Chapter 2. Management Alternatives

2.1 Alternatives Development

During development of the alternatives for the Draft CCP/EA, the Service reviewed and considered a variety of resource, social, economic, and organizational aspects important for managing the Refuge. These biological, physical, and socio-economic conditions are described more fully in the following chapters. As is appropriate for a national wildlife refuge, resource considerations were fundamental in designing alternatives. House Report 105-106 accompanying the Improvement Act states "… the fundamental mission of our System is wildlife conservation: wildlife and wildlife conservation must come first."

Alternatives development by the planning team began by reviewing relevant plans, studies, and past and current research. We also held meetings with American Samoa and Federal agencies and elected officials, local villages, non-profit organizations, and others. Additionally, public scoping occurred during 2009 and over 60 people participated. This helped us to further identify issues and priorities to consider during alternatives development. We also provided planning updates throughout the development of this Draft CCP/EA, which allowed for public comment opportunities to assist with alternatives development. Further details of public involvement and participation can be found in Appendix J.

2.2 Actions Considered but not Developed

During development of the alternatives, the planning team considered the actions detailed below. Both of these actions were ultimately eliminated for the reasons provided.

Tours. Commercial scuba diving and commercial or amateur photographic tours to the Refuge were considered and dismissed due to the safety hazard of navigating the entrance channel (ava). Such activities would also cause unacceptable levels of wildlife disturbance, threats of introduced species, and would require a level of on-site Service oversight currently unavailable in order to adequately manage the use.

Fishing. Fishing in the Refuge, with contemporary, historic, or traditional gear for recreational or traditional use was considered and dismissed due to the small size of the lagoon and its limited fish and giant clam (faisua) populations. The ecological limits of these populations make them vulnerable to exploitation from fishing. Dismissing fishing as an alternative will maintain the value of the Refuge as an intact ecosystem for these populations, meet the Refuge's purposes, fulfill the Governor of American Samoa's support for no-take areas to protect the coral reef ecosystem, and supports the spirit of the Monument Proclamation which prohibits commercial fishing in the Monument.

2.3 Alternative Descriptions

2.3.1 Features Common to All Alternatives

All alternatives contain some common features. These are presented below to reduce the length and redundancy of the individual alternative descriptions.

Access. The Refuge is closed to general public use and access in accordance with the Administration Act. The specific proposed uses of the Refuge are described in Appendices B and C. Specific requests to access the Refuge associated with proposed uses will be evaluated on a case-by-case basis and authorized through issuance of a Refuge Special Use Permit (SUP) by the Refuge/Monument Manager.

Adaptive management. Based on 522 Departmental Manual (DM) 1 (Adaptive Management Implementation policy), Refuge staff shall utilize adaptive management for conserving, protecting, and, where appropriate, restoring lands and resources. Within Title 43 of the CFR 46.30, adaptive management is defined as a system of management practices based upon clearly identified outcomes, where monitoring evaluates whether management actions are achieving desired results (objectives). Adaptive management accounts for the fact that complete knowledge about fish, wildlife, plants, habitats, and the ecological processes supporting them may be lacking. Adaptive management emphasizes learning while doing based upon available scientific information and best professional judgment considering site-specific biotic and abiotic factors on refuge lands and waters. Part of measuring the success of adaptive management in the Refuge also includes 5-year reviews and 15-year revision of the CCP, which will be initiated by the Service and involve many of the same steps and engagement with partners and the public as the original CCP.

Biosecurity measures. Refuge visitation protocols will continue to include strict biosecurity measures to prevent non-native introductions (e.g., rats, ants, scale insects, etc.) and impacts from reactive materials (e.g., iron). Anyone entering the Refuge (including staff) will be required to follow the written aquatic and terrestrial quarantine procedures used for all uninhabited refuges in the Pacific Reefs NWRC. Restrictions are designed to remove or kill pest species that may be in clothes or gear before they are taken to the Refuge.

Cultural and historic resource protection. Cultural and historic resources on refuges receive protection and consideration in accordance with Federal cultural resources laws, Executive orders, and regulations, as well as policies and procedures established by the Department of the Interior (DOI) and the Service. Actions with the potential to affect cultural and historic resources will undergo a thorough review before being implemented, as is consistent with the requirements of cultural resource laws. All ground-disturbing projects will undergo a review (including but not limited to archaeological and cultural surveys) under Section 106 of the National Historic Preservation Act (NHPA). The Service will provide our Regional Historic Preservation Officer (RHPO) a description and location of all projects and activities that affect ground and structures, including project requests from third parties. Information will also include any alternatives being considered. We will also coordinate and consult with the American Samoa Historic Preservation Office (ASHPO) and the Office of Samoan Affairs (OSA) and seek assistance from Manu'a people on issues related to cultural resource education and interpretation, special programs, and the NHPA.

Groundings. To deter ship groundings, we will develop targeted outreach materials and work within the international maritime community (e.g., International Maritime Organization), through appropriate U.S. agencies, to designate the Refuge as "area to be avoided." Also, the Service will reinstall Refuge signage at Rose Atoll as well as improving information available to educate the sailing community about the Refuge's closed status to yachtsmen, and other mariners at regional embarkation points (e.g., harbors in Samoa, French Polynesia). These points are where boaters may depart from, en route to other destinations, and may pass by the Refuge.

Implementation subject to funding availability. After the CCP is completed, actions will be implemented over a period of 15 years as funding becomes available. Draft project priorities and projected staffing/funding needs are included in Appendix D.

Integrated pest management (IPM). In accordance with 517 DM 1 and 569 FW 1, an IPM approach would be used, where practicable, to eradicate, control, or contain pest and invasive species (herein collectively referred to as pests) on refuges. The IPM would involve using methods based upon effectiveness, cost, and minimal ecological disruption, which considers minimum potential effects to non-target species and the refuge environment. Pesticides may be used where physical, cultural, and biological methods or combinations thereof, are impractical or incapable of providing adequate control, eradication, or containment. If a pesticide would be needed on refuge lands or waters, the most specific (selective) chemical available for the target species would be used unless considerations of persistence or other environmental and/or biotic hazards would preclude it. In accordance with 517 DM 1, pesticide usage would be further restricted because only pesticides registered with the U.S. Environmental Protection Agency (EPA) in full compliance with the FIFRA and as provided in regulations, orders, or permits issued by EPA may be applied on lands and waters under refuge jurisdiction.

Environmental harm by pest species would refer to a biologically substantial decrease in environmental quality as indicated by a variety of potential factors including declines in native species populations or communities, degraded habitat quality or long-term habitat loss, and altered ecological processes. Environmental harm may be a result of direct effects of pests on native species including preying and feeding on them; causing or vectoring diseases; killing their young or preventing them from reproducing; out-competing them for food, nutrients, light, nest sites or other vital resources; or hybridizing with them so frequently that within a few generations few if any truly native individuals remain. Environmental harm also can be the result of an indirect effect of pest species. For example, decreased seabird reproduction may result from a pest killing native plants that provide nesting habitat.

Environmental harm may involve detrimental changes in ecological processes. For example, cyanobacterial infestations can inhibit the growth of CCA which is a very important reef builder. This can lead to a situation where reef growth does not keep up with reef erosion, lowering the reef elevation and threatening the islands with ocean inundation. Environmental harm may also cause or be associated with economic losses and damage to human, plant, and animal health.

Predator management is aimed at minimizing entry of non-native predators using quarantine protocols, exclusion, habitat modification, control, and eradication. For example, live trapping and use of bait stations could be used to eradicate illegally-introduced rats and mice. Predator and pest management will be conducted by Service personnel or contractors.

See Appendix G for the Refuge's IPM program documentation to manage pests for this CCP. Along with a more detailed discussion of IPM techniques, this documentation describes the selective use of pesticides for pest management on refuges, where necessary. Throughout the life of the CCP, most proposed pesticide uses on the Refuge would be evaluated for potential effects to biological resources and environmental quality. These potential effects would be documented in "Chemical Profiles" (see Appendix G). Pesticide uses with appropriate and practical best management practices for habitat management would be approved for use where there likely would be only minor, temporary, and localized effects to species and environmental quality based upon non-exceedance of

threshold values in Chemical Profiles. However, pesticides may be used where substantial effects to species and the environment are possible (exceed threshold values) in order to protect human health and safety.

