projects may decline as larger projects
8695 are given higher priority, resulting in less construction but no decline in total numbers of acres
8696 due to economy of scale. Nationwide, the NOAA Restoration Center implemented more than 85
8697 coral restoration projects in waters of Florida, the Caribbean, and the Pacific Islands regions
8698 (NOAA RC PEIS, 2015).

- 8699 ● **Other activities conducted by NOAA and other agencies.** The proposed CRCP activities have
8700 been developed to address the impacts of land-based sources of pollution, fisheries sustainability,
8701 and climate change, and to support recovery of coral reefs. Proposed activities include watershed
8702 restoration, monitoring, mapping, research, coral reef restoration, and physical impacts reduction.
8703 Other agencies overlap with the CRCP in their focus on similar resources and restoration
8704 activities and include projects implemented by other federal, state, and local agencies or groups.
8705 Numerous agencies focus on habitat restoration to conserve native resources, protect fish and
8706 wildlife, and protect humans from storms and flooding. Cumulatively, these programs further
8707 benefit the coral reef ecosystems by implementing conservation and restoration activities that
8708 focus on habitats and resources that, while perhaps not the same habitats and resources, are
8709 ecologically connected and important to coral reef ecosystems.
 - 8710 ○ NOAA’s Marine Debris Program focuses on removal of marine debris and is a much
8711 larger program when compared to the CRCP. The goal is to remove debris that would
8712 otherwise degrade, reduce, or eliminate existing habitat. Similarly, the U.S. Coast Guard
8713 is responsible for removing derelict vessels, which cumulatively benefits CRCP
8714 resources. While removal of such vessels can result in incremental direct adverse effects
8715 to coral reefs and associated habitat, a long-term incremental benefit may occur through
8716 habitat restoration efforts occurring after removal of the vessels.
 - 8717 ○ NMFS is charged with the conservation of many ESA-listed marine species, critical
8718 habitat, and EFH. Some such resources include coral reefs and associated habitat and
8719 species and NMFSs effort to conserve those resources would benefit coral reef
8720 ecosystems that the CRCP aims to conserve.
 - 8721 ○ Similarly, the USFWS has authority under the ESA to protect some marine species and
8722 their designated critical habitat. Examples include sea turtle nesting beaches and
8723 manatees. Thus, the USFWS’s efforts to conserve resources that use coral reef habitats
8724 would benefit coral reef ecosystems as well.
 - 8725 ○ Coral reef conservation programs at State, Territorial, and local levels within the seven
8726 U.S. coral reef jurisdictions also conduct many activities, some similar to CRCP activities
8727 and others beyond the scope of CRCP, that benefit coral reef ecosystems.
 - 8728 ○ The NOAA Habitat Focus Areas is a place-based initiative where NOAA is working
8729 across offices and program to maximize investments, apply science on the ground, and
8730 collaborate with communities in order to protect and restore valuable natural resources.
8731 NOAA selected ten Habitat Focus Areas nationwide; four of these areas are within the
8732 CRCP’s action area: Biscayne Bay, FL; Northeast Reserve Marine Corridor & Culebra
8733 Island, Puerto Rico; West Hawaii, Hawaii; and Manell-Geus, Guam.
 - 8734 ○ To address land-based sources of pollution, the USCRTF began working on watershed
8735 partnerships to leverage member resources and expertise. The USCRTF has identified
8736 priority watersheds in Puerto Rico (Guanica Bay/Rio Loco), Hawaii (West Hawaii), and
8737 American Samoa (Faga’alu).

- 8738 ○ USDA Joint Chiefs’ Landscape Restoration Funding (2018) included mitigation of
8739 wildfire risk in Hawaii and improving water quality and restoring forest ecosystems in
8740 Puerto Rico. These projects could impact downstream co-occurring projects during
8741 construction activities or downstream resources affected by previous projects, resulting in
8742 a cumulative impact to downstream resources, but would be expected to improve the
8743 long-term ecological conditions and benefit resources.
- 8744 ○ State programs such as fish stocking, invasive species removal, land acquisition, and
8745 stormwater management actions performed by state programs may enhance the benefits
8746 of a restoration project. Conversely, state programs may choose their area of activity
8747 based on NOAA proposed activities. State conservation programs would be expected to
8748 result in cumulative benefits to natural resources.
- 8749 ● **Non-governmental coral reef research and conservation.** Non-governmental organizations,
8750 academia, and the private sector all contribute to coral reef research and conservation. Projects
8751 include management capacity building efforts, research to enhance coral resilience, and prize
8752 competitions to design innovative conservation projects. These efforts benefit the same coral reef
8753 ecosystems that CRCP targets.
- 8754 ● **Land development.** The U.S. coastal counties along the Atlantic and Pacific oceans or Gulf of
8755 Mexico were home to about 29% of the total U.S. population in 2016 (U.S. Census Bureau, 2016)
8756 and are concentrations of economic and social activity. Coastal landscapes will continue to be
8757 altered by redevelopment for tourism-related, residential, commercial, industrial, recreational,
8758 agricultural, and forestry purposes. Degradation or development of natural areas, or disruption of
8759 natural processes through increased human activity, may adversely impact the affected area and
8760 specific project sites and resources during implementation of a proposed alternative or after
8761 restoration. Habitat restoration would reduce the adverse impacts of these activities.
- 8762 ● **Military operations.** Within the U.S. coral reef jurisdictions, Guam and Hawaii have U.S.
8763 military bases and associated uses. A Cooperative Security Location in the Caribbean (Aruba-
8764 Curacao) allows U.S. and partner nation aircraft the use of existing airfields to support the
8765 region’s multinational efforts to combat transnational organized crime. Department of Defense
8766 lands may offer opportunities to connect otherwise fragmented landscapes and large areas of land
8767 to mitigation adverse impacts. However, restoration downstream of military bases may be
8768 adversely impacted by ground or surface water contaminated from ammunition, fire-retardants,
8769 and legacy pesticides and asbestos (Copp, 2018). Sound, vibration, and other effects of these
8770 activities will have cumulative effects on protected species, primarily fish, marine mammals, and
8771 sea turtles, as documented in the Department of Defense Record of Decision for proposed
8772 military testing and training activities under the Atlantic (DoD Atlantic ROD, 2018) and Hawaii
8773 and southern California (DoD HI-CA ROD, 2018). Likely to adversely affect determinations
8774 were made for several ESA-listed fish (e.g., Atlantic salmon (*Salmo salar*), oceanic whitetip
8775 shark, scalloped hammerhead shark, and smalltooth sawfish), although no impacts to EFH would
8776 be anticipated. A likely to adversely affect determination based on impacts of echosounder and
8777 transducers, explosives, and vessel strikes was also made for some ESA-listed marine mammals
8778 (e.g., North Atlantic right whale, sei whale, fin whale, blue whale, and sperm whale) (DoD
8779 Atlantic ROD, 2018; DoD HI-CA ROD, 2018). A determination of likely to adversely affect for
8780 ESA-listed green sea turtle, hawksbill sea turtle, Kemp’s ridley, leatherback, and loggerhead sea

8781 turtle in response to military testing and training activities was also made, but not for
8782 corresponding critical habitat.

8783 ● **Marine transportation.** Marine transportation accounts for more than 90% (by weight) of global
8784 trade and is responsible for widespread coastal pollution, vessel strikes to marine mammals,
8785 seabird mortality, releases of invasive species from ballast water, oil and chemical spills, garbage,
8786 underwater sound pollution, and sediment contamination of ports during transshipment or ship
8787 breaking activities (Walker et al., 2019). In 2016, 1,806,650 principal marine vessels were
8788 registered, including: 778,890 bulk carriers, 75,258 general cargo, 503,343 oil tankers, 244,274
8789 container ships, 44,347 chemical tankers, 5,950 ferry and passenger ships, and 1,800 liquefied
8790 natural gas tankers. These activities are expected to occur regardless of proposed activities. The
8791 Oil Pollution Act of 1990 (33 U.S.C. 2701-2761) created a comprehensive prevention, response,
8792 liability, and compensation regime to deal with vessel- and facility-caused oil pollution to U.S.
8793 navigable waters. The U.S. Coast Guard is responsible for removing fuel, oil, and other hazardous
8794 materials from grounded vessels in marine waters, reducing the need for vessel removal under the
8795 CRCP.

8796 ● **Energy activities.** Much of the south Pacific is reducing its reliance on oil and gas, and in 2017,
8797 the Department of the Interior announced nearly \$3.5 million in funding to American Samoa,
8798 Guam, the CNMI, and the USVI for projects to address energy efficiencies and self-sufficiency.
8799 In 2016, the Bureau of Ocean Energy Management accepted bids for wind energy development
8800 areas in Hawaii. The major environmental concerns of offshore wind developments are increased
8801 sound levels, risk of collisions, changes to benthic and pelagic habitats, alterations to food webs,
8802 and pollution from increased vessel traffic or release of contaminants from seabed sediments.
8803 Primarily construction, but also operation, of offshore wind farms would result in cumulative
8804 impacts to fish, sea turtles, marine mammals, and sea birds. Benefits may include acting as
8805 artificial reefs and potential increases in shellfish and the animals that feed on them, including
8806 fish and marine mammals. A safety buffer zone surrounding the wind turbines may become a de-
8807 facto marine reserve, as the exclusion of boats within this zone would reduce disturbance from
8808 shipping (Bailey et al., 2014). U.S. jurisdictions in the Caribbean and Pacific are not sites of oil
8809 exploration; however, the Gulf of Mexico is a major site of oil and gas exploration in the U.S. and
8810 is expected to continue into the foreseeable future, along with increases in oil refining. Proposed
8811 activities would potentially reduce some of the adverse impacts of these activities by protecting
8812 shorelines, improving water and sediment quality, and restoring resources damaged by oil spills.

8813 ● **Marine mineral mining and sand and gravel extraction.** Sand and gravel are mined in the Gulf
8814 of Mexico and in Florida within U.S. jurisdictional waters. The number of requests to Bureau of
8815 Ocean Energy Management for sand from federal waters have increased because suitable
8816 resources in state waters are becoming depleted. Impacts from sand and gravel extraction
8817 activities may affect many benthic resources, including corals (Michel et al., 2013). No sand
8818 mining is planned for the Pacific Islands.

8819 ● **Fisheries and aquaculture.** NOAA and the Western Pacific Fishery Management Council intend
8820 to prepare a PEIS to analyze the potential environmental impacts of a federal aquaculture
8821 management program (NOI issued August 2016) to support an environmentally sound and
8822 economically sustainable aquaculture industry in federal waters of the Pacific Island region,

8823 including American Samoa, CNMI, Guam, and Hawaii. The Gulf of Mexico FMP (developed in
8824 2009) for aquaculture was approved in 2016 and is intended to establish a regional permitting
8825 process to manage the development of an environmentally sound and economically sustainable
8826 aquaculture industry in federal waters of the Gulf of Mexico. That plan, however, remains
8827 ineffective as it was determined by one court not to be authorized by the MSA. Several smaller
8828 scale aquaculture projects in state waters currently exist and are likely to be authorized in the
8829 foreseeable future. Cumulative adverse impacts to natural resources from these activities would
8830 be expected due to potential degradation of water quality and/or habitat, impacts to wild fish
8831 stocks due to genetics from escapements (for example), exceedance of the carrying capacity of a
8832 site, and use of public resources for private profit.

8833 ● **Pollution.** Remaining point source discharges of domestic, municipal, and industrial wastewater
8834 into coastal waters of the U.S. and territories (see Chapter 3) would be expected to continue
8835 unless/until actions or programs outside the CRCP are undertaken to address these issues. For
8836 example, the U.S. Army Corps of Engineers funded planning and implementation of wastewater
8837 treatment projects in the FKNMS in 2006 to control the sources of wastewater into the FKNMS,
8838 including seepage of domestic wastewater from leaking and derelict septic tanks and open “cess
8839 pits” (unlined waste disposal pits located below land surface) into the porous limestone substrate
8840 of the Florida Keys and into FKNMS. The conversions were completed in Key Largo and
8841 Marathon in 2015, and conversions in Monroe County and other locations are underway. Projects
8842 to reduce the pollutant loading into the Florida Keys would improve the quality of water entering
8843 the FKNMS, although continued water quality issues due to legacy sources as well as continued
8844 nutrient loading from land-based non-point sources (e.g., higher nutrient levels from past 20 years
8845 [Briceno & Boyer, 2016]) persist.

8846 ● **Funding.** Public and private funding availability that is normally used to implement restoration
8847 may expand or contract and could affect whether a project is delayed, implemented, and/or
8848 completed. Funding is an inherent uncertainty.

8849 ● **Climate change.** The impacts of climate change, such as rising sea temperatures and sea level
8850 rise can fundamentally change ecosystem function by inundating habitat, altering tidal flow and
8851 sediment transport patterns, eroding shorelines, and causing species distribution shifts and
8852 population declines (Cahoon et al., 2006). Similarly, changes in precipitation and global
8853 meteorological patterns can impact project areas. Similarly, increasing frequency and intensity of
8854 storms, such as hurricanes, can damage or destroy coral reefs and the CRCP’s restoration-related
8855 projects, such as in-water nurseries and erosion-control structures. Although predicting how
8856 climate-related impacts would translate at the local and regional level is difficult, global trends
8857 suggest that these impacts merit serious consideration in coastal management decisions and, more
8858 specifically, project planning and design and program prioritization (NMFS, 2011). Cumulative
8859 adverse impacts to coral reefs from climate change include coral bleaching and mortality, ocean
8860 acidification, disease transmission, direct destruction by storms, and other effects.
8861 Storms cause coastal erosion and other damage due to wind, waves, and water and can result in
8862 substantial damages to coastal communities and natural resources. Hurricanes Katrina (2005) and
8863 Maria (2017) (among the five deadliest hurricanes, in terms of human losses, to strike the U.S.)
8864 are recent examples of large-scale physical damage to the natural and human environment and
8865 how shifting priorities can also affect how/when projects may be implemented. Similarly,

8866 changes in weather patterns or other meteorological shifts may impact project sites and ultimately
8867 change where and when the program is implemented. For example, watershed revegetation and
8868 in-stream habitat restoration projects may be delayed or canceled due to drought or flooding.
8869 Habitat restoration projects would be expected to buffer and reduce some of these impacts.
8870

8871 As described above, activities including energy and mining, coastal development and land use, military
8872 activities, and marine transportation would result in short- and long-term adverse impacts to habitats,
8873 including habitat degradation through reduced water and sediment quality, introduction of invasive
8874 species, habitat fragmentation, and habitat loss. Construction activities from habitat restoration and
8875 conservation and recovery efforts associated with other environmental stewardship and proposed
8876 activities would also contribute to short-term adverse impacts. However, the benefits of habitat
8877 restoration, conservation, and recovery efforts associated with other environmental stewardship and
8878 proposed activities would continue. These actions would likely create new habitats or restore degraded
8879 habitats, protect habitats from fragmentation, and preserve unaffected quality habitats, especially sensitive
8880 habitats.

8881 ***4.7.4 Cumulative Impacts Analysis***

8882 This cumulative impacts analysis evaluates the impacts of the past, present, and reasonably foreseeable
8883 actions of Federal, state, local, and private entities (see Section 4.17.3) within the action area as well as
8884 the incremental contribution of CRCP’s activities under each alternative. Continued activities such as
8885 construction and operation of energy and mining facilities (offshore and onshore); marine transportation
8886 facilities; commercial, industrial, and residential development in coastal habitats (hereinafter “ongoing
8887 activities”) (see previous section) may alter, degrade, or eliminate physical resources due to water quality
8888 pollution, substrate disturbances, and conversion of habitats to developed uses or other human
8889 disturbances. Biological resources may be directly impacted by these ongoing activities through
8890 individual mortality and habitat loss or indirectly affected by degraded water quality, and/or sediment
8891 contamination. Socioeconomic resources would also be affected by these ongoing activities. Other
8892 activities, such as restoration projects, may also occur that would benefit physical, biological, and
8893 socioeconomic resources. Furthermore, the past and ongoing effects of global climate change contribute
8894 significantly to adverse impacts on coral reef ecosystems and associated physical, biological, and
8895 socioeconomic resources.

8896 Overall, the adverse impacts from any CRCP proposed activities, as discussed in earlier sections of
8897 chapter 4, are likely to be short-term and negligible to moderate when they do occur. The CRCP proposed
8898 activities are intended to benefit coral reef ecosystems and contribute incrementally to long-term,
8899 negligible to minor cumulative benefits to physical, biological, and socioeconomic resources. Projects
8900 that do not perform as expected or desired would be modified through adaptive management based on
8901 data collected during monitoring activities. Because the CRCP project implementation periods (and the
8902 associated adverse effects) are short-term, and the beneficial impacts from a project are long-term,
8903 generally, the cumulative impact of the proposed program-wide activities would result in a net
8904 incremental benefit to physical, biological, and socioeconomic resources. When the CRCP activities are
8905 combined with the adverse effects from development, extractive activities, pollution, climate change, and
8906 others listed above, the cumulative impact on physical, biological, and socioeconomic resources may not
8907 result in a net benefit without a change in human behavioral patterns. When considering adverse and
8908 beneficial impacts from all actions identified above, for any of the three alternatives, the incremental

8909 contribution of the CRCP activities to the cumulative effects are not expected to contribute substantially
8910 to cumulative impacts to the physical, biological, or socioeconomic resources when analyzed in
8911 combination with other past, present, and reasonably foreseeable future actions.

8912 **No Action Alternative and Alternative 2.** Many of the potential incremental impacts from the CRCP
8913 activities associated with the No Action Alternative and Alternative 2 would have net benefits and are
8914 expected to alleviate some of the adverse impacts imposed by past, present, and reasonably foreseeable
8915 activities. For example, watershed restoration would reduce the rate of accumulation of sediments and
8916 nutrients into coastal waters. Coral restoration would mitigate some impacts of climate change on corals
8917 and associated habitats. Installation of mooring buoys and removal of marine debris would reduce the
8918 physical damage and debris on the seafloor. Ongoing research activities (e.g., monitoring and mapping)
8919 would likely generate data that would inform coral reef ecosystem management.

8920 Land development, military activities, and mining would likely be the biggest contributors to adverse
8921 impacts on physical resources because they involve disturbance of terrestrial and marine resources that
8922 would likely be permanent. Smaller-scale and shorter-term physical impacts include vessel groundings
8923 and damage from anchoring, which some CRCP activities focus on reducing under the No Action
8924 Alternative and Alternative 2. The incremental contribution of the CRCP activities under these
8925 alternatives would not be detectable for physical resources on land and would be detectable but not
8926 substantial for physical resources in the ocean.

8927 Land development, military activities, pollution, extraction and energy-generating activities, marine
8928 transportation, and climate change all contribute adverse impacts to biological resources, both on land and
8929 in the ocean. Adverse impacts include habitat loss and fragmentation, habitat degradation, population
8930 declines, species distribution shifts, and loss of individuals. Research and conservation activities
8931 conducted by the CRCP, other government and non-governmental organizations, academia, and the
8932 private sector could have temporary minor effects on biological resources that would be outweighed by
8933 the long-term minor to moderate impacts on biological resources. The incremental contribution of the
8934 CRCP activities under these alternatives to cumulative impacts on biological resources would not be
8935 substantial.