Partnerships. Partnerships are critical components in refuge management, including implementing such management as maintaining and restoring resources, conducting inventories and surveys, providing for cultural uses, and coordinating education and outreach opportunities. These important partnerships typically involve joining forces with the American Samoa Government (ASG) as well as other Monument partners, other Federal partners, villages, businesses, and non-governmental organizations in meeting common mission objectives. Some current examples of valued partnerships the Service would maintain include:

Under all alternatives, the Service will maintain regular discussions with the ASG to coordinate on management of the Refuge. The Service will work with the DMWR to continue research, monitoring, education, outreach, interpretation, law enforcement, and management activities at the Refuge. We will continue to work with the OSA to facilitate and maintain appropriate relationships with people in the villages in Manu'a and Tutuila. The Service will also keep the ASDOC and the DMWR informed of activities through regular discussions and common forums such as the Coral Reef Advisory Group and the Rose Atoll Marine National Monument Intergovernmental Committee.

The Service will maintain its partnership with the NOAA through its National Ocean Service, ONMS, NMFS's Marine National Monument Program (MNMP), and Pacific Islands Fisheries Science Center (PIFSC) and its Coral Reef Ecosystem Division (CRED). The CRED provides intensive oceanography, water quality, habitat, biological population, and acoustic data as well as benthic habitat mapping as part of their Reef Assessment Monitoring Program (RAMP). The RAMP missions to the Refuge currently take place every 2 years (from 2002-2012), however, due to decreased funding, NOAA has proposed to scale back missions to every 3 years after 2012. The Service has also worked closely with DMWR since the creation of the Refuge for conducting biological monitoring and habitat restoration projects. The Service will also maintain its partnership with the U.S. Coast Guard (USCG). The USCG has provided a law enforcement presence by having vessels patrol the area, and through overflights of the Refuge.

Additionally we have partnerships with the National Park Service (NPS), ONMS, U.S. Geological Survey, and the ASDOC. The NPS provides the Service office space and will assist with biological monitoring and habitat restoration projects in the future. We will also work closely with NPS on interpretation, environmental education (EE), and outreach (e.g., Refuge display in their visitor center). The Service is building a partnership with ONMS and ASDOC for their proposal to manage uses in the Monument surrounding the Refuge. The Service has overall management responsibility for the Monument in consultation with NOAA/NMFS. The proposed Muliava Unit of Fagatele Bay National Marine Sanctuary may overlay areas of the Monument, outside of the Refuge.

Response capacity. Within 5 years, create response capacity to minimize trespass and poaching using outreach, education, remote sensing, law enforcement, and other methods (e.g., evaluate the possibility of enforcement officers from Manu'a, formalize partnership with USCG for surveillance).

Vessel. The Service will acquire a vessel, part ownership in a vessel, or long-term vessel charter contract to assist with management actions, law enforcement, and monitoring.

Wilderness review. The Service's CCP policy requires that a wilderness review be completed in all CCPs. A wilderness review determines if an area is eligible to be added to the National Wilderness Preservation System. This review consists of three phases: wilderness inventory, wilderness study, and wilderness recommendation. If it is determined that the area meets the minimum requirements for wilderness, the process moves on to the wilderness study phase. As part of the process for this Draft CCP/EA, the team completed a wilderness inventory which can be found in Appendix E. This review concluded that the Refuge is suitable to move on to the wilderness study phase. At the time of writing this Draft CCP/EA, a Draft Legislative Environmental Impact Statement was in the process of being drafted for all eligible National Wildlife Refuges in the Hawaiian and Pacific Islands National Wildlife Refuge Complex in preparation for public and partner review after a public scoping comment period was concluded.

2.3.2 Summary of Alternatives

Both alternative describes a combination of management actions designed to achieve the Refuge purposes, vision, and goals. These alternatives provide different ways to address and respond to management concerns, major public and partner issues, and opportunities identified during the planning process. They also reflect the direction in the Administration Act, Service policies, and legal mandates outlined in Chapter 1. A summary of the key differences between the alternatives is presented in Table 2-.1. A brief description as well as accompanying map of each alternative follows.

2.3.2.1 Alternative A: No Action (Current Management)

This alternative assumes little to no change (based on existing initiatives the Service is already moving forward with) in current management programs and is the base from which to compare the other alternative.

Wildlife and habitat. The Service protects, maintains, and restores habitat for priority species, including seabirds, shorebirds, turtles, native plants, reef fish, invertebrates (including coral), and coralline algae. The Refuge is closed to the general public and entry is limited to those who have been issued a SUP.

The Refuge is extremely remote, being 180 miles from Tutuila. Therefore, it requires a very seaworthy vessel for the full day trip and is very expensive and logistically challenging. Because of this, trips to the Refuge by managers and biologists have been limited to once a year or once every 2 years, and last from 3 days to 3 weeks. These trips have been undertaken by Refuge Complex staff based out of Honolulu and include rapid ecological assessments (REA) for wildlife and ecosystem monitoring, pest species management, and restoration projects including the removal of debris from a 1993 shipwreck. It was not until 2011 that the Refuge had a full-time staff member. The new Refuge Manager (who is also the Monument Manager) is responsible for on-site management as well as coordination with all partners.

Refuge management is aided by our partnership with the CRED, which collects bathymetry data and monitors water quality, coral reef habitat, and fish populations; as well as our partnership with the DMWR, which monitors fish and wildlife populations and conducts habitat restoration projects with Refuge staff.

Outreach, interpretation, and environmental education. The Refuge maintains a Website where general information materials can be found. An interpretive display about Rose Atoll that was housed with the American Samoa National Park was lost in the 2009 tsunami.

Cultural resources. In 2011, village chiefs, students, and teachers and staff from the Samoan Studies Institute visited the Refuge in conjunction with a MNMP grant to DMWR for the Monument. The information gathered by SSI would be used to develop video and printed materials for interpretation and educational use, including cultural resources.

2.3.2.2 Alternative B: Preferred –Enhanced Habitat Restoration, Monitoring, and Outreach

This alternative is the preferred because it improves habitat management for native species, improves our understanding of the status and trends of wildlife and habitat on the Refuge, and provides increased opportunities for public engagement to help protect and manage the Refuge. A vessel contract that provides for at least 2 visits per year of at least 5 days in duration would allow more regular and predictable access for understanding the health of Refuge resources and completing project work.

Wildlife and habitat. In addition to continuing activities in Alternative A, implementing this alternative would enhance protection and management of resources with improved monitoring, law enforcement, and an enhanced understanding of the atoll. By visiting at least twice annually, the quality and quantity of monitoring efforts would be increased. This would allow the creation of a database and time series to aid management decisions. In addition to increasing the frequency of management trips to the Refuge it would fortify close partnerships with our ASG partners. A remote sensing system (e.g., automated camera) would be set up to monitor nesting seabirds, turtles, and other wildlife. More frequent visits would improve information for law enforcement, provide a presence to deter illegal activity, and remote sensing would also provide better management and documentation of unauthorized entry into the Refuge.

We would explore restoration of the littoral forest on Rose Island by extirpating the introduced scale insect (*Pulvinaria urbicola*) and propagating native forest trees. Other pest species would be detected and controlled or eradicated with regular monitoring and a rapid response program. We would continue the restoration effort from the 1993 ship grounding through consistent surveying of the wreck site and removing any debris and continued monitoring.

Several of our strategies also recognize the potential impact climate change may have on Rose Atoll. We propose increased monitoring and data collection to better understand these impacts throughout the life of this 15-year plan. Our proposed management actions aim to maintain and restore habitats and species to strengthen their resiliency, sustainability, and adaptability to meet such challenges.

Attributes for each objective indicate the desired status of that habitat at the time of Refuge management visitation.

Outreach, interpretation, and environmental education. Refuge staff would provide outreach and interpretation opportunities and develop an EE program for American Samoa schools. We would develop programs to inform elected officials, students, and the general public of American Samoa

about the ecology of Rose Atoll and the mission of the Service. We would work closely with our partners to develop complementary interpretive displays for visitor's centers.

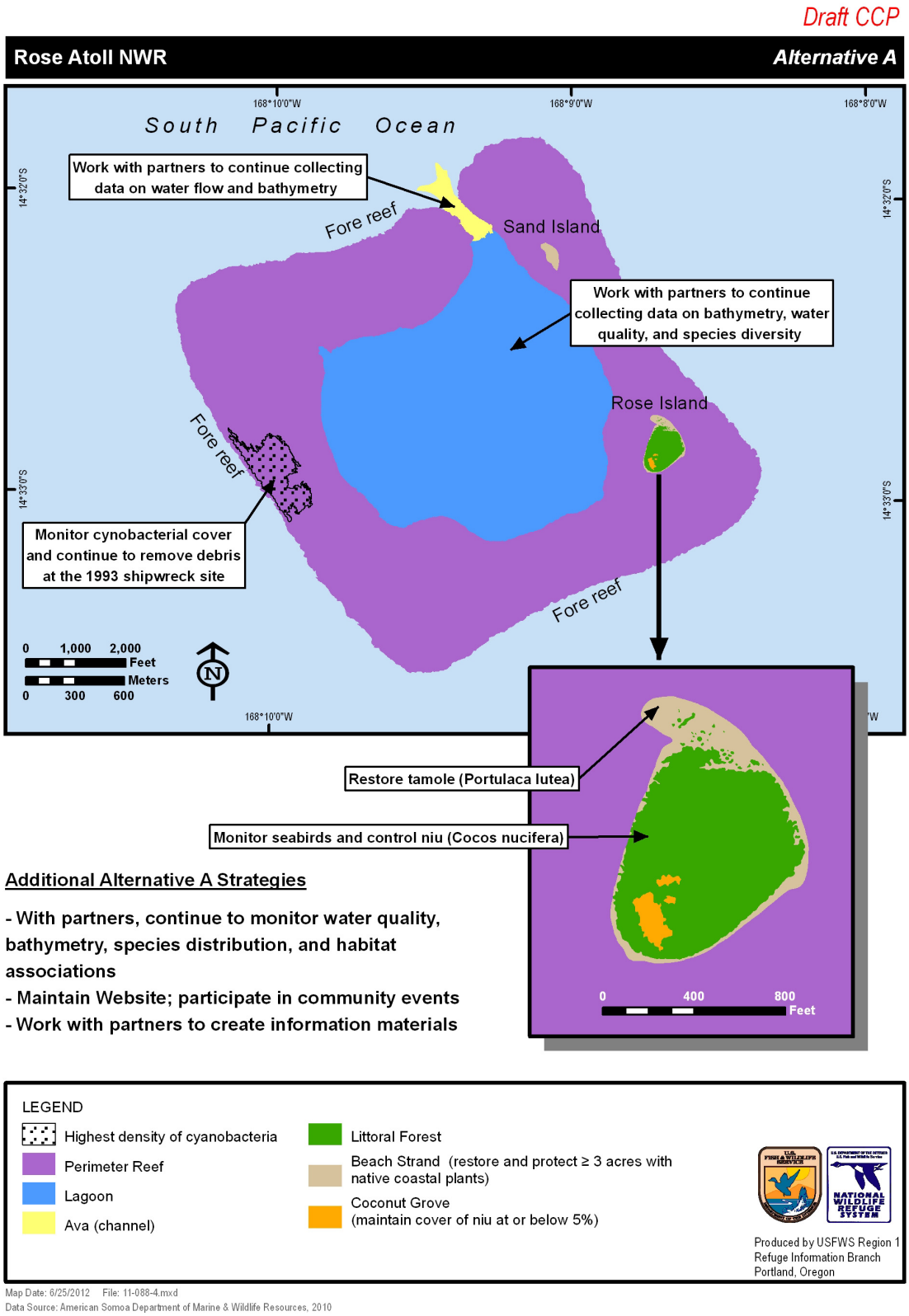
Cultural resources. We would expand Refuge management related to cultural resource management by working with the ASHPO, OSA, and other partners to conduct archaeological surveys at Rose Atoll, integrate cultural resources into interpretation and EE, and improve dialogue with Manu'a villages. We would also work with local officials to facilitate appropriate cultural practices.

Table 2-1. Summary of Alternatives by Issue

Key Themes	Objectives	Alternative A (Current Management)	Alternative B (Enhanced Habitat Restoration, Monitoring, and Outreach)
Lagoon Habitat	1.1 Protect and maintain the lagoon habitats	Work with partners to continue collecting data on bathymetry, water quality, and species diversity	In addition to Alternative A, develop and implement monitoring protocols for fish, corals, other invertebrates, and marine pests to manage populations as needed; install remote sensing to monitor resources and document illegal boat traffic
Perimeter Reef	2.1 Restore, protect, and maintain the perimeter reef	Monitor cyanobacterial cover which greatly increased in response to the 1993 shipwreck, continue to remove debris	In addition to Alternative A, develop reef monitoring program
Ava	3.1 Protect and maintain the ava	Work with partners to continue collecting data on water flow and bathymetry	In addition to Alternative A, survey for predator and prey fish species
Beach Strand	4.1 Restore, protect, and maintain the beach strand	Restore tamole (*Portulaca lutea*)	In addition to Alternative A, prepare and implement a monitoring plan and rapid response program for terrestrial non-native species
Littoral Forest	5.1 Restore, protect, and maintain littoral forest	Monitor seabirds and control niu (*Cocos nucifera*)	In addition to Alternative A, restore native littoral forest, and

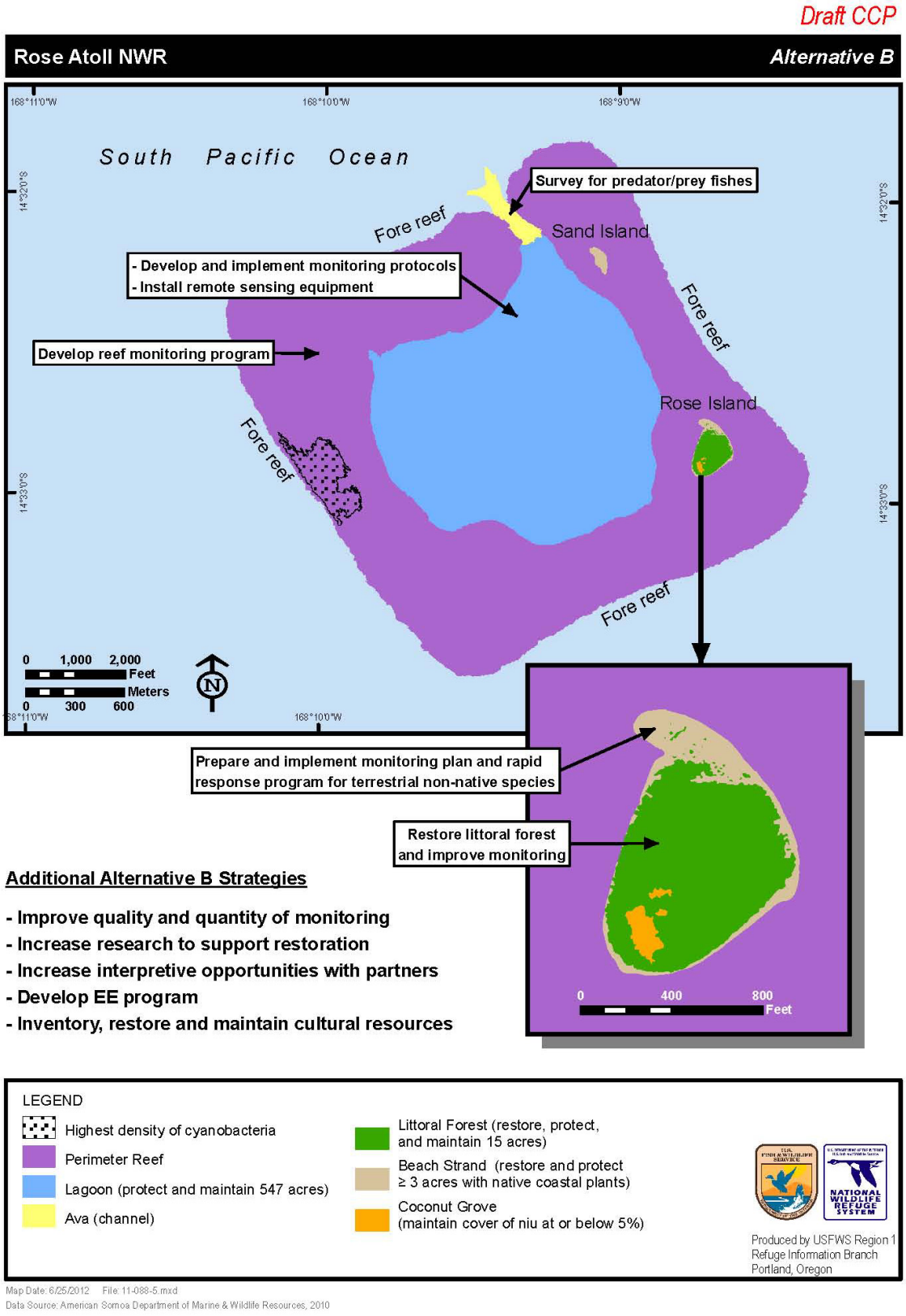
Key Themes	Objectives	Alternative A (Current Management)	Alternative B (Enhanced Habitat Restoration, Monitoring, and Outreach)
			improve monitoring of seabirds, vegetation, and pest species
Inventory, Monitoring, and Research	6.1 Conduct high priority inventory and monitoring (survey) activities and scientific assessments	Work with partners to continue monitoring water quality, bathymetry, species distribution, and habitat associations	In addition to Alternative A, improve the quality and quantity of monitoring efforts by monitoring more often, creating standardized protocols and management databases
	6.2 Conduct high priority research	Limited research	Increase research as part of restoration efforts for habitats and wildlife populations
Outreach, Interpretation, and Environmental Education (EE)	7.1 Enhance and expand interpretation and outreach	Maintain Website; participate in community events	In addition to Alternative A, develop more interpretive opportunities with our partners
	7.2 Develop EE	No EE program	Develop an EE program
Cultural Resources	8.1 Protect and perpetuate cultural resources related to Rose Atoll	Work with partners to create information materials	In addition to Alternative A, inventory, restore, and maintain cultural resources and work with local representatives to facilitate appropriate cultural traditions related to Rose Atoll

Figure 2-1. Alternative A.