8936 Public health and safety, tourism, and socioeconomics can be complicated by large storm events such as
8937 tropical storms and hurricanes (and associated storm surges, winds, and battering waves) that may result
8938 in damage to the shoreline as well as infrastructure such as roadways, bridges, and buildings. In addition,
8939 construction activities and increased human uses of resources can also pose risks to public health and
8940 safety. Taken together, ongoing and likely future actions may benefit socioeconomic resources while
8941 adversely affecting resources such as commercial fisheries and recreation. Several of the past, present,
8942 and reasonably foreseeable activities, including the CRCP activities, would benefit socioeconomic
8943 resources. For example, development projects and extractive activities would likely contribute positively
8944 to the local economy. However, other activities, such as climate change effects and pollution, would
8945 negatively affect local socioeconomic resources as a result of damaged or lost infrastructure or water
8946 quality. The CRCP activities, such as providing information that supports more restrictive fishing
8947 regulations, could cause temporary adverse impacts to fisheries, but over the long-term, conservation
8948 activities such as fishing regulations would likely improve the health of wildlife and fish populations,
8949 which in turn leads to increased opportunities for recreation and fishing and the resulting regional
8950 economic benefits of increased tourism and recreation. In addition, watershed restoration activities would

8951 have short-term local economic benefits due to increased employment and spending. Many of the
8952 proposed activities would also have socioeconomic benefits as a result of the benefits of reduced risk of
8953 potential hazards such as storm surges and shoreline erosion, as well as increased public safety due to
8954 removal of marine debris and installation of mooring buoys. Overall, the cumulative effects on
8955 socioeconomic resources would be long-term, minor to moderate, and beneficial, and the CRCP's
8956 incremental contribution would be long-term, minor, and beneficial.

8957 In the long-term, the CRCP's activities would support the conservation, restoration, and recovery of coral
8958 reef ecosystems and potentially ameliorate some of the adverse impacts of other past, present, and
8959 reasonably foreseeable actions. Based on information available for this analysis, the No Action
8960 Alternative and Alternative 2 are not expected to contribute substantially to cumulative impacts to the
8961 physical, biological, or socioeconomic resources when analyzed in combination with other past, present,
8962 and reasonably foreseeable future actions.

8963 **Alternative 1.** Under Alternative 1, coral reef restoration and intervention activities and activities to
8964 reduce physical impacts to coral reefs (i.e., boat moorings and debris removal) that are part of the CRCP
8965 under the No Action Alternative and Alternative 2 would not occur. Consequently, the potential for
8966 restoration and recovery of coral reefs and associated habitats and biota would be reduced unless
8967 restoration activities conducted outside of the CRCP increase. Natural recovery of all coral reef
8968 ecosystems is not expected (see Section 4.4.3), and reliance on this approach could result in fewer
8969 restored coral reefs. Therefore, in combination with other past, present, and reasonably foreseeable future
8970 actions, cumulative impacts of this alternative would include less restoration and recovery than under the
8971 No Action Alternative and Alternative 2. Other restoration projects would also be ongoing and would
8972 help to reduce some of the adverse impacts of these ongoing activities; however, the lack of the CRCP
8973 activities focused on coral reef restoration and intervention and reducing physical impacts to corals would
8974 result in fewer restored coral reefs. Fewer restored or healthy coral reefs could adversely impact human
8975 health and safety due to, for example, reduced shoreline stabilization, and socioeconomics, due to
8976 degradation and/or loss of the reef fishery.

8977 Other ongoing activities (e.g., coastal development, mining, fishing, and pollution) would continue, and
8978 the impacts of these activities on water quality, sediments, and natural resources, such as fish and wildlife,
8979 coral reefs, and other habitats, would continue. Alternative 1 would, therefore, likely result in fewer
8980 beneficial impacts and thus, a smaller incremental contribution to cumulative impacts to coral reefs and
8981 associated habitats and biota than discussed above for the No Action Alternative and Alternative 2.

8982 **4.8 Relationship of Short-Term Uses and Long-Term Productivity**

8983 Many of the proposed CRCP activities, such as monitoring, mapping, research, watershed restoration,
8984 stream, coral restoration and intervention, and preventing physical impacts are associated with short-term
8985 adverse impacts from construction or implementation of these activities. However, these impacts are
8986 expected to be temporary and the proposed activities are intended to enhance long-term coral reef
8987 ecosystem function and productivity. For example, restored coral habitat would provide food, shelter, and
8988 nursery habitat for many ecologically and economically important animals.

8989 Under the No Action Alternative and Alternative 2, proposed public education programs, technical
8990 assistance activities, and debris removals would be expected to help reduce fishing pressure and restore

8991 ecosystem services provided by healthier coral reefs and associated habitats.s. Under all three alternatives,
8992 watershed restoration and monitoring, mapping, and research activities would continue and would help to
8993 alleviate stormwater runoff in areas where projects would be implemented and provide increased
8994 scientific data and information. However, Under Alternative 1 the continued loss of coral reefs and
8995 associated productivity would result in more overall losses of long-term productivity when compared with
8996 the No Action Alternative and Alternative 2.

8997 **4.9 Irreversible and Irretrievable Commitments of Resources**

8998 Implementation of any of the CRCP alternatives would require an irreversible and irretrievable
8999 commitment of resources due to staff time for project planning and development, funding necessary to go
9000 through the consultation, coordination, and the decision-making processes. Other resource uses that
9001 would be irreversible and irretrievable would be the use of energy through the combustion of fossil fuels
9002 and material resources for construction. However, the level of commitment would vary based on the
9003 activity, and some changes could be made to further reduce and avoid potential impacts to resources, such
9004 as ESA-listed species and designated critical habitat as part of programmatic and individual ESA Section
9005 7 consultations and other statutory compliance efforts. For example, the reconstruction of a wetland
9006 would require more resources than revegetation.

9007 The proposed activities outlined in the No Action Alternative and Alternative 2 generally would require
9008 the commitment of time, money, human effort, construction and restoration materials, and some use of
9009 fossil fuels. Such activities would be irreversible and irretrievable. However, the activities would also
9010 benefit most resources, and may result in a reversal of their present declining trends. Watershed restoration
9011 would involve the removal of specific types of vegetation (mostly invasive species) in favor of natural
9012 vegetation. Conversion to stormwater ponds and LID would change the long-term land use for some
9013 properties. This land use could be changed again in the future and is, therefore, not irreversible. In-water
9014 reef restoration could involve nursery structures or materials placed on reefs that would be irreversible
9015 and irretrievable commitments of such material resources. The potential destruction of cultural resources
9016 during watershed or in-water restoration implementation could occur and would, therefore, be
9017 irreversible. However, appropriate coordination with state or tribal agencies would take place on a
9018 project-by-project basis to avoid this scenario.

9019 Under Alternative 1, the lack of coral reef restoration and intervention activities, such as outplanting and
9020 transplanting, may result in the irreversible and irretrievable commitments because materials and effort
9021 for restoration and intervention activities and mooring buoy installations would not be needed.

9022 **4.10 Unavoidable Adverse Impacts**

9023 Section 102(2)(c)(ii) of NEPA requires that an EIS include information on “any adverse environmental
9024 effects which cannot be avoided should the proposed action be implemented.” Unavoidable adverse
9025 impacts are the effects on the human environment that would remain after mitigation measures and best
9026 practices have been applied. They do not include temporary or permanent impacts that would be
9027 mitigated. While these impacts do not have to be avoided by the planning agency, they must be disclosed,
9028 considered, and mitigated where possible (40 CFR § 1500.2[e]). The No Action Alternative and
9029 Alternative 2 would have the same unavoidable adverse impacts, and Alternative 1 would have fewer
9030 unavoidable adverse impacts because it would lack restoration and intervention activities. Unavoidable

9031 adverse impacts associated with the use of fossil fuels related to implementation of almost all of CRCP's
9032 activities are not expected to result in detectable adverse impacts to resources. In addition, future CRCP
9033 planning phases and associated NEPA analyses would consider the extent to which adverse impacts can
9034 be avoided, including consideration of appropriate mitigation, and would describe those adverse impacts
9035 that are unavoidable. The CRCP's current best practices are identified in Appendix A.

9036 Best practices developed by the CRCP include guidance documents, lessons learned, and project design
9037 criteria for many restoration actions. Project proponents are expected to consider these, and any additional
9038 relevant best practices, in the development of subsequent CRCP projects and associated regulatory
9039 compliance. Trustees use appropriate best practices to avoid or minimize impacts to natural resources,
9040 including ESA-listed species and their designated critical habitats. During any environmental review
9041 process, additional project-specific BMPs or mitigation measures may be recommended or required as
9042 applicable to a specific project, such as endangered species presence or absence and resulting requirement
9043 to stay out of an area, or other factors. The final set of project-specific best practices and mitigation
9044 measures would be determined prior to implementation. Appendix A includes lists of BMPs that would
9045 be included on a project-specific basis, as appropriate, to avoid, minimize, or reduce potential adverse
9046 effects on the resources. As new best practices are established, existing best practices are refined, or new
9047 techniques and information are informed by implementation, these measures will be added to or updated.
9048 Consequently, new projects will have available the current range of best practices to support project
9049 design and implementation.

9050 **4.11 Environmental Review and Consultation Requirements**

9051 The primary legal requirements that generally apply to CRCP activities are discussed in Section 3.4 and
9052 Section 1.10. The CRCP is conducting programmatic consultations pursuant to ESA and MSA, and
9053 correspondence for such consultations is included in Appendix H for the proposed action. As projects are
9054 proposed to implement the CRCP, additional environmental review and consultation may be required
9055 under statutes including the ESA, MMPA, MSA, NMSA, NHPA, and the Fish and Wildlife Coordination
9056 Act.

9057 **4.12 Summary and Comparison of Potential Impacts of Alternatives**

9058 This section presents a summary of potential adverse impacts to resources under the No Action
9059 Alternative, Alternative 1, and Alternative 2. A summary of general impacts expected from activities is
9060 outlined below.

- 9061 ● **Monitoring, mapping, and research activities.** No significant adverse impacts to resources are
9062 anticipated. Benefits of these activities would provide information critical to the conservation and
9063 management of resources such as water quality, fisheries, and coral reefs and associated habitats.
- 9064 ● **Coral restoration and intervention activities.** No significant adverse impacts to resources are
9065 anticipated. The potential risk to coral communities due to invasive species, disease, and
9066 corallivores would be avoided and minimized by implementation of BMPs and/or DCMMs.
9067 Overall benefits to coral reefs and associated habitats and biota be recovery and restoration of
9068 coral reefs in response to fishing impacts, climate change, and land-based sources of pollution.
- 9069 ● **Watershed restoration and management activities.** No significant adverse impacts to resources
9070 are anticipated. Potential impacts of implementing watershed restoration construction and

9071 management activities would be avoided and minimized by implementation of BMPs. Benefits to
9072 resources would include improved coastal and marine water quality due to reduced land-based
9073 sources of pollution and subsequent benefits to coral reefs, seagrasses, and other habitats and
9074 biota.

9075 ● **Reduction in physical impacts to coral reefs.** No significant adverse impacts to resources are
9076 anticipated from activities such as permanent mooring buoys and debris removal. Benefits to
9077 resources would include restored habitats and reduced potential for physical destruction to coral
9078 reefs and associated habitats and biota and contamination of sediments and the water column.

9079 A brief comparison of adverse impacts and benefits among alternatives is provided below and detailed for
9080 each resource in Table 4-3. The summary provides context and intensity of potential impacts using D for
9081 direct, I for indirect, S for short-term, L for long-term, etc., and combining these indicators of context,
9082 followed by the range of anticipated impact intensity (i.e., negligible to moderate). For example, an
9083 adverse impact that is expected to be direct, short- to long- term in duration, local, and negligible to
9084 minor, will appear in the table as D/S-L/L, negligible to minor, with further explanation of the potential
9085 impact(s).

9086 The analysis summarized in Table 4-3 is supported by an impacts matrix that examined (and ranked)
9087 potential impacts to each of the 14 resources (e.g., fisheries) due to each of the 44 activities (e.g., lethal
9088 and nonlethal collection of fish, collection of coral gametes) in each of the four activity groups (e.g.,
9089 mapping, monitoring, and research) for each of the three alternatives. The analysis used an Excel-based
9090 tool to generate a CRCP Impacts Matrix. The impacts matrix display is provided in Appendix G and
9091 presents a corresponding summary of the individual rankings for impacts analysis criteria of intensity,
9092 context, and duration, for each resource and alternative generated by the Excel-based tool.

9093 **No Action Alternative, Alternative 1, and Alternative 2.** All three alternatives would have direct and
9094 indirect, short-term, negligible to moderate, local adverse impacts during the implementation of
9095 monitoring, mapping, and research activities. All three alternatives would also result in benefits from
9096 monitoring, mapping, and research activities that will support data collection and perform research critical
9097 to managing corals and associated coastal and marine resources. No differences in impacts from
9098 monitoring, mapping, and research activities are expected. All three alternatives would implement
9099 watershed restoration and management activities that would reduce erosion, stormwater runoff, and
9100 sediment and other pollutant loading into downstream and coastal waters. Adverse effects would be direct
9101 indirect, short-term, local to larger scale, negligible to moderate, and benefits would be direct and
9102 indirect, both short- and long-term, and local to the specific project location. Stabilized sediments (e.g.,
9103 trails and roads) would restore natural hydrology and reduce sedimentation and erosion in terrestrial,
9104 aquatic, wetland, and floodplain habitats; restore flood storage capacity of wetlands and floodplains; and
9105 restore habitat for listed species. Reductions in sediments and pollutants in coastal waters would improve
9106 water quality and benefit coastal and marine habitats such as corals, seagrasses, mangroves, fish, and
9107 fisheries. No differences in impacts are expected.

9108 **No Action Alternative and Alternative 2.** Only the No Action Alternative and Alternative 2 would
9109 implement activities to directly address the decline in coral reef health and benefit corals and associated
9110 habitats and biota. Both of these alternatives include transplanting and outplanting corals, development of
9111 coral nurseries, reducing invasive species, addressing coral diseases, and reducing physical impacts to
9112 corals from marine debris and vessel anchoring. Benefits would be direct and indirect, long-term, local to

9113 larger scale, and minor to major, depending on the project. Because coral reefs are not expected to recover
 9114 without intervention, these alternatives are the only two that would support the recovery and restoration of
 9115 coral reefs.

9116 **Alternative 2.** Alternative 2 includes DCMMs that may be implemented to further reduce potential
 9117 impacts of many of the proposed activities. DCMMs would be implemented in addition to BMPs that are
 9118 implemented under the current CRCP (No Action Alternative) and would be expected to further benefit
 9119 coral reefs and associated habitats and biota. Expected benefits to coral reefs would be the same as for the
 9120 No Action Alternative, with potentially greater, albeit negligible, benefits.

9121 Among the three alternatives, potential adverse impacts range from direct to indirect, short- to long-term,
 9122 local to larger in scale, and from negligible to major. Benefits under the No Action Alternative,
 9123 Alternative 1, and Alternative 2 are anticipated to be both direct and indirect, both short and long term,
 9124 and potentially both local and large scale, depending on the project. The impacts summary table (Table 4-
 9125 3) provides context and intensity of potential impacts using D for direct, I for indirect, S for short-term, L
 9126 for long-term, etc., and combining these indicators of context, followed by the range of anticipated impact
 9127 intensity (i.e., negligible to moderate). For example, an adverse impact that is expected to be direct, short-
 9128 to long-term in duration, local, and negligible to minor, will appear in the table as D/S-L/L, negligible to
 9129 minor, with further explanation of the potential impact(s).

9130 *Table 4-3. Summary of the impacts to resources anticipated under the alternatives. The CRCP's discretionary conservation and*
 9131 *mitigation measures (DCMMs) are provided in Appendix B. Resources are analyzed for both terrestrial and coastal and marine*
 9132 *environments where relevant. Context factors are abbreviated as: Direct and/or Indirect (D-I)/Short- to Long-term (S-L)/Local to*
 9133 *Large Scale (L-LS), followed by intensity descriptions of negligible to major.*

Resources	No Action Alternative Continued Implementation of the Current CRCP	Alternative 1 Current CRCP without Coral Reef Restoration/Intervention and Reducing Physical Impacts to Coral Reefs	Alternative 2 Current CRCP with Addition of Required DCMMs
Physical Environment			
Sediments and Soils	Adverse Impacts. <u>Terrestrial</u> - D/S/L, negligible to minor due to erosion, sedimentation, compaction, potential introduction of pollutants into soils during monitoring, construction, herbicide use, other watershed proposed activities. <u>Coastal waters:</u> D/S/L, negligible to minor due to sediment resuspension and deposition during vessel and other in-water activities.	Adverse Impacts. <u>Terrestrial</u> - same as for the No Action. <u>Coastal</u> - D/S-L/L, negligible to moderate. Combined adverse impacts to sediments under this alternative are due to continued damage from anchoring and accumulation of marine debris. Benefits. D/S-L/L, negligible to minor, due to	Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs. Benefits. Same as No Action, but with additional, negligible benefits due to DCMMs such as additional dive and vessel training, seafloor habitat avoidance, decontamination of equipment, use of mooring buoys or live boating, etc.