The back sides of maps are blank to improve readability.

Figure 2-2. Alternative B.



The back sides of maps are blank to improve readability.

2.4 Goals, Objectives, and Strategies

A CCP describes management actions that help bring a refuge closer to its vision. A vision broadly reflects the refuge purpose(s), the Refuge System mission and goals, other statutory requirements, and larger-scale plans as appropriate. Goals then define general targets in support of the vision, followed by objectives that direct effort into incremental and measurable steps toward achieving those goals. Strategies identify specific tools and actions to accomplish objectives (USFWS and USGS 2004).

Goals and objectives are the unifying elements of successful refuge management. They identify and focus management priorities, resolve issues, and link to refuge purposes, Service policy, and the Refuge System mission.

The draft goals for the Refuge for the 15 years following completion of the CCP are presented on the following pages. Each goal is followed by the objectives that pertain to it. All objectives are for the lifetime of the CCP unless otherwise specified. Some objectives pertain to multiple goals and have simply been placed in the most appropriate spot. Similarly, some strategies pertain to multiple objectives. The goal order does not imply any priority in this CCP. Priority actions are identified in the staffing and funding analysis (see Appendix D).

Readers, please note the following:

The objective statements as written apply to the Service's Preferred Alternative. Below each objective statement are the strategies that could be employed in order to accomplish the objectives. Note the following:

- Check marks (✓) alongside each strategy show which alternatives include that strategy; and
- If a column for a particular alternative does not include a check mark for a listed strategy, it means that strategy would not be used in that alternative.

Other symbols used in the following tables include:

~ Approximately;
% Percent sign;
> Greater than;
< Less than;
≥ Greater than or equal to; and
≤ Less than or equal to.

2.4.1 Goal 1: Protect and maintain the lagoon habitats to meet the life-history needs of native species in this community.

Objective 1.1 Protect and maintain the lagoon habitats.

Protect a maintain lagoon reef habitats to provide the following attributes:

- 547 acres of shallow (<100 feet) water lagoon habitat to meet life-history requirements of all existing native members of the lagoon community. See Appendix A for species listings;
- Natural flow of marine water with quality measures of pH, salinity, temperature, nutrients, chlorophyll-*a*, that are appropriate to maintain native organisms in the lagoon community;
- Benthic bottom cover of sand interspersed with patch reefs, limestone blocks, and pinnacles providing a variety of substrates and rugose structure to provide habitat for lagoon species;
- Species diversity including algae, fish, turtles, and invertebrates including reef-building corals and reef-building crustose coralline algae;
- Lagoon free of debris; and
- Minimal human disturbance.

Strategies Applied to Achieve Objective:	**Alt A (Current)**	**Alt B (Preferred)**
Work with partners to collect bathymetry data every 10 years in order to document changes in the lagoon, reef, or ava that could affect hydrography or habitat characteristics (see Objective 6.1)	✓	✓
Work with National Oceanic Atmospheric Administration's (NOAA) Coral Reef Ecosystem Division (CRED) and other partners to collect oceanographic and water quality data in order to track changes that could affect the reef or wildlife (see Objective 6.1)	✓	✓
Work with partners to conduct Rapid Ecological Assessment (REA) to document habitat associations and species distribution, density, and diversity in marine habitats (see Objective 6.1)	✓	✓
Identify, prioritize, and implement restoration needs such as debris removal in lagoon habitats affected by anthropogenic impacts such as iron contamination from shipwrecks	✓	✓
Within 5 years, develop and implement monitoring protocols to track populations of focal lagoon species including: fish, corals, giant clams (faisua), other invertebrates, and marine pests to determine abundance, density, and biomass of each at selected sites (see Objective 6.1)		✓
Within 10 years characterize nutrient budgets and dynamics at Rose Atoll and evaluate them relative to data from other similar reef sites to identify possible stressors and the positive effects of healthy seabird colonies adjacent to living reefs (see Objective 6.2)		✓
Within 4 years, install remote sensing systems to document boat traffic in the lagoon		✓

Goatfish in lagoon. Jim Maragos, USFWS.

Rationale: In the middle of an ocean that is mostly over 10,000 feet deep, the lagoon provides 547 acres of shallow water habitat (< 100 feet deep). The reef protects this lagoon from the large swells of the open ocean, and light is able to penetrate to the bottom so corals and other sea life can thrive. While the deepest part of the lagoon has a simple sand bottom, sections on the edge have coral pinnacles which grow up close to the surface providing excellent habitat for faisua (*Tridacna maxima*). This shallow lagoon hosts a unique assemblage of fish and the largest population of faisua in American Samoa. These giant clams are listed under CITES and have suffered serious depletion throughout their range due to over-harvesting. While it can provide larval fish recruitment for the other Samoan Islands, the small size of the lagoon and its limited fish and invertebrate community make it particularly susceptible to fishing pressure.

Monitoring fish and invertebrate abundance and biomass as well as abiotic factors is critical so we can assess if the Service is maintaining the biological integrity, diversity, and environmental health of the lagoon (see Goal 6). Monitoring is key to refining the metrics in the attributes (which currently reflect how little is known at present about this habitat). Ongoing restoration efforts emphasize removal of debris and monitoring the cyanobacterial bloom. We would also pursue installing a remote sensing system to document unauthorized boat traffic in the lagoon since such traffic could involve unregulated fishing or damage other Refuge resources.

2.4.2 Goal 2: Restore, protect, and maintain the perimeter crustose coralline algal reef to meet the life-history needs of native species in this community.

Objective 2.1 Restore, protect, and maintain the perimeter crustose coralline algal reef.

Restore, protect, and maintain the perimeter crustose coralline algal reef (CCA) to support habitats and species with the following attributes:

- Healthy living reef dominated by CCA (*Porolithon* spp.) in a mosaic with small corals forming a network of pools and raised areas that provide habitat for reeftop organisms;
- Geomorphic structure intact with elements of rugosity and a mosaic of microhabitats;
- Boring sea urchins (*Echinometra, Echinostrephus* spp.) are present in at least 50% of available holes along the entire seaward margin of the perimeter reef;
- Holes that can be occupied by boring sea urchins are present at a density of at least 1/m² in the "urchin zone" along the entire seaward margin of the perimeter reef;
- CCA are present in 80% of sampling sites and occupy >25% of total solid substratum;
- Cyanobacteria (*Lyngbya, Oscillotoria, Symploca, Calothrix* spp.) are rare (<5% total cover)
- The erect coralline alga *Jania adherens*, and the mat forming green alga *Codium* spp., are rare (i.e., present in < 5% of sample sites);
- CCA characterized as eroded is not a prominent cover type and the proportion of this type does not fluctuate significantly between surveys;
- Variation in cover of crustose corallines is primarily due to reef position (i.e., fore, mid, or inner

reef), reflecting the wave energy and structural gradients across the reef flat; and

- 100% removal of manmade debris including fishing gear and metallic debris from shipwrecks.

Strategies Applied to Achieve Objective:	**Alt A (Current)**	**Alt B (Preferred)**
Continue monitoring abundance and distribution of the cyanobacterial community which became dominant on a section of the southwest arm of the atoll due to elevated iron levels following a 1993 shipwreck (see Objective 6.1)	✓	✓
Within 5 years, work with partners to develop and implement reef monitoring program, including rate of growth, elevation change, chemical composition and other variables related to reef growth and the atoll's ability to maintain itself in an anticipated environment of climate change and ocean acidification (see Objective 6.1)		✓
Within 5 years, develop and implement monitoring protocols to track abundance and distribution of focal perimeter reef species including eels and urchins to determine abundance, density, and biomass of each at selected sites (see Objective 6.1)		✓
Monitor benthic succession of the reef which was damaged due to the 1993 shipwreck (see Objective 6.1)		✓
Within 2 years, establish systematic marine debris removal program		✓

Rationale: The reef crest of Rose Atoll has a pink hue because it is primarily composed of CCA. It varies between 1,000–3,000 feet wide and has a single channel connecting the inner lagoon with the open ocean. Waves can break hard over the reef crest, but during low tides it can be completely exposed. Several of the dominant species of algae on this reef (*Porolithon onkodes, P. craspedium, and P. gardineri*) are reef-building organisms that form a strong and resilient reef platform upon which all the other shallow water organisms depend. Two other cover types on the reef platform are a coralline red algae *Jania* spp. that forms turfs rather than a crust, and areas of eroded and dead coralline algae that are bare reef matrixes without macroscopic algae present.

Reef crest spillway. Jim Maragos, USFWS.

In 1993 a fishing vessel ran aground on the southwest arm of the reef and broke apart. The vessel released roughly 100,000 gallons of fuel, 500 gallons of oil, and 2,500 pounds of ammonia into the environment. This killed a large area of CCA, and facilitated a population explosion of cyanobacteria and non-reef building algae. Major salvage operations began 6 weeks after the wreck and continued until 2007 due to the large tonnage of metal and the difficulty of working on a remote atoll. The ship rocking back and forth in the waves physically damaged the reef by grinding it away. Because iron is a limiting nutrient at remote oceanic atoll locations, the increased iron levels have to a drastic increase in several species of cyanobacteria (*Symploca* spp., *Oscillatoria* spp., *Lyngbia* spp., and *Calothrix* spp.) and turf forming forms of coralline algae near the shipwreck site. These species are not reef building organisms,

Grounded vessel. USFWS.

and in places where they grow in thick mats, reef building corals and CCA cannot compete, so the reef can begin to erode. These species initially formed a carpet, covering large sections of the reef near the wreck. It is vital to control them in order to maintain the reef.

Though the vast majority of the ship has been removed and the area recovering, there are likely scattered pieces on the fore reef continuing to release iron into the water and promoting the growth of cyanobacteria. This, combined with the acute effects of the initial spill and the physical destruction of the reef by the ship, has seriously damaged the CCA near the shipwreck site and recovery efforts would be ongoing.

It is vital to maintain the living coralline algae on these perimeter reefs because they form a growing platform that is resistant to physical and bio-erosion upon which all the shallow water and terrestrial organisms at the Refuge depend. The focal species of urchins serve as indicators of the state of the reef on areas least affected by the shipwreck and areas where subsequent urchin mortality resulted from spilled fuel and cyanobacterial overgrowth. Densities of peppered morays foraging on the reef flat also are an indication of the productivity and health of that habitat. As identified in Figure 1-2 in Chapter 1, the perimeter reef where this work would occur is the exterior boundary of the Refuge which is the extreme low waterline outside the perimeter reef.

2.4.3 Goal 3: Protect and maintain the natural state of the channel (ava) to protect all other Refuge habitats and the hydrology of the lagoon.

Objective 3.1 Protect and maintain the ava.

Protect and maintain the natural state of the ava to support habitats and species with the following attributes:

- Unobstructed water flow between the lagoon and the ocean;
- Geomorphology that supports hydrology of the atoll; and
- Species diversity and biomass of reef builders and reef dwellers, including large predator and prey fishes, remains high.

Strategies Applied to Achieve Objective:	Alt A (Current)	Alt B (Preferred)
Within 5 years, work with partners to monitor water flow rate and direction in the ava using archival pressure and flow rate instruments that can be downloaded at every visit in order to document any changes in flow through the ava (see Objective 6.1)	✓	✓
Work with partners to collect bathymetry data every 10 years in order to document changes in the lagoon, reef, or ava which could affect hydrography or habitat characteristics (see Objective 6.1)	✓	✓

Within 5 years, develop and implement monitoring protocol to track abundance and biomass of fish, including predatory and prey fish species, around the opening of the ava to detect any changes in structure or function of this important geological feature for large predators in the Refuge (see Objective 6.1)		✓
Work toward the inclusion of better warnings about the hazard to mariners of waters in and near the ava to prevent vessel groundings, and improve public communications about the Refuge being closed		✓
Rationale: The shape, size, and location of the ava are vital to maintaining the lagoon, reef, and island habitats. The ava is a small, direct connection between the lagoon and the open ocean. As ocean water spills into the lagoon over the sides of the reef, it is released out through the ava. Though water usually flows out the ava, tides and waves occasionally create a situation where water flows into the lagoon through the ava. The elevation of the ava controls the water movement out of the lagoon, and plays a major role in the layering of lagoon water by temperature and salinity. Additionally, the shape and location of the ava is an important factor in the location and longevity of the islands on the atoll. Water movement inside the atoll creates currents that remove sand from some areas and deposit it in other areas. This sediment transport regime has created and maintained Rose and Sand Islands as islands dynamic in size and shape but located in roughly the same location since Rantzau mapped Rose Atoll in 1873 (Rodgers et al. 1993). The ava is also the major passageway for fish and other organisms in and out of the lagoon, where species that require more shelter from rough water to breed or live may concentrate. Sharks and other predators congregate at the mouth of the ava waiting for prey. For these reasons, it is vital to protect and maintain the ava because it is fundamental to the functioning of many systems in Rose Atoll. Though there are currently no known threats to the ava and it is stable, given potential climate change impacts, constant alertness to changing conditions is important. As identified in Figure 1-2 in Chapter 1, the ava where this work would occur is the exterior boundary of the Refuge where the boundary line is extended between the extreme low waterlines on each side of the entrance channel.		

2.4.4 Goal 4: Restore, protect, and maintain the beach strand habitat to meet the life-history needs of native species in this community.

Objective 4.1 Restore, protect, and maintain beach strand habitat for shorebirds, ground nesting seabirds, and nesting turtles.

Restore, protect, and maintain ≥3 acres of the beach strand on Sand and Rose Islands to support habitats and species with the following attributes:

- Open ground maintained, with native plants (e.g., tamole) occupying the edge between beach strand and littoral forest;
- Free of terrestrial non-native predators and other non-native animals; and
- Free of pest and non-native plants.

Strategies Applied to Achieve Objective:	Alt A (Current)	Alt B (Preferred)
Within 2 years, use GPS to map the perimeter of the islands at high and low tide on each visit to the Refuge and obtain any available satellite imagery for incorporation into GIS in order to document changes in island size and location (see Objective 6.1)		✓

Within 15 years, restore and protect native coastal plants using best available information about original indigenous ecosystem. Restore native tamole (*Portulaca lutea*; a native yellow purslane) population that was extirpated on Rose Atoll by introduced rats (*Rattus exulans*) but survived on an offshore coral block. Monitor survivorship, growth, and maturation of planted tamole (see Objective 6.1)	✓	✓
Within 10 years, investigate the ecological relationships between marine gastropods such as turban shells (*Turbo* spp.), and land hermit crabs (*Coenobita perlatus* and *C. brevimanus*). Evaluate factors affecting crab populations, including observed reduction in availability of shells to crabs at the Refuge and what management may improve mollusk shell availability to the *Coenobita* spp. which are important scavengers and herbivores on both islands (see Objective 6.2)		✓
Within 5 years, work with universities and other partners to evaluate the geomorphology, hydrology, and sediment budget of Rose Atoll to understand the processes that have maintained the islands as dynamic units (see Objective 6.2)		✓
Within 6 months, revise existing biosecurity measures to comprehensively address prevention of introducing non-native pest species to the atoll		✓
Within 2 years, prepare and implement a monitoring plan and rapid response program for terrestrial non-native species and respond immediately if detected (see Objective 6.1)		✓
Within 2 years, working with NOAA/NMFS and other partners, develop and implement monitoring protocol to track turtle abundance and movements using field counts, tagging, remote sensing, and satellite telemetry (see Objective 6.1)		✓
Within 5 years, working with NOAA/NMFS and other partners, develop a cooperative management plan with Fiji to protect shared stocks of threatened green turtles that migrate between Rose Atoll (to nest) and Fiji (to feed). Meet with appropriate Fiji managers as needed		✓
Rationale: Beach strand is a very dynamic habitat that is constantly being reshaped by the wind, waves, currents, and tides. Likely this will be exacerbated by climate change with more storms, changes in sea level, and coral. All of Sand Island can be classified as beach strand, as can the sandy section of Rose Island between the water and the vegetation. During a storm, beach strand habitat can change dramatically, but when conditions are right, it reforms quickly and is stable in the long run. This is the case with the beach strand habitats of the Refuge. After any given storm the islands may change size and shape, but since the area was mapped by Rantzau in 1873 (Rodgers et al. 1993) the location and total area of the islands has remained surprisingly stable. Because the Refuge provides beach strand habitat free of predators since the 1993 eradication of Polynesian rats (*Rattus exulans*) and is far from human populations, it is ideal foraging habitat for wintering shorebirds and nesting habitat for seabirds and green turtles, and possibly hawksbill turtles. The beach strand is used extensively by nesting sooty terns, brown noddies, brown boobies, and green turtles. The Refuge provides the only known rat-free area in American Samoa for several of these ground-nesting species. Part of enhancing this habitat for these birds and fulfilling BIDEH, is restoring		


Turbo shell used by crab. USFWS.

previously extirpated plants such as the tamole. It is a rare plant that used to exist on the beach strand habitat.