	<p>Additional long-term, negligible to moderate impacts possible from large projects such as stormwater ponds, road stabilizations, and vessel removals.</p> <p>Benefits. D-I/S-L/L-LS, negligible to major due to reduced erosion and land loss, sediment and other pollutant loadings to coastal waters, improved soil and sediment quality, stabilized substrates, reduced debris and contamination, and acquisition of data critical to resource management.</p>	<p>elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>that reduce the amount of disturbance.</p>
<p>Terrestrial Habitats and Biota</p>	<p>Adverse impacts. D/S/L, negligible to minor displacement of fish, wildlife, and vegetation due to sound, runoff, altered hydrology, herbicide use, habitat loss due to construction and other watershed proposed activities; invasive species introduction and loss of native species.</p> <p>Benefits. D/S-L/L, negligible to moderate benefits due to potential increased quality of native habitat for foraging, nesting, and migratory stops for birds and other terrestrial wildlife; restored habitat due to reduced erosion and improved water quality for instream fish and wildlife.</p>	<p>Adverse impacts. D/S/L, negligible to minor, same as No Action, due to watershed proposed activities in terrestrial habitats.</p> <p>Benefits. D-I/S-L/L, negligible to moderate, due to continued mapping, monitoring, and research, and watershed restoration and management activities.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional negligible water quality and habitat improvements due to DCMMs such as erosion and sediment controls and reduced herbicide concentrations.</p>

<p>Wetlands and Floodplains</p>	<p>Adverse impacts. D/S/L, negligible to minor impacts to wetlands and floodplains due to temporary construction activities and introduction of sediments, other pollutants, and invasive species.</p> <p>Benefits. D-I/S-L/L-LS, negligible to moderate due to potential for restored flood capacity, soil rehydration, and increase in native habitat due to reduced erosion and improved water quality.</p>	<p>Adverse impacts. D/S/L, negligible to minor same as No Action, negligible to minor due to watershed proposed activities in terrestrial habitats.</p> <p>Benefits. D-I/S-L/L-LS, same as No Action, negligible to moderate due to information available to support future conservation and management efforts.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional negligible water quality and habitat improvements due to DCMMs such as erosion and sediment controls and reduced herbicide concentrations.</p>
<p>Water Resources</p>	<p>Adverse Impacts. <u>Terrestrial:</u> D/S/L, negligible to minor due to potential for erosion and transport of sediments/other pollutants generated from construction and other activities (see sediments and soils above) and conveyed into downstream and coastal waters. <u>Coastal waters:</u> same as terrestrial with additional impacts from land-based sediments and pollutants, resuspension of sediments due to vessels and other in-water activities associated with monitoring and coral transplanting, and potential contamination from debris.</p> <p>Benefits. D-I/S-L/L, negligible to major due to reduced sediments and other pollutant loadings to downstream waters, potential contamination from marine debris, and major benefits due</p>	<p>Adverse impacts. <u>Terrestrial.</u> D/S/L, negligible to minor impacts. Same as No Action. <u>Coastal waters:</u> D/S/L, negligible to minor impacts due to potential resuspension of sediment from anchoring and marine debris into the water column.</p> <p>Benefits. D-I/S-L/L, and negligible to moderate due to watershed restoration and management activities and continued monitoring, mapping, and research activities.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, but with additional, negligible, benefits due to DCMMs such as additional dive and vessel training, seafloor habitat avoidance, use of mooring buoys and live boating, and others that reduce the opportunity for resuspension of sediments into the water column.</p>

	to acquisition of data critical to management.		
Biological Environment			
Seagrasses	<p>Adverse impacts. D/S/L, negligible to minor due to temporary disturbance during monitoring/surveying, other in-water activities (esp. propeller scars), debris removal, installation of mooring buoys, and coral proposed activities.</p> <p>Benefits. D-I/L/L-LS, negligible to moderate due to reduced sediment and nutrient loading from watershed, reduced disturbance/damage from permanent moorings and debris/contamination, habitat stabilization due to potential coral reef recovery.</p>	<p>Adverse Impacts. D/S-L/L, negligible to moderate due to continued damage from anchoring and accumulation of marine debris, as well as potential loss of buffering effects of coral reefs.</p> <p>Benefits. D/S-L/L, negligible to minor due to elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, but with additional, negligible, benefits due to DCMMs such as additional dive and vessel training, seafloor habitat avoidance, use of mooring buoys and live boating, and others that reduce contact with resource.</p>
Mangroves	<p>Adverse impacts. D-I/S/L, negligible to minor, similar to disturbances described in sediment and soils.</p> <p>Benefits. D-I/S-L/L-LS, negligible to moderate to native mangroves due to reduced sediment and nutrient loadings from the watershed, reduced wave energy and sedimentation due to coral recovery, reduced disturbance and contamination due to permanent moorings and debris removal.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate due to discontinued coral restoration efforts and continued damage from anchoring and accumulation of marine debris.</p> <p>Benefits. D/S-L/L, negligible to minor due to elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, but with additional, negligible benefits due to a reduction of indirect adverse impacts of sediment and pollutant loadings into coastal waters, potential impacts from anchors and marine debris, and erosion as a result of required DCMMs.</p>
Corals and other associated invertebrates and algae	<p>Adverse impacts. D-I/S-L/L, negligible to moderate from temporary disturbance during monitoring, surveying,</p>	<p>Adverse impacts. D-I/S-L/L-LS, negligible to major due to discontinued coral restoration efforts and</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p>

	<p>research, mooring buoy, coral reef restoration, and debris removal activities; potential for disease, corallivores, and invasive species that may increase due to transplanting and outplanting activities.</p> <p>Benefits. D-I/S-L/L-LS, negligible to major due to reduced invasive species, acquisition of data available for recovery and management; reduced runoff from watershed, debris removal, reduced anchoring, and increased recovery due to transplanting and outplanting of corals, control of disease, corallivores, and invasive species, other activities that increase the potential for recovery of coral reefs.</p>	<p>continued damage from anchoring and accumulation of marine debris.</p> <p>Benefits. D/S-L/L, negligible to minor due to elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Benefits. Same as No Action, but with additional, negligible, benefits due to DCMMs such as additional restrictions on the amount of coral removed for transplants, additional decontamination protocols, and further reductions in physical contact with coral to reduce potential for physical damage, disease, corallivore, and invasive species impacts to corals.</p>
Fish	<p>Adverse impacts. D-I/S/L, negligible to minor impacts due to temporary disturbance and loss of habitat during monitoring, surveying, research, mooring buoy installation, debris removal, and coral reef restoration.</p> <p>Benefits. D-I/S-L/L-LS, negligible to major due to reduced watershed runoff, improved water quality and habitat; potential for restored reef habitat and increase in data for resource management.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate due to continued damage from coral reef habitat loss and anchoring and accumulation of marine debris.</p> <p>Benefits. D/S-L/L, negligible to minor due to elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional, negligible benefits due to DCMMs such as additional sediment and erosion control to improve water quality, reduced physical contact with habitats, and sound protocols to further reduce potential sound impacts.</p>
Invasive Species	<p>Adverse impacts. D-I/S-L/L-LS, negligible to moderate due to potential increases in invasive species due to disturbance and incidental</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate due to discontinued coral restoration efforts and continued disturbance from</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p>

	<p>introductions via revegetation materials, transplants, vessels, equipment, trucks, etc.</p> <p>Benefits. <u>Terrestrial:</u> D-I/S-L/L-LS, negligible to major due to opportunities for native species to re-establish due to reduced erosion or revegetation. <u>Coastal and marine waters:</u> interventions to reduce invasive species would support recovery of corals and associated biota.</p>	<p>anchoring and accumulation of marine debris, resulting in continued introduction and establishment of invasive species.</p> <p>Benefits. D/S-L/L, negligible to minor due to the elimination of CRCP components that address invasive species.</p>	<p>Benefits. Same as No Action, with additional negligible benefits due to required DCMMs to reduce the concentration of herbicides used for vegetation management and to reduce the risk of introducing invasive species (as well as disease and corallivores) during coral restoration and intervention activities.</p>
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Regulatory Environment

<p>Essential Fish Habitat</p>	<p>Adverse impacts. D/S/L, negligible to minor disturbance and loss of habitat for fisheries during monitoring, surveying, research, mooring buoy installation, debris removal, and coral reef proposed activities.</p> <p>Benefits. D-I/S-L/L-LS, negligible to major due to restoration of reef and associated habitats (mangroves and seagrasses) due to reduced sediment loading, improved water quality, reduced derelict fishing gear and other debris, and additional data for EFH management.</p>	<p>Adverse impacts. D-I/S-L/L-LS, negligible to moderate due to discontinued coral restoration efforts and continued damage from anchoring and accumulation of marine debris.</p> <p>Benefits. D-I/S-L/L-LS, negligible to minor due to elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional, negligible benefits due to DCMMs such as additional sediment and erosion control to improve water quality, reduced physical contact with habitats, and sound protocols to further reduce potential sound impacts.</p>
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<p>Protected Species</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate due to disturbance/displacement of organisms or habitat due to water quality, hydrologic alteration, or excavation during watershed proposed activities, temporary</p>	<p>Adverse impacts. D-I/S-L/L-LS, negligible to moderate due to discontinued coral restoration efforts and continued damage from anchoring and accumulation of marine debris.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts due to DCMMs.</p> <p>Benefits. Same as No Action, with additional negligible water quality benefits and reduced</p>
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	<p>disturbance during surveying and research activities; potential use of herbicides; other potential impacts would require consultation.</p> <p>Benefits. D-I/L/L-LS, negligible to major due to proposed activities that reduce erosion and sedimentation; negligible to major due to invasive species control, road and trail stabilization, and habitat improvements for listed species.</p>	<p>Benefits. D/S/L, negligible to minor due to the elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>impacts to habitats from in-water activities due to DCMMs such as additional protocols to reduce physical contact with sea floor and potential sound/echosounder impacts, monitor vessel speeds, use of BMPs.</p>
Socioeconomic Environment			
Cultural Resources	<p>Adverse impacts. D-I/S-L/L, permanent, negligible to minor due to section 106 SHPO consultation to identify resources and subsequent unlikely disturbance except to remove or document an object or structure that is discovered.</p> <p>Benefits. D/L/L-LS, negligible to moderate due to the potential discovery and/or acquisition of data to support protection of these resources and protection from erosion and runoff.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to minor due to the prior consultation with SHPO to avoid impacting these resources.</p> <p>Benefits. D-I/L/L, negligible to moderate due to potential documentation, recovery, and protection of cultural resources.</p>	<p>Adverse impacts. Same as No Action, but negligible reductions in adverse impacts, due to DCMMs.</p> <p>Benefits. Same as No Action, with additional negligible benefits due to required DCMMs protocols to reduce sedimentation into or physical contact with potential resources.</p>
Public Health and Safety	<p>Adverse impacts. D-I/S-L/L, negligible to minor due to closure of public and private areas for safety during periods of monitoring or research activities.</p> <p>Benefits. D-I/S-L/L-LS, negligible to moderate due to benefits to coastal storm surge and shoreline protection.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to moderate due to continued accumulation of debris and the potential for adverse impacts to public health and safety.</p> <p>Benefits. D-I/S-L/L, negligible to minor, due to the elimination of CRCP components under this</p>	<p>Adverse impacts. Same as No Action alternative.</p> <p>Benefits. Same as No Action alternative.</p>

		alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.	
	<p>Adverse impacts. D-I/S-L/L, negligible to minor due to potential interruptions in activities.</p> <p>Benefits. D-I/S-L/L, negligible to moderate include data acquisition and information to improve public health and safety.</p>	<p>Adverse impacts. D-I/S-L/L, negligible to major due to discontinued coral restoration efforts and continued damage from anchoring and accumulation of marine debris.</p> <p>Benefits. D/S-L/L, negligible to moderate, due to the elimination of CRCP components under this alternative; benefits of watershed restoration and mapping, monitoring, and research maintained.</p>	<p>Adverse impacts. Same as No Action alternative.</p> <p>Benefits. Same as No Action alternative.</p>

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Appendices

10772 **Appendix A. Best Management Practices Implemented by CRCP**

10773 The following best management practices are used as mitigating measures to minimize the impact of
10774 some in-water research activities, watershed restoration activities, and vessel used. These practices don't
10775 reflect an exhaustive list of best practices used in NOAA programs, but are practices considered in the
10776 analysis of impacts.

10777 **1. Vessel Operations to Minimize or Avoid Impacts to Marine Mammals**

10778 In order to avoid causing injury or death to marine mammals and sea turtles, the following measures
10779 should be taken when consistent with safe navigation:

- 10780 ● Vessel operators and crews shall maintain a vigilant watch for marine mammals and sea turtles to
10781 avoid striking sighted protected species.
- 10782 ● Vessels should maintain speed a speed that is safe for the area in which it is moving through.
- 10783 ● When whales are sighted, maintain a distance of 100 yards or greater between the whale and the
10784 vessel.
- 10785 ● When sea turtles or small cetaceans are sighted, attempt to maintain a distance of 50 yards or
10786 greater between the animal and the vessel whenever possible.
- 10787 ● When small cetaceans are sighted while a vessel is underway (e.g., bow-riding), attempt to
10788 remain parallel to the animal's course. Avoid excessive speed or abrupt changes in direction until
10789 the cetacean has left the area.
- 10790 ● Reduce vessel speed to 10 knots or less when a North Atlantic right whale, mother/calf pairs, or
10791 large assemblages of cetaceans are observed near an underway vessel, when safety permits. A
10792 single cetacean at the surface may indicate the presence of submerged animals in the vicinity;
10793 therefore, prudent precautionary measures should always be exercised. The vessel shall attempt to
10794 route around the animals, maintaining a minimum distance of 100 yards whenever possible.
- 10795 ● Whales may surface in unpredictable locations or approach slowly moving vessels. When an
10796 animal is sighted in the vessel's path or in close proximity to a moving vessel and when safety
10797 permits, reduce speed and shift the engine to neutral. Do not engage the engines until the animals
10798 are clear of the area.
- 10799 ● Abide by the NMFS Southeast and Pacific Islands Regional Marine Mammal Viewing
10800 Guidelines.
- 10801 ● Abide by the Florida Fish and Wildlife Conservation Commission's Standard Manatee
10802 Conditions for In-water Work, if working in an area where manatees might be.
10803 [https://www.fws.gov/northflorida/Manatee/Manatee_Key_Programmatic/20130425_gd_Appendix
10804 %20B_2011_Standard%20Manatee%20Construction%20Conditions.pdf](https://www.fws.gov/northflorida/Manatee/Manatee_Key_Programmatic/20130425_gd_Appendix%20B_2011_Standard%20Manatee%20Construction%20Conditions.pdf)
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10806 **2. Self-Contained Underwater Breathing Apparatus (SCUBA)/Snorkel:**

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- 10808 ● SCUBA divers that will be involved in in-water research and monitoring should have proper
10809 training in diving and be capable of exhibiting responsible dive practices (e.g., proper buoyancy)
10810 such that they minimize injure organisms or cause unnecessary habitat impacts. It is the
10811 responsibility of NOAA or a recipient organization to ensure that divers are trained to a level
10812 commensurate with the type and conditions of the diving activity being undertaken. The
10813 organization must have the capacity (appropriate insurance, safety policies, etc.) to oversee all
10814 proposed diving activities.

- 10815 ● To minimize disturbances, divers should use low-impact techniques which include having no
10816 more than four divers per group, the use of appropriate dive equipment and tools, expert boat
10817 anchoring, job-specific diver training, and diver awareness.
10818 ● When using a boat or platform to conduct in-water work, at least one person should maintain a
10819 visual watch for mobile protected species to ensure none are sighted within the working area. If a
10820 listed species moves into the area of work, cessation of operation of any moving equipment closer
10821 than 50 ft of animal and activities may resume once the species has departed the project area on
10822 its own volition.
10823

10824 **3. Coral Fragmentation Collection**

- 10825 ● Projects proposing the collection of coral fragments for use in laboratory/research studies shall
10826 take less than 20% of the colony unless the applicant/principle investigator demonstrates the
10827 removal of a larger amount will not negatively impact the survival of the coral or impact the local
10828 population of that species.
10829 ● Projects that remove cores from coral colonies will only be approved if the researcher has made
10830 provisions to fill the core hole with clay, cement, or epoxy unless permits do not allow for filling
10831 cores.
10832 ● To avoid transmission of possible disease agents, tools including collection bags, sampling gear,
10833 transect tapes, clipboards, underwater slates, weight belts and other equipment that comes in
10834 contact with the bottom should be decontaminated using diluted chlorine bleach. All tools should
10835 be soaked for 10 minutes in a 10% bleach solution (prepared within 12 hours of use and kept out
10836 of direct sunlight) before moving to new sites (following the field manual by Woodley et al.,
10837 2008¹ and Coral Disease Decontamination Protocol, 2018²).
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10840 **4. Watershed Restoration Activities Best Management Practices**

10841 **a. On-site Pollution Controls**

- 10842 ● Properly confine, remove, and dispose of construction waste, including every type of debris,
10843 discharge water, concrete, cement, grout, washout facility, welding slag, petroleum product, or
10844 other hazardous materials generated, used, or stored on-site.
10845 ● All vehicles and other heavy equipment would be (a) operated in a safe manner; (b) stored,
10846 fueled, and maintained in a vehicle staging area set back from any natural waterbody or wetland;
10847 (c) inspected daily for fluid leaks before leaving the vehicle staging area.
10848 ● Generators, cranes, and any other stationary equipment operated within 150 feet of any natural
10849 waterway or wetland would be maintained as necessary to prevent leaks and spills from entering
10850 the water.
10851 ● Use procedures to contain and control a spill of any hazardous material generated, used or stored
10852 on-site, including notification of proper authorities. Heavy equipment can also leak oil and fluids.
10853 Equipment is always refueled away from stream corridors, and operators are required to have a
10854 spill response plan in place in case of a leak.

¹ Woodley, C.M., A.W. Bruckner, A.L. McLenon, J.L. Higgins, S.B. Galloway and J.H. Nicholson. 2008. Field Manual for Investigating Coral Disease Outbreaks. NOAA Technical Memorandum NOS NCCOS 80 and CRCP 6. National Oceanic and Atmospheric Administration, Silver Spring, MD 85pp.

² <https://nmsfloridakeys.blob.core.windows.net/floridakeys-prod/media/docs/coral-disease-decontamination-protocol.pdf>

10855 **c. Invasive Species Spread Prevention**

- 10856 ● Vehicles or equipment used to manage invasive plants should be cleaned of all debris before
10857 removing it from the treatment site to prevent the unintended spread of seeds, rhizomes or plant
10858 fragments to other areas. Biofouled debris bearing non-native species should be appropriately
10859 treated before moving to reduce the likelihood of introducing or spreading or invasive species.
- 10860 ● Implementation of prevention measures, such as application of Hazard Analysis and Critical
10861 Control Point planning, can be used to identify and minimize the risks introducing non-native
10862 organisms during restoration activities.

10863

10864 *Activities that reduce disturbance to vegetation and soils*

10865 **d. Erosion Control**

- 10866 ● Temporary erosion controls would be in place before any significant alteration of the action site
10867 and would be monitored during construction to ensure proper function. Any number of erosion
10868 control structures or approaches may be used: turbidity curtains, hay bales, and erosion mats may
10869 be used where appropriate. When possible, stream flow would be diverted from work areas to
10870 prevent excess turbidity.
- 10871 ● Confine vegetation and soil disturbance to the minimum area, and minimum length of time, as
10872 necessary to complete the action, and otherwise prevent or minimize erosion associated with the
10873 action.
- 10874 ● Anticipate erosion and head cuts through grade control structures or bank recontouring.
- 10875 ● Cease work under high flows or seasonal conditions that threaten to disturb turbidity reduction
10876 measures, except for efforts to avoid or minimize resource damage.
- 10877 ● Exposed areas would be mulched and seeded after ground-disturbing activities are complete.
- 10878 ● Site restoration - Any woody debris, mature native vegetation, topsoil, and native channel
10879 material displaced by construction would be stockpiled for use during site restoration. When
10880 construction is finished, all streambanks, soils, and vegetation would be cleaned up and restored
10881 as necessary to renew ecosystem processes that form and maintain productive fish habitats.

10882 **e. Methods to Reduce Soil Compaction**

- 10883 ● Existing access ways would be used whenever possible. Temporary access roads would not be
10884 built on slopes greater than 50%, where grade, soil, or other features suggest a likelihood of
10885 excessive erosion or failure. Soil disturbance and compaction would be minimized within 150
10886 feet of a natural waterbody or wetland. All temporary access roads would be obliterated when the
10887 action is completed, the soil would be stabilized, and the site would be revegetated. Temporary
10888 roads in wet or flooded areas would be restored shortly after the work period is complete.
- 10889 ● Heavy equipment would be selected and operated in a manner that minimizes adverse effects to
10890 the environment (e.g., minimally-sized, low pressure tires, minimal hard turn paths for tracked
10891 vehicles, temporary mats or plates within wet areas or sensitive soils).
- 10892 ● To the extent feasible, heavy equipment would work from the top of the bank, unless work from
10893 another location would result in less habitat disturbance.

10894 **f. Planting or Installing Vegetation for Watershed Management**

- 10895 ● Projects should use an appropriate assemblage of species native to the action area or region,
10896 including trees, shrubs, and herbaceous species should be planted.

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- For all geographic areas, no more than 5% of the below ground biomass of an existing donor bed would be harvested for transplanting purposes. Plants harvested would be taken in a manner to thin an existing bed without leaving any noticeable bare areas. Harvesting of flowering shoots would occur only from widely separated plants.