Ghost crabs (*Ocypoda* spp.) forage and dig their burrows in the beach strand as well. The land hermit crabs *Coenobtia perlatus* and *C. brevimanus* are numerically and ecologically important in the terrestrial ecosystem of Rose Atoll, serving as the dominant herbivores and scavengers of the system. Densities of these two species have decreased markedly since 1991 and biologists visiting the Refuge have noticed a change in the condition and type of the marine gastropod shells that the crabs are using for their homes. There seem to be fewer of the preferred shells in the genus *Turbo* and those that are being used have more damage and wear. Substitutes such as the partridge tun (*Tonna perdix*) shells are more fragile and presumably offer less protection.


Tava'e'ula (red-tailed tropic bird). Kelsie Ernsberger, USFWS.

Tagging data demonstrates that Rose Atoll and Fiji share a common stock of green turtles. After nesting at Rose Atoll, the turtles migrate directly to Fiji to feed on extensive seagrass beds there (there is little seagrass in American Samoa). A comprehensive recovery plan requires protection at both its nesting and feeding destinations of this species. While turtle harvesting is prohibited in Fiji, enforcement there is difficult due to the hundreds of small islands and remote villages, thus poaching is considered a serious threat. Green turtles are a threatened species with a very small population size at Rose Atoll (est. 24-36 nesting females).

In order to maintain the beach strand as a naturally occurring dynamic habitat which benefits many species, we would control any plant or animal pest species, and monitor the size and shape of the islands to ensure they are maintaining themselves under changing climatic conditions.

2.4.5 Goal 5: Restore, protect, and maintain littoral forest to meet the life-history needs of native species in this community including plants, seabirds, shorebirds, landbirds, waterbirds, reptiles, and land crabs.

Objective 5.1 Restore, protect, and maintain littoral forest.

Restore, protect, and maintain 15 acres of the littoral forest with the following attributes:

- Forest species composition includes a mixture of pu'a vai (*Pisonia grandis*), taukanave (*Cordia subcordata*), tausuni (*Tournefortia argentea*), fotulona (*Hernandia nymphaeifolia*), talie (*Terminalia samoensis*), fao (*Neisosperma oppositifolium*), fau (*Hibiscus tiliaceus*), and all other indigenous species that recruit through natural means and resembling comparable islands in the region that have not been previously affected by rats;
- <5% introduced niu (*Cocos nucifera*) cover of total vegetated area;

• Free of introduced terrestrial non-native predators and other non-native animals; and • Free of pest and non-native plants.		
Strategies Applied to Achieve Objective:	**Alt A (Current)**	**Alt B (Preferred)**
Within 2 years, prepare a monitoring and rapid response program for terrestrial non-native species and respond immediately if detected (see Objective 6.1)		✓
Maintain cover of introduced niu (coconut palms [*Cocos nucifera*]) at or below 5% using mechanical or direct application of herbicides as appropriate (see Appendix G)	✓	✓
Within 2 years, review existing vegetation community distribution data and develop GIS database of terrestrial and marine habitats and update them every 5 years (see Objective 6.1)		✓
Within 3 years and working with experts, prepare a restoration design that identifies which desired species would require active propagation and outplanting and which would recruit naturally now that rat herbivory has been eliminated. Part of this strategy would be to work with universities and other partners to investigate composition and structure of terrestrial communities on Rose Island prior to the introduction of rats to inform ecological restoration activities (see Objective 6.2)		✓
Within 4 years, develop and implement a monitoring protocol to track changes in numbers, cover, and basal area of different plant species (see Objective 6.1)		✓
Within 5 years, implement restoration design and begin outplanting vegetation		✓
Continue monitoring presence or absence of breeding bird populations (annually or less often depending on visit schedule to the Refuge) as one indicator of the success of habitat restoration measures	✓	
Within 3 years, develop and implement a monitoring protocol to track seabird abundance, nesting rates, and feeding territories. Include remote sensing observations to improve future monitoring efforts (see Objective 6.1)		✓
Within 10 years, eradicate the scale insect (*Pulvinaria urbicola*) and any other non-native insects, specifically focusing on eradicating introduced ant species that facilitate scale growth and spread		✓

Fua'o nesting in Pisonia. USFWS.

Rationale: The tropical wet littoral forest ecotype has become very rare in the Pacific Islands due to the value of mesic coastal sites for human habitation. There are no records of the species composition of the forest on Rose Island prior to the introduction of Polynesian rats. When first described, Rose Island had a native plant community made up of only pu'a vai, tamole, and ufi'atuli (Mayor 1921, Setchell 1924, Satchet 1954) and the introduced niu. Presently, the forest is dominated by tausuni but this is a recent change in forest community. Tausuni was not recorded on Rose Island until 1970 (Swerdloff and Needham 1970) but is a good saltwater disperser and often recruits on sandy islets throughout the tropical Pacific. Tausuni is indigenous to the Pacific and provides habitat for tree-nesting seabirds. Since rats were eradicated at the Refuge in 1993, the plant community has been released from this source of seed and seedling herbivory so propagules from indigenous Samoan plants that wash ashore are now able to survive, increasing the total number of species present to at least eight. Factors leading to the decline of the pu'a vai forest and subsequent dominance of tausuni include hurricane damage from six significant storms since 1987, and the introduction of the scale insect. In March 2011, there were only three very unhealthy large pu'a vai trees remaining on Rose Island but a number of seedlings and saplings survive.

The littoral forest on Rose Island provides nesting habitat for the majority of seabird species in the Refuge as well the Pacific reef heron. Various seabirds nest in different parts of the forest with some nesting in the trees and others nesting on the ground. Niu have been planted on Rose Island on several occasions (Satchet 1954). While early attempts to establish niu failed (perhaps due to the presence of the rat), there is presently a thriving population that is spreading rapidly. If no efforts are made to control the niu, it is very possible they would become the dominant vegetation on Rose Island. This would be highly detrimental to seabird populations since the straight trunks of nui do not provide places to build nests, and falling coconuts can crush birds. While eradication of nui is a possibility, it is desirable to maintain a small nui grove due to their importance in Samoan culture.

Invasive ants, including *Pheidole megacephala* and *Tetramorium bicarinatum*, are known to occur on Rose Atoll. These ants are severely disrupting the ecology of the atoll, including facilitating an outbreak of *Pulvinaria urbicola*, an invasive scale insect responsible for killing *Pisonia grandis* trees. These aggressive, predatory ants are also likely reducing numbers of arthropods native to the atoll. Once ants are removed, natural enemies of the scale, such as predaceous beetles and parasitic wasps that may now be prevented from attacking the scale by the ants, would be expected to increase in number and to reduce scale abundances to a level better tolerated by *Pisonia*. *Pisonia* trees are declining throughout their range, and the eradication of ants would facilitate the removal of *Pulvinaria* scale and help in the recovery of an isolated *Pisonia* forest.

The goal of restoring and maintaining the littoral pu'a vai forest community would be a long-term project involving the eradication of non-native or invasive species, the propagation and planting of native forest tree seedlings, and an in-depth monitoring program so we can track the effectiveness of restoration efforts.

2.4.6 Goal 6: Gather scientific information (inventories, monitoring, assessments, and research) to support adaptive management decisions under objectives for Goals 1-5.

Objective 6.1 Conduct high priority inventory and monitoring (survey) activities and scientific assessments.