10901 **g. Adequate training of volunteers**

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- Training should be provided to ensure minimal impact to the restoration site by volunteers. Volunteers shall be trained in the use of low-impact techniques for planting, equipment handling, and moving around the restoration site to avoid unnecessary impacts on native flora and fauna.

10905 **h. Activities that avoid disturbing sensitive areas and species**

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- Sensitive resource areas adjacent to the action area, such as buffers, archeological sites, and wetlands would be flagged to avoid accidental impacts.
 - All applicable work windows for species listed under the Endangered Species Act would be followed.
 - Training should be provided to ensure minimal impact to the restoration site by volunteers. Volunteers shall be trained in the use of low-impact techniques for planting, equipment handling, and moving around the restoration site to avoid unnecessary impacts on native flora and fauna.

10913 **5. In-water restoration activities**

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- When barges and other boats must moor on site to accomplish restoration work, mooring locations would be chosen to minimize damage to existing coral reefs or adjacent submerged aquatic vegetation beds.

10918 **6. Other**

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- Vessels used in implementing activities must meet all EPA Vessel General Permits and Coast Guard requirements.
 - Projects involving laboratory studies will follow the laboratory's environmental compliance guidelines and ensure that chemicals are disposed of in a proper manner, and comply with the ethical treatment of animals.

10924 **Appendix B. CRCP Discretionary Mitigation Measures**

10925 The following practices are used as discretionary mitigation measures to avoid or minimize potentially
10926 adverse impacts during the implementation of activities under the CRCP. Where appropriate, these
10927 practices will be incorporated into all CRCP funded activities. These practices are not an exhaustive list
10928 of best practices used in NOAA programs, but are practices considered in the analysis of impacts.
10929 Additional discretionary measures in the form of conservation recommendations may be developed
10930 through consultation with NMFS pursuant to Section 7 of the Endangered Species Act (ESA) and the
10931 Essential Fish Habitat provisions of the Magnuson Stevens Act.

10932 1. Vessels Operations -

10933 a. To reduce the risk of vessel impacts to coral reefs, colonized hard bottom, and seagrass
10934 areas, vessel operator must carry and consult appropriate NOAA nautical charts, NOAA
10935 benthic habitat maps and aerial photographs and/or use real-time data (e.g., GPS with
10936 nautical chart and depth finder on boat) will be continuously observed to verify water
10937 depths and vessel location.

10938 2. Vessel Anchoring for all in-water boat use:

10939 a. Vessel operators should use recreational mooring buoys or live boating (boat operator
10940 keeps engine on to keep boat on station without anchoring) when possible. If anchoring,
10941 only used designated anchoring area or in mud or sand.
10942 b. If anchoring is necessary, vessels should be anchored preferentially on sandy bottom
10943 whenever possible. If anchoring on sandy bottom is not possible, vessels may be
10944 anchored on vegetated bottom that consists of seagrass and/or algae (seaweed). Vessels
10945 should not be anchored on hard bottom that contains hard and/or soft coral, regardless of
10946 the percentage of coral cover present. The type of bottom present will be confirmed by
10947 divers, onboard using a glass-bottom bucket, or by other appropriate means, prior to
10948 anchoring.
10949 c. If the vessel is anchored on vegetated bottom (seagrass/algae), the anchor will be
10950 removed from the seafloor in a manner that minimizes disturbance to the vegetation, for
10951 example, by attaching a secondary anchor line to the rear of any plow-type anchor and
10952 pulling the anchor free from the seafloor before lifting to the surface.

10953 3. Remotely Operated Vehicles (ROV)

10954 a. ROV operators should have the training necessary to maintain and operate these vehicles
10955 at a depth above the seafloor and coral relief in order to avoid contact.
10956 b. Use stiffer line materials for towing and keep lines taut during operations to reduce
10957 potential for entanglement.

10958 4. Acoustics/Echo Sounder Restrictions:

10959 a. Operate all active acoustic systems at or above 180 kHz when practicable.
10960 b. If echosounder frequencies less than 180 must be employed, operate at the lowest
10961 possible power (to reduce source level) and ping-rate (to reduce accumulated energy).
10962 c. Use directional echosounders with the smallest beam width practicable to concentrate
10963 noise directly under vessel to maximum extent practicable.
10964 d. Minimize use of all active acoustic systems (e.g., turn off all non-navigational
10965 echosounder when not actively mapping)

- 10966 e. Power down or turn off mapping echosounder if a marine mammal is observed closely
10967 approaching or within 100m of the vessel.
- 10968 5. Self-Contained Underwater Breathing Apparatus (SCUBA)/Snorkel:
10969 a. The dive team lead will make sure that underwater conditions (e.g., visibility, current
10970 speeds) and weather are suitable for diving to ensure the safety of divers and for ability to
10971 avoid damaging sensitive underwater habitats.
10972 b. The point of entry and exit will be carefully selected to avoid damaging coral.
10973 c. Divers should stay off the bottom and should never stand or rest on corals or other sessile
10974 benthic invertebrates.
10975 d. During all in-water activities, participants in education programs and other activities
10976 should avoid stepping on/standing on corals, kicking coral colonies while swimming, and
10977 placing equipment on top of sensitive benthic resources.
- 10978 6. Instruments Moored to the Seafloor:
10979 a. The installation and removal of in-water structures for research equipment should be
10980 performed by divers; all equipment must be removed once the study is complete.
10981 b. Moored instruments should be securely placed on/anchored into uncolonized hard bottom
10982 areas of rubble or sand.
10983 c. Any lines associated with moored instruments should be taught to reduce the possibility
10984 of entanglement of protected species.
10985 d. Heavy instruments should lowered and retrieved using air lift bags.
- 10986 7. Coral Nursery
10987 a. When determining new nursery sites the following factors should be considered: 1)
10988 Proximity to natural live bottom, 2) hydrological and geological factors, and 3) traditional
10989 uses of the proposed site.
10990 b. Nursery maintenance and monitoring plan should be developed. The plan should include
10991 method(s) to be used to remove structures that are no longer needed, functional, or of a
10992 design that has become obsolete. The plan should also include a timeframe for the
10993 removal of structures and restoration of the area to pre-construction conditions to
10994 commence no later than 30 days after the structures are no longer in use.
10995 c. Structures must be constructed in a manner that ensures the structures will not move or
10996 flip during storm events or due to human impacts such as anchor drag:
10997 i. Stabilization of structures can be achieved with the use of weights and/or
10998 penetrating anchor systems such as Duckbill® or Helix® anchors or rebar driven
10999 to sufficient depth to prevent movement or lifting of the structures.
11000 ii. Structures must be placed a minimum of 50 ft from live stony corals and seagrass
11001 beds to avoid potential impacts from movement of structures.
11002 d. Floating structures that use lines as part of the support system or for attaching corals must
11003 be constructed in a manner to eliminate or minimize the chances of entanglement of sea
11004 turtles and marine mammals:
11005 i. Line nurseries must have, at a minimum, either horizontal or vertical components
11006 that are rigid (e.g., PVC pipe) to prevent the structures from collapsing and
11007 potentially causing entanglement of animals.
11008 ii. Vertical lines for anchoring structures to the seafloor must have sufficient tension
11009 created by buoys on the line to avoid slack.

- 11010 iii. Buoys should be tied to the rigid component of the structure with the minimum
- 11011 use of line such that less than 50 cm (20 in) of line is exposed between each buoy
- 11012 and the structure.
- 11013 iv. Line used to attach corals vertically to the nursery structures must be no longer
- 11014 than 20 cm (8 in).
- 11015 v. Horizontal lines must be at least 20 cm (8 in) apart and must be kept taut and
- 11016 supported by a rigid frame structure (PVC or similar) in order to avoid slack in
- 11017 the horizontal lines.
- 11018 e. The use of monofilament lines instead of steel cables to reduce the need to replace cables
- 11019 regularly is acceptable as long as the lines for floating structures are kept taut and follow
- 11020 the recommendations above for new floating structures to minimize entanglement of
- 11021 marine organisms.
- 11022 f. All applicable permits for the installation of coral nursery structures shall be obtained
- 11023 prior to installation.

11024 8. Coral Restoration/Transplantation/Relocation:

- 11025 a. Unless part of scientifically vetted study with risks analyzed and appropriate approval
- 11026 such as an ESA consultation, if applicable, outplants/transplants must be from a
- 11027 ‘genetically connected’ population (e.g., corals are not transplanted from Puerto Rico to
- 11028 Florida).
- 11029 b. Restoration projects should include a scientific hypothesis, experimental design and
- 11030 follow-up monitoring, such as monitoring of the control sites where corals were collected
- 11031 from, to ensure the project does not have significant cumulative impacts, and to ensure
- 11032 that lessons learned from the project can be applied to future efforts thereby mitigating
- 11033 their potential for causing significant adverse impacts.
- 11034 c. Projects involving the collecting corals for transplantation should only collect a minimal
- 11035 portion of the wild colony, based on best practices that have been recommended by the
- 11036 international community (e.g., no more than 20% of a colony is removed and colonies are
- 11037 removed from areas where there are competitive interactions and are likely to die or be
- 11038 overgrown).
- 11039 d. When relocating, avoid placing the transplanted corals/grid and any required equipment
- 11040 (e.g., tools, sensors, weights, etc.) on live bottom substrate.
- 11041 e. Transporting live coral either from collection site to nursery or nursery to outplanting
- 11042 site:
 - 11043 i. Each coral may be carried by hand or in a bucket to the relocation site.
 - 11044 ii. In order to reduce stress to the coral from transport and to increase the likelihood
 - 11045 of success, the coral colonies should remain submerged in seawater at all times.
 - 11046 iii. Corals should be handled as little as possible.
 - 11047 iv. Detached coral colonies should not be in contact with each other to prevent
 - 11048 additional harm to their structures and tissue.
 - 11049 v. If a bucket or container is used for transportation and transportation will be above
 - 11050 water (such as on a vessel to get from the removal site to the transplant site), the
 - 11051 seawater should be routinely changed to avoid prolonged exposure to increased
 - 11052 water temperatures.
 - 11053 vi. Corals should be reattached the same day they are removed; they should not be
 - 11054 stored overnight in transport containers.

11055 9. Coral Fragment Collection:

11056 a. Monitor, if possible, the parent coral colonies from which samples have been taken to
11057 track and record that tissue regeneration across the lesions has been effective.

11058 10. Invasive Species:

11059 a. In areas where there is an identified risk of spreading invasive species or if particular
11060 activity can increase the chance of spreading invasive species, grantees/principle
11061 investigators should ensure invasive species are not introduced to non-native areas
11062 through means such as: 1) cleaning instruments or tools according to scientific protocols
11063 to ensure no biofouling is present (e.g., scraping, treating surface with a mild bleach
11064 solution, storing removed species in a safe location to decompose, etc.); 2) rinsing dive
11065 gear in a bleach solution at the end of each day in the field; 3) sanitizing vessels and all
11066 gear at each departure from port; 4) disinfecting equipment and gear between use/sites;
11067 and 5) decontamination of clothing and soft gear to be taken ashore from a vessel by
11068 freezing materials for 48 hours or by the use of new clothing or soft gear.
11069 b. Laboratory studies involving the use of live plants, animals, bacteria, and virus must
11070 ensure proper steps are taken so that non-native species or pathogens are not introduced
11071 or spread as a result of the work.

11072 11. Reduce Impacts to Essential Fish Habitat and Designated Critical Habitat:

11073 a. Projects involving the use of traps, nets, or other types of fishing gear used to sample fish
11074 populations must include measures to ensure the use of these gear types is in a way that
11075 minimizes impacts to benthic habitats.
11076 b. Nets must be monitored at all times to insure ESA-listed sea turtles and other non-target
11077 species do not become entangled. If entanglement does occur, the animals will be freed
11078 immediately in accordance with any existing guidelines.
11079 c. Fishing gear will not be deployed in areas with ESA-listed corals if there is a likelihood
11080 that gear could become entangled in coral.

11081 12. Bottom Sediment Sample Collection:

11082 a. Avoid collecting bottom samples in seagrass ESA critical habitat.

11083 13. For project that may temporarily increase sedimentation:

11084 a. Due to the high risk of sedimentation or suspended material, operations should be halted
11085 during peak stony coral spawning periods. To allow for recruitment sediment generating
11086 activities should be limited for a three-week period after the primary spawning event.
11087 b. Avoid sediment-generating activities during soft coral spawning periods if soft corals are
11088 observed at or near the site. Sediment generating activities should be restricted for three
11089 weeks beginning one week after the full moon of each month to protect the spawning
11090 season for soft corals if they are present.

11091 14. Buoy Installation:

11092 a. Buoys should only be installed at locations with no or low vertical relief and no coral
11093 colonization within 1-meter radius from the buoy anchor location to avoid breakage or
11094 abrasion of sessile benthic organism from the movement of buoy and tackle. All buoy
11095 mooring systems must have floats on the lines to prevent any tackle from dragging on the
11096 bottom.
11097 b. The attachment of a 11.5-inch buoy to the buoy chain approximately 2 feet above the
11098 chain attachment point to the bottom anchor in order to prevent the anchor chain from
11099 dragging on the seafloor should the chain become detached from the anchor.

- 11100 c. The use of a helical screw anchor or drill and epoxied pin anchor, depending on substrate
- 11101 type, to minimize the footprint of the anchor in the marine bottom.
- 11102 d. Anchors will only be installed in sandy bottom areas free of submerged aquatic
- 11103 vegetation (SAV), coral, or hard bottom.
- 11104 e. The use of an oversight vessel to ensure no marine mammals or sea turtles are in the area
- 11105 during buoy installation. If marine mammals or sea turtles are observed, operations will
- 11106 cease until the animal has left the area.
- 11107 f. GPS locations of the buoys will be collected once installation is complete and once a
- 11108 month for 3 months to determine whether the buoys are moving. If the buoys have not
- 11109 moved during the first 3 months after installation, quarterly monitoring will be done from
- 11110 the surface and once every 6 months using divers.

11111 15. Watershed Restoration Activities:

- 11112 a. Use only native or naturalized plants in vegetative plantings.
- 11113 b. Avoid using products with large concentrations of pesticides.
- 11114 c. Avoid planting vegetation when a storm is approaching.

11115 16. Terrestrial Work Restrictions:

- 11116 a. Do not collect birds (live or dead) or their eggs, nests, or parts (e.g., feathers).
- 11117 b. Take all necessary precautions to prevent wounding any birds or disturbing any bird
- 11118 nests.

11119 17. Other

- 11120 a. Projects involving implementation of management measures that may have negative
- 11121 socioeconomic implications (e.g., activities that affect the livelihood of user groups such
- 11122 as fishing regulations), should include efforts to educate the user groups regarding the
- 11123 need for these measures and assist user groups in identifying alternatives they could
- 11124 pursue to minimize economic burdens.
- 11125

11126 **Appendix C. EFH- HAPC's under the Four Fishery Management Councils: South Atlantic,**
 11127 **Caribbean, Gulf of Mexico, and Western Pacific Regional**
 11128

11129 **South Atlantic Fishery Management Council**

Essential Fish Habitat	Fisheries/Species	HAPC's
Wetlands		
Estuarine and marine emergent wetlands	Shrimp, Snapper-Grouper	Shrimp: state designated nursery habitats and mangrove wetlands
Tidal palustrine forested wetlands	Shrimp	
Submerged Aquatic Vegetation		
Estuarine and marine submerged aquatic vegetation	Shrimp, Snapper-Grouper, Spiny Lobster	Snapper-Grouper, Shrimp
Shell bottom		
Oyster reefs and shell banks	Snapper-Grouper	Snapper-Grouper
Coral and Hardbottom		
Coral reefs, live/hardbottom, medium to high rock outcroppings from shore to at least 183 meters.	Snapper-Grouper, Spiny Lobster, Coral, Coral Reefs and Live Hard/bottom Habitat	The Point, Ten Fathom Ledge, and Big Rock, marine protected areas; worm reefs off central east coast of Florida and nearshore hardbottom; coral and hardbottom habitat from Jupiter through the Dry Tortugas, FL; Deepwater Coral HAPCs
Rock overhangs, rock outcrops, manganesephosphorite rock slab formations, and rocky reefs		Blueline Tilefish (in Snapper- Grouper)
Artificial reefs	Snapper-Grouper	Special Management Zones
Soft bottom		
Subtidal, intertidal non-vegetated flats	Shrimp	
Offshore marine habitats used for spawning and growth to maturity	Shrimp	
Sandy shoals of capes and offshore bars	Coastal Migratory Pelagics	Sandy shoals; Cape Lookout; Cape Fear; Cape Hatteras and Hurl Rocks
Troughs and terraces intermingled with sand, mud, or shell hash at depths of 150 to 300 meters		Golden Tilefish (in Snapper-Grouper)

Water Column		
Ocean-side waters, from the surf to the shelf break zone, including Sargassum	Coastal Migratory Pelagics	
All coastal inlets	Coastal Migratory Pelagics	Shrimp, Snapper-Grouper
All state-designated nursery habitats of particular importance	Coastal Migratory Pelagics	Shrimp, Snapper-Grouper
High salinity bays, estuaries	Cobia (in Coastal Migratory Pelagics)	Spanish mackerel: Bogue Sound, New River, NC; Broad River, SC
Pelagic Sargassum	Dolphin	
Gulf Stream	Shrimp, Snapper-Grouper, Coastal Migratory Pelagics, Spiny Lobster, Dolphin-Wahoo	
Spawning area in the water column above the adult habitat and the additional pelagic environment	Snapper-Grouper	

11130 For additional information, go to: <http://safmc.net/download/SAFMCEFHUsersGuideFinalNov16.pdf>

11131 **Caribbean Fishery Management Council**

11132 **Coral - Ecologically Important Habitats**

11133 **Puerto Rico**

- 11134 • Luis Peña Channel, Culebra
- 11135 • Mona/Monito
- 11136 • La Parguera, Lajas
- 11137 • Caja de Muertos, Ponce
- 11138 • Tourmaline Reef
- 11139 • Guánica State Forest
- 11140 • Punta Petrona, Santa Isabel
- 11141 • Ceiba State Forest
- 11142 • La Cordillera, Fajardo
- 11143 • Guayama Reefs
- 11144 • Steps and Tres Palmas, Rincon
- 11145 • Los Corchos Reef, Culebra
- 11146 • Desecheo Reefs, Desecheo

11147

11148 **St. Croix**

- 11149 • St. Croix Coral Reef Area of Particular Concern, including the East End Marine Park
- 11150 • Buck Island Reef National Monument
- 11151 • South Shore Industrial Area Patch Reef and Deep Reef System
- 11152 • Frederiksted Reef System
- 11153 • Cane Bay
- 11154 • Green Cay Wildlife Refuge

11155

11156 **Reef Fish - Spawning Habitats**

11157 **Puerto Rico**

- 11158 • Tourmaline Bank/Buoy 8
- 11159 • Abrir La Sierra Bank/Buoy 6
- 11160 • Bajo de Sico
- 11161 • Vieques, El Seco

11162

11163 **St. Croix**

- 11164 • Mutton snapper spawning aggregation area
- 11165 • East of St. Croix (Lang Bank)
- 11166 • St. Thomas
- 11167 • Hind Bank Marine Conservation District
- 11168 • Grammanik Bank

11169

11170 **Reef Fish - Ecologically Important Habitats**

11171 **Puerto Rico**

- 11172 • Hacienda la Esperanza, Manítí
- 11173 • Bajuras and Tiberones, Isabela
- 11174 • Cabezas de San Juan, Fajardo
- 11175 • JOBANNERR, Jobos Bay
- 11176 • Bioluminescent Bays, Vieques
- 11177 • Boquerón State Forest
- 11178 • Pantano Cibuco, Vega Baja

- 11179 • Piñones State Forest
- 11180 • Río Espiritu Santo, Río Grande
- 11181 • Seagrass beds of Culebra Island (nine sites designated as Resource Category 1 and two additional sites)
- 11182
- 11183 • Northwest Vieques seagrass west of Mosquito Pier, Vieques
- 11184

St. Thomas

- 11185
- 11186 • Southeastern St. Thomas, including Cas Key and the mangrove lagoon in Great St. James Bay
- 11187 • Saba Island/Perseverance Bay, including Flat Key and Black Point Reef
- 11188

St. Croix

- 11189
- 11190 • Salt River Bay National Historical Park and Ecological Preserve and Marine Reserve and Wildlife Sanctuary
- 11191
- 11192 • Altona Lagoon
- 11193 • Great Pond South Shore Industrial Area
- 11194 • Sandy Point National Wildlife Refuge
- 11195
- 11196

11197

11198 **Gulf of Mexico Fishery Management Council**

11199 **Florida**

- 11200 • Madison-Swanson Marine Reserve
- 11201 • Tortugas North
- 11202 • Tortugas South
- 11203 • Florida Middle Grounds
- 11204 • Pulley Ridge

11205
11206 **Texas/Louisiana Topographic Features (Reefs and Banks)**

- 11207 • West Flower Garden Banks
- 11208 • East Flower Garden Banks
- 11209 • Stetson Bank
- 11210 • 29 Fathom Bank
- 11211 • MacNeil Bank
- 11212 • Rezak Sidner Bank
- 11213 • Rankin Bright Bank
- 11214 • Geyer Bank
- 11215 • McGrail Bank
- 11216 • Bouma Bank
- 11217 • Sonnier Bank
- 11218 • Alderdice Bank
- 11219 • Jakkula Bank

11220

11221 **Western Pacific Regional Fishery Management Council**

Combined foot print for all Management Unit Species:	
American Samoa	All bottom habitat from the shoreline to a depth of 400 m (1312 ft); the water column from the shoreline to EEZ, and from the surface to 1000 m (3281 ft).
Hawaii	All bottom habitat from the shoreline to a depth of 400 m (1312 ft), and the outer reef slopes at depths between 400 m to 700 m (1312 ft and 2297 ft); the water column from the shoreline to EEZ, and from the surface to 1000 m (3281 ft).
Guam and CNMI	All bottom habitat from the shoreline to a depth of 400 m (1312 ft); the water column from the shoreline to EEZ, and from the surface to 1000 m (3281 ft).