Conduct inventory and monitoring (survey) activities that evaluate resource management activities to facilitate adaptive management. These surveys contribute to the enhancement, protection, preservation, and management of wildlife populations and their habitats on and off Refuge lands. Specifically, they can be used to determine if we are meeting resource management objectives identified under Goals 1-5. These surveys have the following attributes:

- Long-term monitoring that centers on focal species population status and trends in order to determine if the Refuge is sustaining biological integrity, diversity, and environmental health at current levels;
- Projects would adhere to scientifically defensible protocols for data collection;
- Data collection techniques would require minimal animal mortality or disturbance and minimal habitat destruction;
- Collect the minimum number of samples (e.g., water, soils, vegetative litter, plants, macroinvertebrates, vertebrates) for robust statistical analysis requirements in order to minimize long-term or cumulative impacts; and
- Follow quarantine and cleaning protocols to minimize the potential spread or introduction of non-native and pest species.

Conduct scientific assessments providing baseline information and expanding knowledge on the status of biological integrity, diversity, and environmental health to better inform resource management decisions. These scientific assessments would contribute to the development of Refuge resource objectives and they would also be used to facilitate habitat restoration through selection of appropriate habitat management strategies based upon site-specific conditions. These assessments have the following attributes:

- Use accepted standards, where available, for completion of assessment; and
- Scale and accuracy of assessments would be appropriate for development and implementation of Refuge habitat and wildlife management actions.

The following is a list of priority monitoring and other activities to support resource management decisions on the Refuge:	**Alt A (Current)**	**Alt B (Preferred)**
Finalize Memorandum of Understanding (MOU) with DMWR to coordinate data collection and management activities at the Refuge	✓	✓
Work with partners to deploy an Ecological Acoustic Recorder (EAR) in the ava to collect biological data that may improve monitoring of behavior and abundance of marine organisms	✓	✓
Within 5 years, begin to monitor climate change variables and responses including: sea level, temperature, water quality (pH, conductivity, dissolved oxygen, nitrogen, photosynthetically available light (PAR), phosphorus, iron) and the frequency and duration of extreme storm events	✓	✓

Work with partners to monitor status and trends of focal communities (hard corals, algae), including the incidence and severity of coral and algal disease and bleaching	✓	✓
Within 5 years, monitor the growth and survival rate of coral colonies at different depths		✓
Work with partners to conduct REA to document habitat associations and species distribution, density, and diversity in marine habitats (see Objective 1.1)	✓	✓
Work with NOAA's CRED and other partners to collect oceanographic and water quality data in order to track changes that could affect the reef or wildlife (see Objective 1.1)	✓	✓
Within 5 years, develop and implement monitoring protocols to track populations of focal lagoon species including: fish, corals, giant clams (faisua), other invertebrates, and marine pests to determine abundance, density, and biomass of each at selected sites (see Objective 1.1)		✓
Work with partners to collect bathymetry data every 10 years in order to document changes in the lagoon, reef, or ava which could affect hydrography or habitat characteristics (see Objectives 1.1, 3.1)	✓	✓
Within 5 years, develop and implement monitoring protocols to track abundance and distribution of focal perimeter reef species including eels and urchins to determine abundance, density, and biomass of each at selected sites (see Objective 2.1)		✓
Continue monitoring abundance and distribution of the cyanobacterial community which became dominant on a section of the southwest arm of the atoll due to elevated iron levels following a 1993 shipwreck (see Objective 2.1)	✓	✓
Monitor benthic succession of the reef which was damaged due to the 1993 shipwreck (see Objective 2.1)		✓
Within 5 years, work with partners to develop and implement reef monitoring program, including rate of growth, elevation change, chemical composition, and other variables related to reef growth and the atoll's ability to maintain itself in an anticipated environment of climate change and ocean acidification (see Objective 2.1)		✓
Within 5 years, work with partners to monitor water flow rate and direction in the ava using archival pressure and flow rate instruments that can be downloaded at every visit in order to document any changes in flow through the ava (see Objective 3.1)	✓	✓
Within 5 years, develop and implement monitoring protocol to track abundance and biomass of fish, including predatory and prey fish species, around the opening of the ava to detect any changes in structure or function of this important geological feature for large predators in the Refuge (see Objective 3.1)		✓

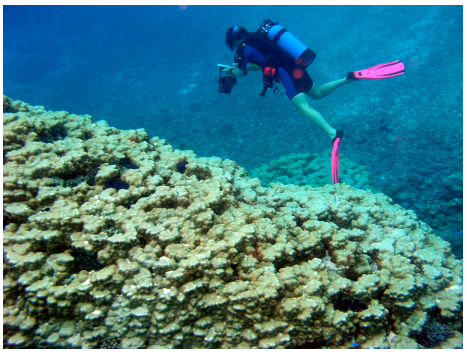
Within 2 years, working with NOAA/NMFS and other partners, develop and implement monitoring protocol to track turtle abundance and movements using field counts, tagging, remote sensing and satellite telemetry (see Objective 4.1)		✓
Within 2 years, use GPS to map the perimeter of the islands at high and low tide on each visit to the Refuge and obtain any available satellite imagery for incorporation into GIS in order to document changes in island size and location (see Objective 4.1)		✓
Monitor survivorship, growth, and maturation of outplanted tamole (see Objective 4.1)		✓
Within 2 years, prepare and implement a monitoring plan and rapid response program for terrestrial non-native species and respond immediately if detected (see Objectives 4.1 and 5.1)		✓
Within 2 years, review existing vegetation community distribution data and develop GIS database of terrestrial and marine habitats and update them every 5 years (see Objective 5.1)		✓
Within 4 years, review available vegetation data and develop and implement a monitoring protocol to track changes in numbers, cover, and basal area of different species (see Objective 5.1)		✓
Within 3 years, develop and implement a monitoring protocol to track seabird abundance, nesting rates, and feeding territories. Include remote sensing observations to improve future monitoring efforts (see Objective 5.1)		✓
Within 2 years, develop and implement a monitoring protocol to track changes in numbers, cover and basal area of different plant species (see Objective 5.1)		✓

Tamole to transplant for restoration. Jiny Kim, USFWS.

Rationale: The Administration Act requires us to "monitor the status and trends of fish, wildlife, and plants in each refuge." Surveys would be used to track populations and abiotic variables in order to assess progress toward achieving refuge management objectives (under Goals 1-5 in this CCP) derived from the Refuge System mission, refuge purposes, and maintenance of BIDEH (601 FW 3). Determining resource status and evaluating progress toward achieving objectives is essential to implementing adaptive management on DOI lands and waters as required by policy (522 DM 1). Specifically, results of surveys would be used to refine management strategies over time in order to achieve resource objectives. Surveys would provide the best available scientific information to promote a transparent decision making process for resource management on refuge lands and waters.

Monitoring data would help us track the effects of climate change and ocean acidification on the Refuge. As a living reef, built and maintained by CCA, corals, and other calcifying organisms, Rose Atoll will be particularly susceptible to sea level rise and ocean acidification. As the sea rises, the reef will need to

grow faster to maintain the same elevation in relation to sea level, but at the same time, the concentration of carbonate ions (the calcifying organisms needed to build the reef) will be declining due to ocean acidification and coral bleaching will become more common as the ocean warms. Monitoring the growth of the reef and abiotic factors would help us understand what is happening to the reef and predict and plan for future conditions. Where applicable, monitoring would also tie into a larger remote sensing system.



Monitoring Porites lutea. Jim Maragos, USFWS.

In accordance with DOI policy for implementing adaptive management on refuge lands (522 DM 1), appropriate and applicable environmental assessments are necessary to determine resource status, promote learning, and evaluate progress toward achieving objectives whenever using adaptive management. These assessments would provide fundamental information about biotic (e.g., vegetation data layer) as well as abiotic processes and conditions (e.g., soils, topography) that are necessary to ensure that implementation of on-the-ground resource management achieve resource management objectives identified under Goals 1-5.

Objective 6.2 Facilitate high-priority research at the Refuge to directly support management objectives and guide management decisions.

Facilitate research projects that provide the best science for habitat and wildlife management on and off the Refuge. Scientific findings gained through these projects would expand knowledge regarding life-history needs of species and species groups as well as identify or refine habitat and wildlife management actions. Research also would reduce uncertainty regarding wildlife and habitat responses to Refuge management actions in order to achieve desired outcomes reflected in resource management objectives and to facilitate adaptive management. These research projects have the following attributes:

- Focus wildlife population research on assessments of species-habitat relationships. Develop models that predict wildlife response to management;
- Design and conduct issue-driven (problem-driven) research unlikely to be reliably addressed using long-term monitoring. Develop models that predict wildlife response to management;
- Promote Refuge research and science priorities within the broader scientific community. Ensure that cooperative research focuses on meeting information needs identified in biological goals and objectives;
- Assigns a high priority to the collection of information that would better predict, understand, and address the effects of climate change and ocean acidification on fish, wildlife, and their habitats at all spatial scales in the Refuge, as well as the ability of managers to meet CCP objectives in response to climate changes;
- Adhere to scientifically defensible protocols for data collection in order to develop the best science for resource management;
- Data collection techniques would have minimal animal mortality or disturbance and minimal habitat destruction;
- Collect the minimum number of samples (e.g., water, soils, vegetative litter, plants, macroinvertebrates, vertebrates) to meet robust statistical analysis requirements in order to minimize long-term or cumulative impacts;

- Follow quarantine and cleaning protocols to minimize the potential spread or introduction of non-native and pest species; and
- Often result in peer-reviewed articles in scientific journals and publications and/or symposiums.