11222

Appendix D. NOAA Restoration Center PEIS Project List, March 2019

Project Name	State	Project Type	Date Signed
Restoring Abundance to Hawaiian Fisheries and Coastal Communities through Restoration of Fishpond Estuaries - Phase III	HI	Invasive Species Control	2/11/2019
Building Community Capacity for Habitat Restoration and Conservation in the Manell-Geus HFA	GU	Freshwater Stream Bank Restoration and Erosion Reduction	7/2/2018
FEMA USVI post-hurricane coral assessment and restoration	VI	Reef Restoration- Coral	4/5/2018
FEMA Puerto Rico post-hurricane coral assessment and restoration	PR	Reef Restoration- Coral	4/5/2018
M/V Vogetrader Grounding	HI	Reef Restoration- Coral	1/17/2018
Building Community Capacity for Habitat Restoration and Conservation in the Manell-Geus HFA	GU	Planning, Feasibility Studies, Design Engineering, and Permitting	7/5/2017
Community and Coral Restoration and Resilience in the West Hawaii HFA	HI	Environmental Education Programs, Partnerships; Training Programs	7/5/2017
NE Puerto Rico Wave Attenuation Modeling	PR	Planning, Feasibility Studies, Design Engineering, and Permitting	6/30/2017
Expanding Efforts on Building Resiliency in the Puerto Rico Northeast Reserves	PR	Planning, Feasibility Studies, Design Engineering, and Permitting	6/29/2017
Kawaihae Watershed Stabilization and Restoration in Hawaii	HI	Reef Restoration- Coral	6/27/2017
Restoring Abundance to Hawaiian Fisheries and Coastal Communities through Restoration of Fishpond Estuaries - Phase II	HI	Invasive Species Control	6/15/2017
Building Resiliency in the Puerto Rico Northeast Reserves by Addressing Land-based Sources of Pollution (LBSPs), Restoring Coral Reef Habitat	PR	Road Upgrading/Decommissioning; Trail Restoration	5/2/2017
Wetland and Stream Restoration in He'eia, O'ahu (Hawaii)	HI	Invasive Species Control	12/7/2016

Project Name	State	Project Type	Date Signed
Restoring Streams in Wahikuli Watershed, Hawaii	HI	Freshwater Stream Bank Restoration and Erosion Reduction	12/5/2016
Unpaved Road Stabilization - Culebra, Puerto Rico	PR	Road Upgrading/Decommissioning; Trail Restoration	11/25/2016
Kawaihae Watershed Stabilization and Restoration in Hawaii	HI	Reef Restoration- Coral	6/27/2017
Restoring Abundance to Hawaiian Fisheries and Coastal Communities through Restoration of Fishpond Estuaries	HI	Invasive Species Control	6/24/2016
Unpaved Road Stabilization - Culebra, Puerto Rico	PR	Road Upgrading/Decommissioning; Trail Restoration	6/16/2016
Active Coral Propagation - FL	FL	Reef Restoration- Coral	6/16/2016
Coral active propagation - USVI and PR	PR	Species Enhancement	6/6/2016
Culebra Unpaved Road Stabilization - Coronel	PR	Road Upgrading/Decommissioning; Trail Restoration	6/6/2016
Seeding reefs with Diadema antillarum - Puerto Rico	PR	Species Enhancement	6/3/2016
Building Resiliency in the PR Northeast Reserves by Addressing LBSP, Restoring Coral Reef Habitat	PR	Road Upgrading/Decommissioning; Trail Restoration	5/23/2016
Grounding Response - PR and USVI	PR	Reef Restoration- Coral	5/18/2016
Building Resiliency in the Puerto Rico Northeast Reserves	PR	Reef Restoration- Coral	4/27/2016

Appendix E. USFWS Listed ESA Species

Listed status	Species	Jurisdiction
Animals		
T	Knot, red Wherever found (<i>Calidris canutus rufa</i>)	Florida
T	Manatee, West Indian Wherever found (<i>Trichechus manatus</i>)	Florida, Puerto Rico
T	Snake, eastern indigo Wherever found (<i>Drymarchon corais couperi</i>)	Florida
T	Stork, wood AL, FL, GA, MS, NC, SC (<i>Mycteria americana</i>)	Florida
T	Plover, piping [Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered. (<i>Charadrius melodus</i>)	Florida
T	Sea turtle, green North Atlantic DPS (<i>Chelonia mydas</i>)	Florida, Hawaii, Guam, CNMI, and American Samoa
E	Sea turtle, hawksbill Wherever found (<i>Eretmochelys imbricata</i>)	Florida, Puerto Rico, Virgin Islands, Hawaii,
E	Sea turtle, leatherback Wherever found (<i>Dermochelys coriacea</i>)	Florida, Puerto Rico, Virgin Islands, Hawaii
E	Woodpecker, red-cockaded Wherever found (<i>Picoides borealis</i>)	Florida
E	Tiger beetle, Miami Wherever found (<i>Cicindelidia floridana</i>)	Florida
E	Mouse, Key Largo cotton Wherever found (<i>Peromyscus gossypinus allapaticola</i>)	Florida
T	scrub-jay, Florida Wherever found (<i>Aphelocoma coerulescens</i>)	Florida
T	Snail, Stock Island tree Wherever found (<i>Orthalicus reses</i> (not incl. <i>nesodryas</i>))	Florida
E	Sparrow, Cape Sable seaside Wherever found (<i>Ammodramus maritimus mirabilis</i>)	Florida
E	Warbler, Kirtland's Wherever found (<i>Setophaga kirtlandii</i> (= <i>Dendroica kirtlandii</i>))	Florida
E	Warbler (=wood), Bachman's Wherever found (<i>Vermivora bachmanii</i>)	Florida
E	Woodrat, Key Largo Wherever found (<i>Neotoma floridana smalli</i>)	Florida
E	Panther, Florida Wherever found (<i>Puma</i> (= <i>Felis</i>) <i>concolor coryi</i>)	Florida
E	Rabbit, Lower Keys marsh Wherever found (<i>Sylvilagus palustris hefneri</i>)	Florida
E	Rice rat lower FL Keys (<i>Oryzomys palustris natator</i>)	Florida
T	Tern, roseate Western Hemisphere except NE U.S. (<i>Sterna dougallii dougallii</i>)	Florida, Puerto Rico, Virgin Islands
T	Crocodile, American U.S.A. (FL) (<i>Crocodylus acutus</i>)	Florida
E	Mouse, Anastasia Island beach Wherever found (<i>Peromyscus polionotus phasma</i>)	Florida

Listed status	Species	Jurisdiction
T	Mouse, southeastern beach wherever found (<i>Peromyscus polionotus niveiventris</i>)	Florida
E	Bat, gray Wherever found (<i>Myotis grisescens</i>)	Florida
E	Kite, Everglade snail Wherever found (<i>Rostrhamus sociabilis plumbeus</i>)	Florida
E	bat, Florida bonneted Wherever found (<i>Eumops floridanus</i>)	Florida
E	Butterfly, Bartram's hairstreak Wherever found (<i>Strymon acis bartrami</i>)	Florida
E	Butterfly, Miami Blue Wherever found (<i>Cyclargus (=Hemiargus) thomasi bethunebakeri</i>)	Florida
T	Caracara, Audubon's crested FL pop. (<i>Polyborus plancus audubonii</i>)	Florida
E	Deer, key Wherever found (<i>Odocoileus virginianus clavium</i>)	Florida
E	Butterfly, Florida leafwing Wherever found (<i>Anaea troglodyta floridalis</i>)	Florida
E	Butterfly, Schaus swallowtail Wherever found (<i>Heraclides aristodemus ponceanus</i>)	Florida
E	Anole, Culebra Island giant Wherever found (<i>Anolis roosevelti</i>)	Puerto Rico
E	Blackbird, yellow-shouldered Wherever found (<i>Agelaius xanthomus</i>)	Puerto Rico
T	Boa, Mona Wherever found (<i>Epicrates monensis monensis</i>)	Puerto Rico
E	Boa, Puerto Rican Wherever found (<i>Epicrates inornatus</i>)	Puerto Rico
E	Boa, Virgin Islands tree Wherever found (<i>Epicrates monensis granti</i>)	Puerto Rico, Virgin Islands
T	Coqui, golden Wherever found (<i>Eleutherodactylus jasperii</i>)	Puerto Rico
E	Coqui, Llanero Wherever found (<i>Eleutherodactylus juanariveroi</i>)	Puerto Rico
E	Gecko, Monito Wherever found (<i>Sphaerodactylus micropithecus</i>)	Puerto Rico
T	Guajon Wherever found (<i>Eleutherodactylus cooki</i>)	Puerto Rico
E	Hawk, Puerto Rican broad-winged Wherever found (<i>Buteo platypterus brunnescens</i>)	Puerto Rico
E	Hawk, Puerto Rican sharp-shinned Wherever found (<i>Accipiter striatus venator</i>)	Puerto Rico
T	Iguana, Mona ground Wherever found (<i>Cyclura stejnegeri</i>)	Puerto Rico
E	Nightjar, Puerto Rican Wherever found (<i>Caprimulgus noctitherus</i>)	Puerto Rico
E	Parrot, Puerto Rican Wherever found (<i>Amazona vittata</i>)	Puerto Rico
E	Pigeon, Puerto Rican plain Wherever found (<i>Columba inornata wetmorei</i>)	Puerto Rico
T	Toad, Puerto Rican crested Wherever found (<i>Peltophryne lemur</i>)	Puerto Rico
T	Warbler, elfin-woods Wherever found (<i>Setophaga angelae</i>)	Puerto Rico
E	Lizard, St. Croix ground Wherever found (<i>Ameiva polops</i>)	Virgin Islands
E	Akekee Wherever found (<i>Loxops caeruleirostris</i>)	Hawaii
E	akepa, Hawaii Wherever found (<i>Loxops coccineus</i>)	Hawaii
E	akepa, Maui Wherever found (<i>Loxops ochraceus</i>)	Hawaii
E	akialoa, Kauai (honeycreeper) Wherever found (<i>Akialoa stejnegeri</i>)	Hawaii
E	akiapolaau Wherever found (<i>Hemignathus wilsoni</i>)	Hawaii
E	Akikiki Wherever found (<i>Oreomystis bairdi</i>)	Hawaii

Listed status	Species	Jurisdiction
E	Albatross, short-tailed Wherever found (Phoebastria (=Diomedea) albatrus)	Hawaii
E	Amphipod, Kauai cave Wherever found (Spelaeorchestia koloana)	Hawaii
E	Bat, Hawaiian hoary Wherever found (Lasiurus cinereus semotus)	Hawaii
E	Coot, Hawaiian Wherever found (Fulica americana alai)	Hawaii
E	Creeper, Hawaii Wherever found (Oreomystis mana)	Hawaii
E	Creeper, Molokai Wherever found (Paroreomyza flammea)	Hawaii
E	Creeper, Oahu Wherever found (Paroreomyza maculata)	Hawaii
E	Crow, Hawaiian (=‘alala) Wherever found (Corvus hawaiiensis)	Hawaii
E	Damselfly, blackline Hawaiian Wherever found (Megalagrion nigrohamatum nigrolineatum)	Hawaii
E	Damselfly, crimson Hawaiian Wherever found (Megalagrion leptodemas)	Hawaii
E	Damselfly, flying earwig Hawaiian Wherever found (Megalagrion nesiotes)	Hawaii
E	Damselfly, oceanic Hawaiian Wherever found (Megalagrion oceanicum)	Hawaii
E	Damselfly, orangeblack Hawaiian Wherever found (Megalagrion xanthomelas)	Hawaii
E	Damselfly, Pacific Hawaiian Wherever found (Megalagrion pacificum)	Hawaii
E	Duck, Hawaiian (=koloa) Wherever found (Anas wyvilliana)	Hawaii
E	Duck, Laysan Wherever found (Anas laysanensis)	Hawaii
E	elepaio, Oahu Wherever found (Chasiempis ibidis)	Hawaii
E	Finch, Laysan (honeycreeper) Wherever found (Telespyza cantans)	Hawaii
E	Finch, Nihoa (honeycreeper) Wherever found (Telespyza ultima)	Hawaii
E	fly, Hawaiian picture-wing Wherever found (Drosophila aglaia)	Hawaii
E	fly, Hawaiian picture-wing Wherever found (Drosophila differens)	Hawaii
E	Fly, Hawaiian picture-wing Wherever found (Drosophila digressa)	Hawaii
E	fly, Hawaiian picture-wing Wherever found (Drosophila hemipeza)	Hawaii
E	fly, Hawaiian picture-wing Wherever found (Drosophila heteroneura)	Hawaii
T	fly, Hawaiian picture-wing Wherever found (Drosophila mulli)	Hawaii
E	fly, Hawaiian picture-wing Wherever found (Drosophila musaphilia)	Hawaii
E	fly, Hawaiian picture-wing Wherever found (Drosophila obatai)	Hawaii
E	fly, Hawaiian picture-wing Wherever found (Drosophila ochrobasis)	Hawaii
E	Fly, Hawaiian picture-wing Wherever found (Drosophila sharpi)	Hawaii
E	fly, Hawaiian picture-wing Wherever found (Drosophila substenoptera)	Hawaii
E	fly, Hawaiian picture-wing Wherever found (Drosophila tarphytrichia)	Hawaii
E	gallinule, Hawaiian common Wherever found (Gallinula galeata sandvicensis)	Hawaii
E	Goose, Hawaiian Wherever found (Branta (=Nesochen) sandvicensis)	Hawaii
E	Hawk, Hawaiian (=‘lo) Wherever found (Buteo solitarius)	Hawaii
E	honeycreeper, (Akohekohe) crested Wherever found (Palmeria dolei)	Hawaii
T	‘Iiwi Wherever found (Drepanis coccinea)	Hawaii
E	Millerbird, Nihoa (old world warbler) Wherever found (Acrocephalus familiaris kingi)	Hawaii
E	Moth, Blackburn's sphinx Wherever found (Manduca blackburni)	Hawaii
E	nukupuu, Kauai Wherever found (Hemignathus hanapepe)	Hawaii
E	nukupuu, Maui Wherever found (Hemignathus affinis)	Hawaii
E	‘O‘o, Kauai (honeyeater) Wherever found (Moho braccatus)	Hawaii
E	‘O‘u (honeycreeper) Wherever found (Psittirostra psittacea)	Hawaii
E	Palila (honeycreeper) Wherever found (Loxioides bailleui)	Hawaii
E	parrotbill, Maui (Kiwikiu) Wherever found (Pseudonestor xanthophrys)	Hawaii

Listed status	Species	Jurisdiction
E	petrel, Hawaiian Wherever found (<i>Pterodroma sandwichensis</i>)	Hawaii
E	picture-wing fly, Hawaiian Wherever found (<i>Drosophila montgomeryi</i>)	Hawaii
E	picture-wing fly, Hawaiian Wherever found (<i>Drosophila neoclavisetae</i>)	Hawaii
E	Po'ouli (honeycreeper) Wherever found (<i>Melamprosops phaeosoma</i>)	Hawaii
T	Sea turtle, green Central North Pacific DPS (<i>Chelonia mydas</i>)	Hawaii, Guam, CNMI, American Samoa
T	Sea turtle, olive ridley Wherever found, except when listed as endangered under 50 CFR 224.101 (<i>Lepidochelys olivacea</i>)	Hawaii
T	Shearwater, Newell's Townsend's Wherever found (<i>Puffinus auricularis newelli</i>)	Hawaii
E	Shrimp, anchialine pool Wherever found (<i>Procaris hawaiiiana</i>)	Hawaii
E	Shrimp, anchialine pool Wherever found (<i>Vetericaris chaceorum</i>)	Hawaii
E	Snail, Lanai tree Wherever found (<i>Partulina semicarinata</i>)	Hawaii
E	Snail, Lanai tree Wherever found (<i>Partulina variabilis</i>)	Hawaii
T	Snail, Newcomb's Wherever found (<i>Erinna newcombi</i>)	Hawaii
E	Snails, Oahu tree Wherever found (<i>Achatinella</i> spp.)	Hawaii
E	Spider, Kauai cave wolf or pe'e pe'e maka 'ole Wherever found (<i>Adelocosa anops</i>)	Hawaii
E	Stilt, Hawaiian Wherever found (<i>Himantopus mexicanus knudseni</i>)	Hawaii
E	Storm-petrel, band-rumped USA (HI) (<i>Oceanodroma castro</i>)	Hawaii
E	Thrush, large Kauai (=kamao) Wherever found (<i>Myadestes myadestinus</i>)	Hawaii
E	Thrush, Molokai Wherever found (<i>Myadestes lanaiensis rutha</i>)	Hawaii
E	Thrush, small Kauai (=puaiohi) Wherever found (<i>Myadestes palmeri</i>)	Hawaii
E	Tree snail, Newcomb's Wherever found (<i>Newcombia cumingi</i>)	Hawaii
E	Yellow-faced bee, anthricinan Wherever found (<i>Hylaeus anthracinus</i>)	Hawaii
E	Yellow-faced bee, assimilans Wherever found (<i>Hylaeus assimilans</i>)	Hawaii
E	Yellow-faced bee, easy Wherever found (<i>Hylaeus facilis</i>)	Hawaii
E	yellow-faced bee, Hawaiian Wherever found (<i>Hylaeus kuakea</i>)	Hawaii
E	yellow-faced bee, Hawaiian Wherever found (<i>Hylaeus longiceps</i>)	Hawaii
E	yellow-faced bee, Hawaiian Wherever found (<i>Hylaeus mana</i>)	Hawaii
E	Yellow-faced bee, hilaris Wherever found (<i>Hylaeus hilaris</i>)	Hawaii
E	Bat, little Mariana fruit Wherever found (<i>Pteropus tokudae</i>)	Guam
T	Bat, Mariana fruit (=Mariana flying fox) Wherever found (<i>Pteropus mariannus mariannus</i>)	Guam, CNMI
E	Butterfly, Mariana eight-spot Wherever found (<i>Hypolimnas octocula marianensis</i>)	Guam
E	Butterfly, Mariana wandering Wherever found (<i>Vagrans egistina</i>)	Guam, CNMI
E	Crow, Mariana (=aga) Wherever found (<i>Corvus kubaryi</i>)	Guam, CNMI
E	Kingfisher, Guam Micronesia Wherever found (<i>Halcyon cinnamomina cinnamomina</i>)	Guam
E	Megapode, Micronesia Wherever found (<i>Megapodius laperouse</i>)	Guam, CNMI
E	Moorhen, Mariana common Wherever found (<i>Gallinula chloropus guami</i>)	Guam, CNMI
E	Rail, Guam Wherever found, except where listed as an experimental population (<i>Rallus owstoni</i>)	Guam

Listed status	Species	Jurisdiction
E	skink, Slevin's Wherever found (Emoia slevini)	Guam, CNMI
E	Snail, fragile tree Wherever found (Samoana fragilis)	Guam, CNMI
E	Snail, Guam tree Wherever found (Partula radiolata)	Guam
E	Snail, Humped tree Wherever found (Partula gibba)	Guam
E	Swiftlet, Mariana gray Wherever found (Aerodramus vanikorensis bartschi)	Guam, CNMI
E	Warbler, nightingale reed (old world warbler) Wherever found (Acrocephalus luscinia)	Guam, CNMI
E	White-eye, bridled Wherever found (Zosterops conspicillatus conspicillatus)	Guam
E	Bat, Pacific sheath-tailed Wherever found (Emballonura semicaudata rotensis)	CNMI
E	damselfly, Rota blue Wherever found (Ischnura luta)	CNMI
E	damselfly, Rota blue Wherever found (Ischnura luta)	CNMI
E	Snail, Langford's tree Wherever found (Partula langfordi)	CNMI
E	White-eye, Rota bridled Wherever found (Zosterops rotensis)	CNMI
E	Bat, Pacific sheath-tailed American Samoa (Emballonura semicaudata semicaudata)	American Samoa
E	Ground-Dove, Friendly American Samoa DPS (Gallicolumba stairi)	American Samoa
E	[no common name] Snail Wherever found (Eua zebrina)	American Samoa
E	[no common name] Snail Wherever found (Ostodes strigatus)	American Samoa
Plants		
E	Chaffseed, American (Schwalbea americana)	Florida
T	Butterwort, Godfrey's (Pinguicula ionantha)	Florida
T	Crabgrass, Florida pineland (Digitaria pauciflora)	Florida
E	fern, Florida bristle (Trichomanes punctatum ssp. floridanum)	Florida
E	Flax, Carter's small-flowered (Linum carteri carteri)	Florida
E	Flax, sand (Linum arenicola)	Florida
E	Lead-plant, Crenulate (Amorpha crenulata)	Florida
E	Milkpea, Small's (Galactia smallii)	Florida
E	Pea, Big Pine partridge (Chamaecrista lineata keyensis)	Florida
E	Prairie-clover, Florida (Dalea carthagenensis floridana)	Florida
T	Sandmat, pineland (Chamaesyce deltoidea pinetorum)	Florida
T	silverbush, Blodgett's (Argythamnia blodgettii)	Florida
E	Spurge, deltoid (Chamaesyce deltoidea ssp. deltoidea)	Florida
E	Spurge, wedge (Chamaesyce deltoidea serpyllum)	Florida
E	Thoroughwort, Cape Sable (Chromolaena frustrata)	Florida
T	Bonamia, Florida (Bonamia grandiflora)	Florida
T	Buckwheat, scrub (Eriogonum longifolium var. gnaphalifolium)	Florida
E	Cactus, Florida semaphore (Consolea corallicola)	Florida
T	Spurge, Garber's (Chamaesyce garberi)	Florida
E	Prickly-apple, fragrant (Cereus eriophorus var. fragrans)	Florida

Listed status	Species	Jurisdiction
E	Campion, fringed (Silene polypetala)	Florida
E	Jacquemontia, beach (Jacquemontia reclinata)	Florida
E	Polygala, tiny (Polygala smallii)	Florida
E	Pawpaw, four-petal (Asimina tetramera)	Florida
E	Gourd, Okeechobee (Cucurbita okeechobeensis ssp. okeechobeensis)	Florida
E	Bariaco (Trichilia triacantha)	Puerto Rico
E	Boxwood, Vahl's (Buxus vahlii)	Puerto Rico, Virgin Islands
E	Capa rosa (Callicarpa ampla)	Puerto Rico
T	Chumbo, Higo (Harrisia portoricensis)	Puerto Rico
E	Chupacallos (Pleodendron macranthum)	Puerto Rico
T	Cobana negra (Stahlia monosperma)	Puerto Rico
E	Erubia (Solanum drymophilum)	Puerto Rico
E	Fern, Elfin tree (Cyathea dryopteroides)	Puerto Rico
E	Goetzea, beautiful (Goetzea elegans)	Puerto Rico
E	Higuero de sierra (Crescentia portoricensis)	Puerto Rico
E	Holly, Cook's (Ilex cookii)	Puerto Rico
T	Manaca, palma de (Calyptrionoma rivalis)	Puerto Rico
E	No common name (Adiantum vivesii)	Puerto Rico
E	No common name (Aristida chaseae)	Puerto Rico
E	No common name (Auerodendron pauciflorum)	Puerto Rico
E	No common name (Catesbaea melanocarpa)	Puerto Rico, Virgin Islands
E	No common name (Chamaecrista glandulosa var. mirabilis)	Puerto Rico
E	No common name (Cordia bellonis)	Puerto Rico
E	No common name (Cranichis ricartii)	Puerto Rico
E	No common name (Daphnopsis hellerana)	Puerto Rico
E	No common name (Elaphoglossum serpens)	Puerto Rico
E	No common name (Eugenia woodburyana)	Puerto Rico
T	No common name (Gesneria pauciflora)	Puerto Rico
E	No common name (Gonocalyx concolor)	Puerto Rico
E	No common name (Ilex sintenisii)	Puerto Rico
E	No common name (Lepanthes eltoroensis)	Puerto Rico
E	No common name (Leptocereus grantianus)	Puerto Rico
E	No common name (Lyonia truncata var. proctorii)	Puerto Rico
E	No common name (Mitracarpus maxwelliae)	Puerto Rico

Listed status	Species	Jurisdiction
E	No common name (Mitracarpus polycladus)	Puerto Rico
E	No common name (Myrcia paganii)	Puerto Rico
E	No common name (Polystichum calderonense)	Puerto Rico
T	No common name (Schoepfia arenaria)	Puerto Rico
E	No common name (Tectaria estremerana)	Puerto Rico
E	No common name (Ternstroemia subsessilis)	Puerto Rico
E	No common name (Thelypteris inabonensis)	Puerto Rico
E	No common name (Thelypteris verecunda)	Puerto Rico
E	No common name (Thelypteris yaucoensis)	Puerto Rico
T	No common name (Varronia rupicola)	Puerto Rico
E	No common name (Vernonia proctorii)	Puerto Rico
E	Palo colorado (Ternstroemia luquillensis)	Puerto Rico
E	Palo de jazmin (Styrax portoricensis)	Puerto Rico
E	Palo de nigua (Cornutia obovata)	Puerto Rico
E	Palo de ramon (Banara vanderbiltii)	Puerto Rico
E	Palo de rosa (Ottoschulzia rhodoxylon)	Puerto Rico
E	Pelos del diablo (Aristida portoricensis)	Puerto Rico
E	Peperomia, Wheeler's (Peperomia wheeleri)	Puerto Rico
E	Prickly-ash, St. Thomas (Zanthoxylum thomasianum)	Puerto Rico, Virgin Islands
E	Uvillo (Eugenia haematocarpa)	Puerto Rico
E	Walnut (=Nogal), West Indian (Juglans jamaicensis)	Puerto Rico
E	No common name (Agave eggersiana)	Virgin Islands
E	No common name (Calyptanthus thomasiana)	Virgin Islands
E	A`e (Zanthoxylum dipetalum var. tomentosum)	Hawaii
E	A`e (Zanthoxylum hawaiiense)	Hawaii
E	A`e (Zanthoxylum oahuense)	Hawaii
T	`Ahinahina (Argyroxiphium sandwicense ssp. macrocephalum)	Hawaii
E	`Ahinahina (Argyroxiphium sandwicense ssp. sandwicense)	Hawaii
E	`Aiakeakua, popolo (Solanum sandwicense)	Hawaii
E	`Aiea (Nothocestrum breviflorum)	Hawaii
E	`Aiea (Nothocestrum latifolium)	Hawaii
E	`Aiea (Nothocestrum peltatum)	Hawaii
E	`Akoko (Euphorbia celastroides var. kaenana)	Hawaii
E	`Akoko (Euphorbia deppeana)	Hawaii
E	`Akoko (Euphorbia eleanoriae)	Hawaii

Listed status	Species	Jurisdiction
E	`Akoko (Euphorbia haeleeleana)	Hawaii
E	`Akoko (Euphorbia herbstii)	Hawaii
E	`Akoko (Euphorbia kuwaleana)	Hawaii
E	`Akoko (Euphorbia remyi var. kauaiensis)	Hawaii
E	`Akoko (Euphorbia remyi var. remyi)	Hawaii
E	`Akoko (Euphorbia rockii)	Hawaii
E	"Akoko (Euphorbia halemanui)	Hawaii
E	`Akoko, Ewa Plains (Euphorbia skottsbergii var. skottsbergii)	Hawaii
E	`aku (Cyanea tritomantha)	Hawaii
E	`aku`aku (Cyanea platyphylla)	Hawaii
E	`Ala `ala wai nui (Peperomia subpetiolata)	Hawaii
E	Alani (Melicope adscendens)	Hawaii
E	Alani (Melicope balloui)	Hawaii
E	Alani (Melicope christophersenii)	Hawaii
E	Alani (Melicope degeneri)	Hawaii
E	Alani (Melicope haupuensis)	Hawaii
E	Alani (Melicope hiiakae)	Hawaii
E	Alani (Melicope knudsenii)	Hawaii
E	Alani (Melicope lydgatei)	Hawaii
E	Alani (Melicope makahae)	Hawaii
E	Alani (Melicope mucronulata)	Hawaii
E	Alani (Melicope munroi)	Hawaii
E	Alani (Melicope ovalis)	Hawaii
E	Alani (Melicope pallida)	Hawaii
E	Alani (Melicope paniculata)	Hawaii
E	Alani (Melicope puberula)	Hawaii
E	Alani (Melicope quadrangularis)	Hawaii
E	Alani (Melicope reflexa)	Hawaii
E	Alani (Melicope saint-johnii)	Hawaii
E	Alani (Melicope zahlbruckneri)	Hawaii
E	`Anaunau (Lepidium arbuscula)	Hawaii
E	`Anunu (Sicyos albus)	Hawaii
E	`Anunu (Sicyos macrophyllus)	Hawaii
E	aumakua, Palapalai (Dryopteris crinalis var. podosorus)	Hawaii
E	Aupaka (Isodendrion hosakae)	Hawaii
E	Aupaka (Isodendrion laurifolium)	Hawaii
T	Aupaka (Isodendrion longifolium)	Hawaii

Listed status	Species	Jurisdiction
E	`Awikiwiki (Canavalia molokaiensis)	Hawaii
E	`Awikiwiki (Canavalia napaliensis)	Hawaii
E	`Awikiwiki (Canavalia pubescens)	Hawaii
E	Awiwi (Schenkia sebaeoides)	Hawaii
E	'Awiwi (Kadua cookiana)	Hawaii
E	bean, sea (Mucuna sloanei var. persericea)	Hawaii
E	Bluegrass, Hawaiian (Poa sandvicensis)	Hawaii
E	Bluegrass, Mann's (Poa mannii)	Hawaii
E	Chaff-flower, round-leaved (Achyranthes splendens var. rotundata)	Hawaii
E	diellia, Asplenium-leaved (Asplenium dielirectum)	Hawaii
E	`Ena`ena (Pseudognaphalium sandwicensium var. molokaiense)	Hawaii
E	Fern, pendant kii (Adenophorus periens)	Hawaii
E	Gardenia (=Na`u), Hawaiian (Gardenia brighamii)	Hawaii
E	Geranium, Hawaiian red-flowered (Geranium arboreum)	Hawaii
E	Haha (Cyanea acuminata)	Hawaii
E	Haha (Cyanea asarifolia)	Hawaii
E	Haha (Cyanea asplenifolia)	Hawaii
E	Haha (Cyanea calycina)	Hawaii
E	Haha (Cyanea copelandii ssp. copelandii)	Hawaii
E	Haha (Cyanea copelandii ssp. haleakalaensis)	Hawaii
E	haha (Cyanea crispa)	Hawaii
E	Haha (Cyanea dolichopoda)	Hawaii
E	haha (Cyanea dunbariae)	Hawaii
E	haha (Cyanea duvalliorum)	Hawaii
E	Haha (Cyanea eleeleensis)	Hawaii
E	haha (Cyanea gibsonii)	Hawaii
E	Haha (Cyanea glabra)	Hawaii
E	Haha (Cyanea grimesiana ssp. grimesiana)	Hawaii
E	Haha (Cyanea grimesiana ssp. obatae)	Hawaii
E	Haha (Cyanea hamatiflora ssp. carlsonii)	Hawaii
E	Haha (Cyanea hamatiflora ssp. hamatiflora)	Hawaii
E	Haha (Cyanea humboldtiana)	Hawaii
E	Haha (Cyanea kolekoleensis)	Hawaii
E	Haha (Cyanea koolauensis)	Hawaii
E	Haha (Cyanea kuhihewa)	Hawaii
E	Haha (Cyanea kunthiana)	Hawaii
E	Haha (Cyanea lanceolata)	Hawaii
E	Haha (Cyanea lobata)	Hawaii

Listed status	Species	Jurisdiction
E	Haha (Cyanea longiflora)	Hawaii
E	haha (Cyanea magnicalyx)	Hawaii
E	Haha (Cyanea mannii)	Hawaii
E	haha (Cyanea maritae)	Hawaii
E	Haha (Cyanea marksii)	Hawaii
E	haha (Cyanea mauiensis)	Hawaii
E	Haha (Cyanea mceldowneyi)	Hawaii
E	haha (Cyanea munroi)	Hawaii
E	Haha (Cyanea obtusa)	Hawaii
E	Haha (Cyanea pinnatifida)	Hawaii
E	Haha (Cyanea procera)	Hawaii
E	Haha (Cyanea profuga)	Hawaii
E	Haha (Cyanea purpurellifolia)	Hawaii
T	Haha (Cyanea recta)	Hawaii
E	Haha (Cyanea remyi)	Hawaii
E	Haha (Cyanea rivularis)	Hawaii
E	Haha (Cyanea shipmanii)	Hawaii
E	Haha (Cyanea stictophylla)	Hawaii
E	Haha (Cyanea st.-johnii)	Hawaii
E	Haha (Cyanea superba)	Hawaii
E	Haha (Cyanea truncata)	Hawaii
E	Haha (Cyanea undulata)	Hawaii
E	haiwale (Cyrtandra ferripilosa)	Hawaii
E	Haiwale (Cyrtandra gracilis)	Hawaii
E	Haiwale (Cyrtandra paliku)	Hawaii
E	Haiwale (Cyrtandra waiolani)	Hawaii
E	Ha`iwale (Cyrtandra crenata)	Hawaii
E	Ha`iwale (Cyrtandra dentata)	Hawaii
E	Ha`iwale (Cyrtandra filipes)	Hawaii
E	Ha`iwale (Cyrtandra giffardii)	Hawaii
E	Ha`iwale (Cyrtandra hematos)	Hawaii
E	Ha`iwale (Cyrtandra kaulantha)	Hawaii
T	Ha`iwale (Cyrtandra limahuliensis)	Hawaii
E	Ha`iwale (Cyrtandra munroi)	Hawaii
E	Ha`iwale (Cyrtandra oenobarba)	Hawaii
E	Ha`iwale (Cyrtandra oxybapha)	Hawaii
E	Ha`iwale (Cyrtandra polyantha)	Hawaii

Listed status	Species	Jurisdiction
E	Ha`iwale (Cyrtandra sessilis)	Hawaii
E	Ha`iwale (Cyrtandra subumbellata)	Hawaii
E	Ha`iwale (Cyrtandra tintinnabula)	Hawaii
E	Ha`iwale (Cyrtandra viridiflora)	Hawaii
E	Hala pepe (Pleomele fernaldii)	Hawaii
E	Hala pepe (Pleomele forbesii)	Hawaii
E	Hala pepe (Pleomele hawaiiensis)	Hawaii
E	Hau kuahiwi (Hibiscadelphus giffardianus)	Hawaii
E	Hau kuahiwi (Hibiscadelphus hualalaiensis)	Hawaii
E	Hau kuahiwi (Hibiscadelphus woodii)	Hawaii
E	Heau (Exocarpos luteolus)	Hawaii
E	Heau (Exocarpos menziesii)	Hawaii
E	Hibiscus, Clay's (Hibiscus clayi)	Hawaii
E	Hoawa (Pittosporum halophilum)	Hawaii
E	Hoawa (Pittosporum hawaiiense)	Hawaii
E	Ho`awa (Pittosporum napaliense)	Hawaii
E	Hohiu (Dryopteris glabra var. pusilla)	Hawaii
E	Holei (Ochrosia haleakalae)	Hawaii
E	Holei (Ochrosia kilaueaensis)	Hawaii
E	Honohono (Haplostachys haplostachya)	Hawaii
E	Hulumoa (Korthalsella degeneri)	Hawaii
E	Ihi (Portulaca villosa)	Hawaii
E	Ihi`ihi (Marsilea villosa)	Hawaii
E	Iliau, dwarf (Wilkesia hobdyi)	Hawaii
E	Ischaemum, Hilo (Ischaemum byrone)	Hawaii
E	Kamakahala (Labordia cyrtandrae)	Hawaii
E	Kamakahala (Labordia helleri)	Hawaii
E	Kamakahala (Labordia lydgatei)	Hawaii
E	Kamakahala (Labordia pumila)	Hawaii
E	Kamakahala (Labordia tinifolia var. lanaiensis)	Hawaii
E	Kamakahala (Labordia tinifolia var. wahiawaensis)	Hawaii
E	Kamakahala (Labordia triflora)	Hawaii
E	Kamanomano (Cenchrus agrimonioides)	Hawaii
E	Kamapua`a (Kadua fluviatilis)	Hawaii
E	Kauai hau kuahiwi (Hibiscadelphus distans)	Hawaii
E	Kauila (Colubrina oppositifolia)	Hawaii
E	Kaulu (Pteralyxia kauaiensis)	Hawaii

Listed status	Species	Jurisdiction
E	Kaulu (<i>Pteralyxia macrocarpa</i>)	Hawaii
E	Kio`ele (<i>Kadua coriacea</i>)	Hawaii
E	Kiponapona (<i>Phyllostegia racemosa</i>)	Hawaii
E	Kohe malama malama o kanaloa (<i>Kanaloa kahoolawensis</i>)	Hawaii
E	Koholapehu (<i>Dubautia latifolia</i>)	Hawaii
E	Koki`o (<i>Kokia drynarioides</i>)	Hawaii
E	Koki`o (<i>Kokia kauaiensis</i>)	Hawaii
E	Koki`o, Cooke's (<i>Kokia cookei</i>)	Hawaii
E	Koki`o ke`oke`o (<i>Hibiscus arnottianus</i> ssp. <i>immaculatus</i>)	Hawaii
E	Koki`o ke`oke`o (<i>Hibiscus waimeae</i> ssp. <i>hanneriae</i>)	Hawaii
E	Kolea (<i>Myrsine fosbergii</i>)	Hawaii
E	Kolea (<i>Myrsine juddii</i>)	Hawaii
E	Kolea (<i>Myrsine knudsenii</i>)	Hawaii
T	Kolea (<i>Myrsine linearifolia</i>)	Hawaii
E	Kolea (<i>Myrsine mezii</i>)	Hawaii
E	Kolea (<i>Myrsine vaccinioides</i>)	Hawaii
E	Ko`oko`olau (<i>Bidens amplexens</i>)	Hawaii
E	Ko`oko`olau (<i>Bidens campylothea</i> ssp. <i>pentamera</i>)	Hawaii
E	Ko`oko`olau (<i>Bidens campylothea</i> ssp. <i>waihoiensis</i>)	Hawaii
E	Ko`oko`olau (<i>Bidens conjuncta</i>)	Hawaii
E	Ko`oko`olau (<i>Bidens micrantha</i> ssp. <i>ctenophylla</i>)	Hawaii
E	Ko`oko`olau (<i>Bidens micrantha</i> ssp. <i>kalealaha</i>)	Hawaii
E	Ko`oko`olau (<i>Bidens wiebkei</i>)	Hawaii
E	Ko`oloa`ula (<i>Abutilon menziesii</i>)	Hawaii
E	kopa (<i>Kadua cordata</i> <i>remyi</i>)	Hawaii
E	Kopiko (<i>Psychotria grandiflora</i>)	Hawaii
E	Kopiko (<i>Psychotria hexandra</i> ssp. <i>oahuensis</i>)	Hawaii
E	Kopiko (<i>Psychotria hobdyi</i>)	Hawaii
E	Kuahiwi laukahi (<i>Plantago hawaiiensis</i>)	Hawaii
E	Kuahiwi laukahi (<i>Plantago princeps</i>)	Hawaii
E	Kuawawaenohu (<i>Schiedea lychnoides</i>)	Hawaii
E	Kula wahine noho (<i>Isodendrion pyriformium</i>)	Hawaii
E	Kulu`i (<i>Nototrichium humile</i>)	Hawaii
E	Kupukupu makalii (<i>Cyclosorus boydiae</i>)	Hawaii
E	Lau `ehu (<i>Panicum niihauense</i>)	Hawaii
E	Laulihilihi (<i>Schiedea stellarioides</i>)	Hawaii
E	lehua makanoe (<i>Lysimachia daphnoides</i>)	Hawaii

Listed status	Species	Jurisdiction
E	Liliwai (<i>Acaena exigua</i>)	Hawaii
E	Lo`ulu (<i>Pritchardia hardyi</i>)	Hawaii
E	Lo`ulu (<i>Pritchardia kaalae</i>)	Hawaii
E	Lo`ulu (<i>Pritchardia lanigera</i>)	Hawaii
E	Lo`ulu (<i>Pritchardia maideniana</i>)	Hawaii
E	Lo`ulu (<i>Pritchardia munroi</i>)	Hawaii
E	Lo`ulu (<i>Pritchardia napaliensis</i>)	Hawaii
E	Lo`ulu (<i>Pritchardia remota</i>)	Hawaii
E	Lo`ulu (<i>Pritchardia schattaueri</i>)	Hawaii
E	Lo`ulu (<i>Pritchardia viscosa</i>)	Hawaii
E	Loulou, Baker's (<i>Pritchardia bakeri</i>)	Hawaii
E	Love grass, Fosberg's (<i>Eragrostis fosbergii</i>)	Hawaii
E	Mahoe (<i>Alectryon macrococcus</i>)	Hawaii
T	Makou (<i>Peucedanum sandwicense</i>)	Hawaii
E	Makou (<i>Ranunculus hawaiiensis</i>)	Hawaii
E	Makou (<i>Ranunculus mauiensis</i>)	Hawaii
E	Ma`o hau hele, (=native yellow hibiscus) (<i>Hibiscus brackenridgei</i>)	Hawaii
E	Ma`oli`oli (<i>Schiedea apokremnos</i>)	Hawaii
E	Ma`oli`oli (<i>Schiedea hawaiiensis</i>)	Hawaii
E	Ma`oli`oli (<i>Schiedea kealiae</i>)	Hawaii
E	Ma`oli`oli (<i>Schiedea pubescens</i>)	Hawaii
E	Mapele (<i>Cyrtandra cyaneoides</i>)	Hawaii
E	Mehamehame (<i>Flueggea neowawraea</i>)	Hawaii
E	Naenae (<i>Dubautia kalalauensis</i>)	Hawaii
E	Naenae (<i>Dubautia kenwoodii</i>)	Hawaii
E	Na`ena`e (<i>Dubautia herbstobatae</i>)	Hawaii
E	Na`ena`e (<i>Dubautia imbricata</i> ssp. <i>imbricata</i>)	Hawaii
E	Na`ena`e (<i>Dubautia pauciflorula</i>)	Hawaii
E	Na`ena`e (<i>Dubautia plantaginea</i> ssp. <i>humilis</i>)	Hawaii
E	Na`ena`e (<i>Dubautia plantaginea</i> ssp. <i>magnifolia</i>)	Hawaii
E	Na`ena`e (<i>Dubautia waialealae</i>)	Hawaii
E	Nani wai`ale`ale (<i>Viola kauaiensis</i> var. <i>wahiawaensis</i>)	Hawaii
E	Nanu (<i>Gardenia mannii</i>)	Hawaii
E	Nanu (<i>Gardenia remyi</i>)	Hawaii
E	Naupaka, dwarf (<i>Scaevola coriacea</i>)	Hawaii
E	Nehe (<i>Lipochaeta fauriei</i>)	Hawaii
E	Nehe (<i>Lipochaeta lobata</i> var. <i>leptophylla</i>)	Hawaii

Listed status	Species	Jurisdiction
E	Nehe (Lipochaeta micrantha)	Hawaii
E	Nehe (Lipochaeta waimeaensis)	Hawaii
E	nehe (Melanthera kamolensis)	Hawaii
E	Nehe (Melanthera tenuifolia)	Hawaii
E	Nioi (Eugenia koolauensis)	Hawaii
E	No common name (Abutilon eremitopetalum)	Hawaii
E	No common name (Abutilon sandwicense)	Hawaii
E	No common name (Achyranthes mutica)	Hawaii
E	No common name (Amaranthus brownii)	Hawaii
E	No common name (Asplenium dielfalcatum)	Hawaii
E	No common name (Asplenium diellaciniatum)	Hawaii
E	No common name (Asplenium dielmannii)	Hawaii
E	No common name (Asplenium dielpallidum)	Hawaii
E	No common name (Asplenium peruvianum var. insulare)	Hawaii
E	No common name (Asplenium unisorum)	Hawaii
E	No common name (Bidens hillebrandiana ssp. hillebrandiana)	Hawaii
E	No common name (Bonamia menziesii)	Hawaii
E	No common name (Cyanea kauaulaensis)	Hawaii
E	No common name (Cyperus fauriei)	Hawaii
E	No common name (Cyperus neokunthianus)	Hawaii
E	No common name (Cyperus pennatiformis)	Hawaii
E	No common name (Cyrtandra nanawaleensis)	Hawaii
E	No common name (Cyrtandra wagneri)	Hawaii
E	No common name (Delissea rhytidosperra)	Hawaii
E	No common name (Delissea undulata)	Hawaii
E	No common name (Deparia kaalaana)	Hawaii
E	No common name (Diplazium molokaiense)	Hawaii
E	No common name (Doryopteris angelica)	Hawaii
E	No common name (Doryopteris takeuchii)	Hawaii
E	No common name (Festuca hawaiiensis)	Hawaii
E	No common name (Festuca molokaiensis)	Hawaii
E	No common name (Gouania hillebrandii)	Hawaii
E	No common name (Gouania meyenii)	Hawaii
E	No common name (Gouania vitifolia)	Hawaii
E	No common name (Hesperomannia arborescens)	Hawaii
E	No common name (Hesperomannia arbuscula)	Hawaii

Listed status	Species	Jurisdiction
E	No common name (Hesperomannia lydgatei)	Hawaii
E	No common name (Huperzia stemmermanniae)	Hawaii
E	No common name (Kadua degeneri)	Hawaii
E	No common name (Kadua haupuensis)	Hawaii
E	No common name (Kadua parvula)	Hawaii
E	No common name (Kadua st.-johnii)	Hawaii
E	No common name (Keysseria (=Lagenifera) erici)	Hawaii
E	No common name (Keysseria (=Lagenifera) helenae)	Hawaii
E	No common name (Labordia lorenciana)	Hawaii
E	No common name (Lepidium orbiculare)	Hawaii
E	No common name (Lipochaeta venosa)	Hawaii
E	No common name (Lobelia koolauensis)	Hawaii
E	No common name (Lobelia monostachya)	Hawaii
E	No common name (Lobelia niihauensis)	Hawaii
E	No common name (Lobelia oahuensis)	Hawaii
E	No common name (Lysimachia filifolia)	Hawaii
E	No common name (Lysimachia iniki)	Hawaii
E	No common name (Lysimachia lydgatei)	Hawaii
E	No common name (Lysimachia maxima)	Hawaii
E	No common name (Lysimachia pendens)	Hawaii
E	No common name (Lysimachia scopulensis)	Hawaii
E	No common name (Lysimachia venosa)	Hawaii
E	No common name (Microlepidia strigosa var. mauiensis)	Hawaii
E	No common name (Neraudia angulata)	Hawaii
E	No common name (Neraudia ovata)	Hawaii
E	No common name (Neraudia sericea)	Hawaii
E	No common name (Phyllostegia bracteata)	Hawaii
E	No common name (Phyllostegia brevidens)	Hawaii
E	No common name (Phyllostegia floribunda)	Hawaii
E	No common name (Phyllostegia glabra var. lanaiensis)	Hawaii
E	No common name (Phyllostegia haliakalae)	Hawaii
E	No common name (Phyllostegia helleri)	Hawaii
E	No common name (Phyllostegia hirsuta)	Hawaii
E	No common name (Phyllostegia hispida)	Hawaii
E	No common name (Phyllostegia kaalaensis)	Hawaii
E	No common name (Phyllostegia knudsenii)	Hawaii
E	No common name (Phyllostegia mannii)	Hawaii

Listed status	Species	Jurisdiction
E	No common name (Phyllostegia mollis)	Hawaii
E	No common name (Phyllostegia parviflora)	Hawaii
E	No common name (Phyllostegia pilosa)	Hawaii
E	No common name (Phyllostegia renovans)	Hawaii
E	No common name (Phyllostegia stachyoides)	Hawaii
E	No common name (Phyllostegia velutina)	Hawaii
E	No common name (Phyllostegia waimeae)	Hawaii
E	No common name (Phyllostegia warshaueri)	Hawaii
E	No common name (Phyllostegia wawrana)	Hawaii
E	No common name (Platanthera holochila)	Hawaii
E	No common name (Platydesma cornuta var. cornuta)	Hawaii
E	No common name (Platydesma cornuta var. decurrens)	Hawaii
E	No common name (Platydesma remyi)	Hawaii
E	No common name (Poa siphonoglossa)	Hawaii
E	No common name (Polyscias bisattenuata)	Hawaii
E	No common name (Polyscias flynnii)	Hawaii
E	No common name (Polyscias lydgatei)	Hawaii
E	No common name (Polyscias racemosa)	Hawaii
E	No common name (Pteris lidgatei)	Hawaii
E	No common name (Remya kauaiensis)	Hawaii
E	No common name (Remya montgomeryi)	Hawaii
E	No common name (Sanicula mariversa)	Hawaii
E	No common name (Sanicula purpurea)	Hawaii
E	No common name (Sanicula sandwicensis)	Hawaii
E	No common name (Santalum involutum)	Hawaii
E	No common name (Schiedea attenuata)	Hawaii
E	No common name (Schiedea diffusa ssp. macraei)	Hawaii
E	No common name (Schiedea diffusa subsp. diffusa)	Hawaii
E	No common name (Schiedea haleakalensis)	Hawaii
E	No common name (Schiedea helleri)	Hawaii
E	No common name (Schiedea hookeri)	Hawaii
E	No common name (Schiedea jacobii)	Hawaii
E	No common name (Schiedea kaalae)	Hawaii
E	No common name (Schiedea kauaiensis)	Hawaii
E	No common name (Schiedea laui)	Hawaii
E	No common name (Schiedea lydgatei)	Hawaii
E	No common name (Schiedea membranacea)	Hawaii
E	No common name (Schiedea nuttallii)	Hawaii
E	No common name (Schiedea obovata)	Hawaii

Listed status	Species	Jurisdiction
E	No common name (Schiedea salicaria)	Hawaii
E	No common name (Schiedea sarmentosa)	Hawaii
E	No common name (Schiedea spergulina var. leiopoda)	Hawaii
T	No common name (Schiedea spergulina var. spergulina)	Hawaii
E	No common name (Schiedea trinervis)	Hawaii
E	No common name (Schiedea viscosa)	Hawaii
E	No common name (Sicyos lanceoloideus)	Hawaii
E	No common name (Silene alexandri)	Hawaii
T	No common name (Silene hawaiiensis)	Hawaii
E	No common name (Silene lanceolata)	Hawaii
E	No common name (Silene perlmanii)	Hawaii
E	No common name (Spermolepis hawaiiensis)	Hawaii
E	No common name (Stenogyne angustifolia var. angustifolia)	Hawaii
E	No common name (Stenogyne bifida)	Hawaii
E	No common name (Stenogyne campanulata)	Hawaii
E	No common name (Stenogyne cranwelliae)	Hawaii
E	No common name (Stenogyne kaalae ssp. sherffii)	Hawaii
E	No common name (Stenogyne kanehoana)	Hawaii
E	No common name (Stenogyne kauaulaensis)	Hawaii
E	No common name (Stenogyne kealiae)	Hawaii
E	No common name (Tetramolopium arenarium)	Hawaii
E	No common name (Tetramolopium filiforme)	Hawaii
E	No common name (Tetramolopium lepidotum ssp. lepidotum)	Hawaii
E	No common name (Tetramolopium remyi)	Hawaii
T	No common name (Tetramolopium rockii)	Hawaii
E	No common name (Trematolobelia singularis)	Hawaii
E	No common name (Vigna o-wahuensis)	Hawaii
E	No common name (Viola helenae)	Hawaii
E	No common name (Viola lanaiensis)	Hawaii
E	No common name (Viola oahuensis)	Hawaii
E	No common name (Wikstroemia skottsbergiana)	Hawaii
E	No common name (Wikstroemia villosa)	Hawaii
E	No common name (Xylosma crenatum)	Hawaii
E	Nohoanu (Geranium hanaense)	Hawaii
E	Nohoanu (Geranium hillebrandii)	Hawaii
E	Nohoanu (Geranium kauaiense)	Hawaii
E	Nohoanu (Geranium multiflorum)	Hawaii
E	nui, haha (Cyanea horrida)	Hawaii
E	Oha (Delissea subcordata)	Hawaii

Listed status	Species	Jurisdiction
E	Ohai (Sesbania tomentosa)	Hawaii
E	`Oha wai (Clermontia drepanomorpha)	Hawaii
E	`Oha wai (Clermontia lindseyana)	Hawaii
E	`Oha wai (Clermontia oblongifolia ssp. brevipes)	Hawaii
E	`Oha wai (Clermontia oblongifolia ssp. mauiensis)	Hawaii
E	`Oha wai (Clermontia peleana)	Hawaii
E	`Oha wai (Clermontia pyularia)	Hawaii
E	`Oha wai (Clermontia samuelii)	Hawaii
E	`Ohe (Joinvillea ascendens ascendens)	Hawaii
E	`Ohe`ohe (Polyscias gymnocarpa)	Hawaii
E	olua (Hypolepis hawaiiensis var. mauiensis)	Hawaii
E	Olulu (Brighamia insignis)	Hawaii
E	Opuhe (Urera kaalae)	Hawaii
E	Pa`iniu (Astelia waialealae)	Hawaii
E	Pamakani (Tetramolopium capillare)	Hawaii
E	Pamakani (Viola chamissoniana ssp. chamissoniana)	Hawaii
E	Panicgrass, Carter's (Panicum fauriei var. carteri)	Hawaii
E	Papala (Charpentiera densiflora)	Hawaii
E	Pauoa (Ctenitis squamigera)	Hawaii
E	pilo (Kadua laxiflora)	Hawaii
E	Pilo kea lau li`i (Platydesma rostrata)	Hawaii
E	Po`e (Portulaca sclerocarpa)	Hawaii
E	Popolo (Cyanea solanacea)	Hawaii
E	Popolo (Solanum nelsonii)	Hawaii
E	Popolo ku mai (Solanum incompletum)	Hawaii
E	Pua `ala (Brighamia rockii)	Hawaii
E	Pu`uka`a (Cyperus trachysanthos)	Hawaii
E	Reedgrass, Hillebrand's (Calamagrostis hillebrandii)	Hawaii
E	Reedgrass, Maui (Calamagrostis expansa)	Hawaii
E	Remya, Maui (Remya mauiensis)	Hawaii
E	Sandalwood, Lanai (= `iliahi) (Santalum haleakalae var. lanaiense)	Hawaii
E	Schiedea, Diamond Head (Schiedea adamantis)	Hawaii
E	SILVERSWORD, MAUNA LOA (=Ka'u) (Argyroxiphium kauense)	Hawaii
E	Uhi uhi (Mezoneuron kavaiense)	Hawaii
E	Vetch, Hawaiian (Vicia menziesii)	Hawaii
E	Wahane (Pritchardia aylmer-robinsonii)	Hawaii
E	Wawae`iole (Huperzia mannii)	Hawaii

Listed status	Species	Jurisdiction
E	Wawae`iole (Huperzia nutans)	Hawaii
E	Aplokating-palaoan (Psychotria malaspinae)	Guam
T	Fadang (Cycas micronesica)	Guam, CNMI
E	halomtano, Berenghenas (Solanum guamense)	Guam
T	halumtano, Cebello (Bulbophyllum guamense)	Guam, CNMI
E	Iagu, Hayun (=Guam), Tronkon guafi (Rota) (Serianthes nelsonii)	Guam, CNMI
T	No common name (Dendrobium guamense)	Guam, CNMI
E	No common name (Eugenia bryanii)	Guam, CNMI
T	No common name (Maesa walkeri)	Guam, CNMI
T	No common name (Nervilia jacksoniae)	Guam, CNMI
E	No common name (Phyllanthus saffordii)	Guam
T	No common name (Tabernaemontana rotensis)	Guam
E	No common name (Tinospora homosepala)	Guam
T	No common name (Tuberolabium guamense)	Guam, CNMI
E	Paudedo (Hedyotis megalantha)	Guam
E	Ufa-halomtano (Heritiera longipetiolata)	Guam, CNMI
E	No common name (Nesogenes rotensis)	CNMI
E	No common name (Osmoxylon mariannense)	CNMI
T	No common name (Tabernaemontana rotensis)	CNMI

Appendix F. List of marine mammals found within the U.S. regions where CRPC works

Common Name	Scientific Name	Pacific	Southeast	Gulf	Caribbean
Atlantic Spotted dolphin	<i>Stenella frontalis</i>		X	X	X
Blainville's Beaked Whale	<i>Mesoplodon densirostris</i>	X		X	
Blue Whale	<i>Balaenoptera musculus</i>	X			
Bottlenose Dolphin	<i>Tursiops truncatus</i>	X	X	X	X
Bryde's Whale	<i>Balaenoptera edeni</i>	X		X	
Clymene Dolphin				X	X
Common Dolphin	<i>Delphinus delphis</i>	X			
Cuvier's Beaked Whale	<i>Ziphius cavirostris</i>	X		X	X
Dense Beaked Whale	<i>Mesoplodon densirostris</i>			X	
Dugong*	<i>Dugong dugon</i>	X			
Dwarf Sperm Whale	<i>Kogia simus</i>	X		X	
False Killer Whale — Hawaiian Pelagic	<i>Pseudorca crassidens</i>	X		X	
Fin Whale	<i>Balaenoptera physalus</i>	X	X	X	X
Florida manatee	<i>Trichechus manatus latirostris</i>		X	X	
Fraser's Dolphin	<i>Lagenodelphis hosei</i>	X		X	
Gervais Beaked Whale	<i>Mesoplodon europaeus</i>		X	X	
Hawaiian Monk Seal	<i>Neomonachus schauinslandi</i>				
Humpback Whale	<i>Megaptera novaeangliae</i>	X	X		
Killer Whale	<i>Orcinus orca</i>	X		X	
Long-finned Pilot Whale	<i>Globicephala melaena</i>	X			
Longman's Beaked Whale	<i>Indopacetus pacificus</i>	X			
Melon-Headed Whale	<i>Peponocephala electra</i>	X	X	X	
Minke Whale	<i>Balaenoptera acutorostrata</i>	X	X	X	X
North Pacific Right Whale	<i>Eubalaena japonica</i>	X			
Pantropical Spotted Dolphin	<i>Stenella attenuata</i>	X		X	
Pilot whale, Short finned	<i>Globicephala macrorhynchus</i>				X
Pygmy killer whale	<i>Feresa attenuata</i>	X		X	
Pygmy Sperm Whale	<i>Kogia breviceps</i>	X		X	
Risso's Dolphin	<i>Grampus griseus</i>	X	X	X	
Rough-toothed Dolphin	<i>Steno bredanensis</i>	X	X	X	
Sei Whale	<i>Balaenoptera borealis</i>	X	X	X	X
Short-Finned Pilot Whale	<i>Globicephala macrorhynchus</i>		X	X	
Sperm Whale	<i>Physeter macrocephalus</i>	X		X	
Spinner Dolphin	<i>Stenella longirostris</i>	X		X	X
Striped Dolphin	<i>Stenella coeruleoalba</i>	X		X	
West Indian manatee	<i>Trichechus manatus manatus</i>				X

Appendix G. The CRCP Impacts Matrix

CRCP Impacts Matrix: Comparison for Coral Reef Restoration/Interventions and Reductions in Physical Impacts to Coral Reefs										
I = Intensity, C = Context, D = Duration										
- 3 = Major (-), -2 = Moderate (-), -1 = Minor (-), 0 = Negligible, 1 = Minor (+), 2 = Moderate (+), 3 = Major (+)										
A = Adverse, B = Benefit										
Resource	No Action Alternative			Alternative 1			Alternative 2			
		A	B	A	B		A	B		
Soils and Seidments	I	-1	3	Minor (-) to Major (+)	-1	1	Moderate (-) to Minor (+)	-1	3	Minor (-) to Major (+)
	C	-1	2		-1	0		-1	2	
	D	-1	2		-2	0		-1	2	
Terrestrial Habitat and Biota	I	-1	2	Minor (-) to Moderate (+)	-1	2	Minor (-) to Moderate (+)	-1	2	Minor (-) to Moderate (+)
	C	-1	2		-1	2		-1	2	
	D	-1	2		-1	2		-1	2	
Wetlands and Floodplains	I	-1	2	Minor (-) to Moderate (+)	-1	2	Minor (-) to Moderate (+)	-1	2	Minor (-) to Moderate (+)
	C	-1	2		-1	1		-1	2	
	D	-1	2		-1	1		-1	2	
Water Resources	I	-1	3	Minor (-) to Major (+)	-1	1	Minor (-) to Moderate (+)	-1	3	Minor (-) to Major (+)
	C	-1	2		-1	2		-1	2	
	D	-1	2		-1	2		-1	2	
Seagrasses	I	-1	2	Minor (-) to Moderate (+)	-1	1	Moderate (-) to Minor (+)	-1	2	Minor (-) to Moderate (+)
	C	-1	2		-1	0		-1	2	
	D	-1	2		-2	0		-1	2	
Mangroves	I	-1	2	Minor (-) to Moderate (+)	-1	1	Moderate (-) to Minor (+)	-1	2	Minor (-) to Moderate (+)
	C	-1	2		-1	0		-1	2	
	D	-1	2		-2	0		-1	2	
Corals, Other Assocaited Invertebrates, and Algae	I	-1	3	Moderate (-) to Major (+)	-3	1	Major (-) to Minor (+)	-1	3	Moderate (-) to Major (+)
	C	-2	2		-3	1		-2	2	
	D	-1	2		-2	0		-1	2	
Fish	I	-1	3	Minor (-) to Major (+)	-2	1	Moderate (-) to Minor (+)	-1	2	Minor (-) to Major (+)
	C	-1	2		-1	1		-1	2	
	D	-1	2		-2	0		-1	2	
Invasive Species	I	-2	3	Moderate (-) to Major (+)	-2	0	Moderate (-) to Minor (+)	-2	3	Moderate (-) to Major (+)
	C	-2	2		-1	1		-2	2	
	D	-2	2		-2	0		-2	2	
Essential Fish Habitat	I	-1	3	Minor (-) to Major (+)	-2	1	Moderate (-) to Minor (+)	-1	3	Minor (-) to Major (+)
	C	-1	2		-2	1		-1	2	
	D	-1	2		-2	1		-1	2	
Protected Species (Sea Turtles, Whales, and Birds)	I	-2	3	Moderate (-) to Major (+)	-2	1	Moderate (-) to Minor (+)	-2	3	Moderate (-) to Major (+)
	C	-1	2		-1	0		-1	2	
	D	-1	2		-2	0		-1	2	
Cultural Resources	I	-1	2	Minor (-) to Moderate (+)	0	2	Minor (-) to Moderate (+)	-1	2	Minor (-) to Moderate (+)
	C	-1	2		-1	2		-1	2	
	D	-1	2		0	2		-1	2	
Public Health and Safety	I	-1	2	Minor (-) to Moderate (+)	0	1	Moderate (-) to Minor (+)	-1	2	Minor (-) to Moderate (+)
	C	-1	2		0	1		-1	2	
	D	-1	2		-2	0		-1	2	
Economic Environment	I	-1	2	Minor (-) to Moderate (+)	0	1	Moderate (-) to Minor (+)	-1	2	Minor (-) to Moderate (+)
	C	-1	2		0	1		-1	2	
	D	-1	2		-2	1		-1	2	

Appendix H. Consultation and Coordination Letters

1. NMFS ESA Consultation Request and Response
2. NMFS EFH Early Coordination Request
3. USFWS ESA Consultation Transmittal Letter (Informal Consultation Underway)
4. Coastal Zone Management Coordination Transmittal Letters
5. SHPO Coordination Transmittal Letters



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1315 East West Hwy
Silver Spring, MD 20910

Subject: Request for Initiation of Programmatic Consultation under Section 7 of the Endangered Species Act for Activities to Implement the Coral Reef Conservation Program

Dear Ms. Tortorici,

The purpose of this letter is to formally initiate the programmatic consultation process related to implementation of activities under the National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP) to ensure compliance with the Endangered Species Act (ESA) Section 7, including authorization for anticipated and unanticipated incidental takes. This initiation letter does not include the programmatic Biological Assessment (BA), which is under development and will be completed using information in the CRCP's Draft Programmatic Environmental Impact Statement, also under development. The CRCP is also initiating early coordination with NOAA's Office of Habitat Conservation regarding Essential Fish Habitat (EFH), and when the BA is ready for the Section 7 consultation, CRCP would like to conduct a joint consultation to meet EFH and ESA Section 7 requirements in a streamlined process.

The CRCP's activities are based on carrying out the policies and purposes of the Coral Reef Conservation Act, 16 U.S.C. § 6401, et seq., which are to protect, conserve, and restore the nation's coral reefs by maintaining healthy ecosystem function. The CRCP brings together expertise from across NOAA for a multidisciplinary approach to studying and effectively managing these complex ecosystems. The CRCP also works with a variety of partners that include other federal agencies, state and territorial agencies, research and academic institutions, non-governmental organizations, and community groups in both the Pacific (Pacific Islands Region) and Atlantic Oceans (Gulf of Mexico, South Atlantic, and Caribbean Sea) to conserve shallow-water coral reef ecosystems across multiple states and territories using a targeted approach focused on local issues. Additionally, the CRCP supports capacity building in other nations (e.g., those in the wider Caribbean, the Coral Triangle, the South Pacific, and Micronesia) that have coral reefs with ecological connectivity to U.S. coral reef resources.

The CRCP's current strategic plan focuses efforts on four areas of work, which are also supported through cross-cutting functions. These four areas are improving fisheries sustainability, reducing land-based sources of pollution, increasing resilience to climate change impacts, and restoring viable coral populations. The cross-cutting functions include research and monitoring, mapping, social science, communications, and capacity building. Domestically, the CRCP supports on-the-ground and in-the-water actions to conserve coral reef ecosystems through resilience-based management in the seven U.S. coral reef jurisdictions. Internationally, the CRCP supports capacity-building efforts to strengthen local frameworks and policies to build marine protected area networks; to improve and maintain resilience of

coral reef ecosystems; to observe, predict, communicate, and manage the effects of climate change; to reduce impacts of fishing on coral reef ecosystems; and to reduce impacts from land-based pollution.

After reviewing the status of the ESA-listed species and designated critical habitat in the action area, the CRCP has determined that planned activities may adversely affect some ESA-listed species and designated critical habitat. Considering the existing CRCP mitigation measures that are designed to avoid or minimize impacts to these species and/or their habitats during implementation of activities, the CRCP expects effects to be negligible or minor. Attached is a brief description of the action area, the activities the CRCP intends to implement within the action area, ESA-listed species and designated critical habitat within the action area, and mitigation measures to reduce potential impacts of CRCP's activities.

Prior to issuance of a Biological Opinion from the NMFS, the CRCP will notify NMFS of any proposed activities that are underway via memos written in compliance with ESA Section 7(a)(2) (describing the proposed action during the consultation period, and effects of the proposed action) and ESA Section 7(d) (describing time limitations regarding the proposed action).

If you have any questions, please contact Liz Fairey, the CRCP Environmental Compliance Coordinator, at liz.fairey@noaa.gov or 301-427-8632.

Sincerely,

A handwritten signature in cursive script that reads "Jennifer L. Koss".

Jennifer Koss

Director, Coral Reef Conservation Program

Attachment 1



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

JUN 21 2019

Refer to NMFS No: OPR-2019-01044

Ms. Jennifer Koss
Director
Coral Reef Conservation Program
Office for Coastal Management
Building 4
1305 East-West Highway
Silver Spring, MD 20910

RE: Request for Programmatic Consultation Pursuant to Section 7 of the Endangered Species Act on the Implementation of Activities under the Coral Reef Conservation Program

Dear Ms. Koss:

JEN

On May 16, 2019, the National Marine Fisheries Service (NMFS) received your request for programmatic formal consultation under section 7 of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) for the implementation of activities under the Coral Reef Conservation Program (CRCP). Activities would take place in coral jurisdictions throughout the U.S. The CRCP also supports capacity building in other nations in the Caribbean and Pacific that have coral reef ecosystems with ecological connectivity to U.S. coral resources. This response to your request was prepared by NMFS pursuant to section 7(a)(2) of the ESA, implementing regulations at (50 CFR Part 402), and agency guidance.

Enclosed with your request was an overview document describing: the action area, the activities CRCP intends to implement within the action area, ESA-listed species and designated critical habitat within the action area, and avoidance and minimization measures CRCP intends to implement as part of program activities in the action area in order to reduce the potential effects of the action on ESA resources. I also understand that the CRCP is developing a programmatic Biological Assessment (BA) for this consultation. My staff have been providing technical assistance to you and your staff on the CRCP, including refining the avoidance and minimization measures for program activities, reviewing the content of the draft Programmatic Environmental Impact Statement, and providing comments regarding the contents of the BA.

You also noted that the CRCP will inform NMFS of any proposed program activities in the action area, which will require the implementation of the avoidance and minimization measures as described in the information accompanying your letter, via memoranda written in compliance with ESA section 7(a)(2), 7(d). Any reports or other documentation generated as part of the completion of the activities should be provided to NMFS as part of the programmatic consultation for implementation of activities under the CRCP.



We will respond as to whether or not we agree with the analysis in the memoranda regarding particular activities within 15 working days of receipt of a memorandum. To comply with ESA section 7 regulations (50 CFR 402.14(c)), the initiation package submitted with the request for consultation must apply the best scientific and commercial data available. Until we receive you BA and determine that it has enough information, we cannot initiate formal consultation. In the meantime, we will continue to provide technical assistance and work with you and your staff regarding information to be included in the BA.

The ESA requires that after initiation of formal consultation, the action agency may not make any irreversible or irretrievable commitment of resources that would preclude the formulation or implementation of any reasonable and prudent alternatives that would avoid violating section 7(a)(2) (50 CFR §402.09). This prohibition is in force during the consultation process and continues until the requirements of section 7(a)(2) are satisfied.

I look forward to our continued work with you and your staff on this project. If you have any questions, please contact Dr. Lisamarie Carrubba, Consultation Biologist, at (301) 427-8493, or by e-mail at lisamarie.carrubba@noaa.gov or me at (301) 427-8495 or by e-mail at cathy.tortorici@noaa.gov.

Sincerely,



Cathryn E. Tortorici
Chief, ESA Interagency Cooperation Division
Office of Protected Resources



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office for Coastal Management
Silver Spring Metro Center, Building 4
1305 East-West Highway
Silver Spring, Maryland 20910

May 17, 2019

Kara Meckley
Chief, Habitat Protection Division
Office of Habitat Conservation
1315 East West Hwy
Silver Spring, MD 20910

Subject: Request for Early Coordination of Programmatic Consultation on Essential Fish Habitat for Activities to Implement the Coral Reef Conservation Program

Dear Ms. Meckley,

The National Oceanic Atmospheric Administration (NOAA), Coral Reef Conservation Program (CRCP) is requesting early coordination on a programmatic consultation for impacts to Essential Fish Habitat (EFH). Currently, the CRCP is drafting a Programmatic Environmental Impact Statement, and we intend to use the information in the draft document to support the early coordination.

This letter is in reference to the CRCP's action to carry out the policies and purposes of the Coral Reef Conservation Act, 16 U.S.C. § 6401, et seq., which are to protect, conserve, and restore the nation's coral reefs by maintaining healthy ecosystem function. The CRCP brings together expertise from across NOAA for a multidisciplinary approach to studying and effectively managing these complex ecosystems. The CRCP also works with a variety of partners that include other federal agencies, state and territorial governments and agencies, research and academic institutions, non-governmental organizations, and community groups in both the Pacific (Pacific Islands Region) and Atlantic Oceans (Gulf of Mexico, South Atlantic, and Caribbean Sea) to conserve shallow-water coral reef ecosystems across multiple states and territories using a targeted approach focused on local issues. Additionally, the CRCP supports capacity building in other nations (e.g., those in the wider Caribbean, the Coral Triangle, the South Pacific, and Micronesia) that have coral reefs with ecological connectivity to the coral reef ecosystems in the U.S.

The CRCP's current strategic plan focuses efforts on four areas of work, which are also supported through cross-cutting functions. These four areas are improving fisheries sustainability, reducing land-based sources of pollution, increasing resilience to climate change impacts, and restoring viable coral populations. The cross-cutting functions of the CRCP include research and monitoring, mapping, social science, communications, and capacity building. Domestically, the CRCP supports on-the-ground and in-the-water actions to conserve coral reef ecosystems through resilience-based management in the seven U.S. coral reef jurisdictions. Internationally, the CRCP supports capacity-building efforts to strengthen local frameworks and policies to build marine protected area networks; to improve and maintain resilience of coral reef ecosystems; to observe, predict, communicate, and manage the effects of climate change on coral reefs; to reduce impacts of fishing on coral reef ecosystems; and to reduce impacts from land-based pollution.

The CRCP has also initiated formal consultation with National Marine Fisheries Service's Office of Protected Resources (OPR) pursuant to Section 7 of the Endangered Species Act and is working with OPR

to develop a biological assessment (BA). Once the BA is ready for the Section 7 consultation, the CRCP intends to conduct a joint consultation to meet EFH and ESA Section 7 requirements in a streamlined process. Attached is a description of the action area, the activities the CRCP intends to implement within the action area, a general EFH characterization, and CRCP mitigation measures to reduce potential impacts to EFH.

After reviewing the status of the EFH in the action area, it is likely that some of the planned activities would have adverse effects on EFH. Considering the existing CRCP mitigation measures that are designed to avoid or minimize impacts to habitats during implementation of activities, the CRCP expects the proposed action would have negligible to minor adverse impacts to EFH.

If you have any questions, please contact Liz Fairey, the CRCP Environmental Compliance Coordinator, at liz.fairey@noaa.gov or 301-427-8632.

Sincerely,

A handwritten signature in cursive script that reads "Jennifer L. Koss".

Jennifer Koss
Director, Coral Reef Conservation Program

Attachment 1