The following is a prioritized list of research to support resource management decisions on the Refuge:	**Alt A (Current)**	**Alt B (Preferred)**
Within 10 years, characterize nutrient budgets and dynamics at Rose Atoll and evaluate them relative to data from other similar reef sites to identify possible stressors and the positive effects of healthy seabird colonies adjacent to living reefs (see Objective 1.1)		✓
Within 5 years, work with universities and other partners to evaluate the geomorphology, hydrology, and sediment budget of Rose Atoll to understand the processes that have maintained the islands as dynamic units (see Objective 4.1)		✓
Within 10 years, investigate the ecological relationships between marine gastropods such as turban shells (*Turbo* spp.), and land hermit crabs (*Coenobita perlatus* and *C. brevimanus*). Evaluate factors affecting crab populations, including observed reduction in availability of shells to crabs at the Refuge and what management may improve mollusk shell availability to the *Coenobita* spp., which are important scavengers and herbivores on both islands (see Objective 4.1)		✓
Within 3 years, work with universities and other partners to investigate composition and structure of terrestrial communities on Rose Island prior to the introduction of rats to inform ecological restoration activities (see Objective 5.1)		✓

Pisonia research. Jim Maragos, USFWS.

Rationale: Rose Atoll is unique in the Samoan archipelago in being a coralline algal atoll. Research projects on Refuge lands and waters would address a wide range of natural resource questions. Examples of research projects include habitat use and life-history requirements for particular species, practical methods for habitat management and restoration, extent and severity of environmental contaminants, techniques to control or eradicate pest species, effects of climate change, and ocean acidification on environmental conditions and associated habitat and wildlife response, identification and analyses of paleontological specimens, wilderness character, and modeling of wildlife populations. Projects may be species-specific, Refuge-specific, or evaluate the relative contribution of the Refuge to larger landscape (e.g., archipelago, regional, Pacific, global) issues and trends. Like monitoring, results of research projects would expand the best available scientific information and potentially reduce uncertainties to promote transparent decision-making processes for resource management over time on the Refuge and other protected areas. In combination with results of surveys, research would promote adaptive management on the Refuge. Scientific publications resulting

from research on the Refuge would help increase the understanding of the Refuge System for resource conservation and management in the larger science realm.

2.4.7 Goal 7: Strengthen resource conservation and the public's shared stewardship of the ecological, geologic, and cultural richness of the Refuge by providing outreach, interpretation, and environmental education opportunities.

Objective 7.1 Enhance and expand interpretation and outreach.

Provide high-quality interpretation and outreach that supports a knowledgeable public who are aware of the conservation provided by the Refuge. The public is informed about the Refuge's complex ecosystem, cultural connections, geologic history, and management challenges by focusing on "bringing the Refuge to the people, instead of the people to the Refuge." Interpretation and outreach associated with the Refuge would have the following attributes:

- People are exposed to at least one of the four key interpretive themes regarding:
  - Ecology;
  - Geology;
  - Culture; and
  - the NWRS;
- Products and messages engage a diverse audience from American Samoa and across the United States and Oceania;
- Outreach and interpretation use standard media as well as social media and evolving technologies; and
- Supports the Service's "Connecting People with Nature" emphasis.

Strategies Applied to Achieve Objective:	Alt A (Current)	Alt B (Preferred)
Install minimal signage on Rose Island to inform people of Refuge boundary and regulations	✓	✓
Maintain Refuge Website and update at least annually with current information such as species lists, interactive tools, management updates, news releases, science reports, etc.	✓	✓
Develop brochures, Website and utilize social media and other outreach tools specifically designed to communicate Refuge protection and safety issues and make these available to mariners		✓
Develop outreach messages using social media such as blogs or interpretive videos on line to "bring the Refuge to the people"		✓
Explore opportunities and community interest for supporting the development of a Refuge "Friends" group to help with interpretation, outreach, and other Refuge needs		✓
Develop a Refuge volunteer program to provide local and national stewardship opportunities and assist in Refuge management activities		✓

Work with partners (especially within the Manu'a Islands) to develop interpretive displays and printed materials to provide outreach messages at visitor centers as well as mobile displays for traveling exhibits		✓
Participate in community meetings and local events to educate people about the Refuge, especially within the Manu'a Islands	✓	✓
Enhance law enforcement through the production of interpretive brochures for distribution in American Samoa and to the yachting community and collaboration with the USCG and NOAA for enforcement		✓
Work with partners to deploy an EAR in the ava to collect data on boat entry into the lagoon		✓

Rationale: The mission of the Service is "working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people." As reflected in the first three words, the Service acknowledges that we cannot effectively carry out our enormous natural resource management mission single-handedly. Thus, outreach is needed to enlist the support of a wide range of people and agencies by improving communications with them. The fundamental purpose of Service outreach is to build understanding, trust and support from a variety of groups by helping them understand what the Service does and why we do it.

Because the Refuge is closed to the general public due to the hazards of getting there and the sensitivity of the resources to disturbance, visits to the Refuge are rare and require a SUP. Therefore, our interpretation and outreach program would be based on "bringing the Refuge to the people," instead of bringing the people to the Refuge. In order to reach people, we would work with our partners to establish Refuge displays for visitor centers in American Samoa, and develop outreach materials and social media capacity to provide other interpretive opportunities for people in American Samoa and around the world.

The Service did not have staff stationed in American Samoa before February 2011, so the public often confuse the Service with the DMWR or the NPS. Few people are aware of the Service in American Samoa and what we do. Messages describing the Service and the Refuge System need to be developed, along with good communications with a variety of people and organizations. Good communication with elected officials is essential for the Service to be effective and responsive to the American Samoa public. Conservation groups have a great interest in resource management, and their support can influence others. Businesses can be a source of funding or support through partnerships. Other Federal agencies, as well as American Samoa and village governments, can help give momentum to the Service's outreach initiatives, and their support can enhance a project's likelihood of success. Finally, the news media can directly inform mass audiences. Each of these can have a significant bearing on how effectively the Service's mission is accomplished and the Refuge achieves its goals.

Objective 7.2 Develop environmental education products and programs to perpetuate and enhance knowledge and appreciation of wildlife, habitat, and their importance to American Samoa culture and the world.

Provide a high-quality EE program associated with Rose Atoll National Wildlife Refuge with the following attributes:

- Focuses on students in American Samoa from pre-K through college;
- Involves local teachers to ensure program is relevant to local students and curricula;
- Incorporates measurable learning objectives and uses audience-appropriate curricula; and

• Supports and complements the Service's mission, and the Refuge's purpose(s) and goals.		
Strategies Applied to Achieve Objective:	**Alt A (Current)**	**Alt B (Preferred)**
Create EE materials such as DVDs and posters for use with school groups		✓
Work with partners to develop EE curriculum and classroom materials that introduce students to American Samoa wildlife, protected areas, and conservation of natural resources, especially in relation to effects from man-made climate change		✓
Partner with schools and universities to conduct surveys and/or relevant research		✓
Explore appropriate on-site EE opportunities (<once every 3 years) to allow a small group of teachers and students (<10 people) to visit the Refuge for specific EE purposes developed with the Refuge's EE program		✓
Develop a brief, picture-oriented PowerPoint presentation describing the ecology of the Refuge and present this to three American Samoa schools each year		✓
Develop a student intern program with the Refuge office to introduce students to protected areas and wildlife management		✓
Rationale: American Samoa is a rapidly changing society which is in the process of enhancing EE in the schools' curriculum. This creates an excellent opportunity for the Service to play a role in helping to develop EE programs. As a small Refuge with a small staff, working with our partners would be vital to the success of any EE program. Because we manage a coral crustose coralline algal atoll in American Samoa, the Service is in a position to educate people about the effects of climate change and ocean acidification. In the past, the Service has had a very limited EE program. There have been rare trips to the Refuge for teachers and students, but these trips are very expensive, can only be done with strict biological restrictions in place to avoid disturbance, and only reach a handful of students. We would be able to reach many more students through outdoor programs, classroom presentations and activities, and internship programs. We can include people outside of American Samoa with an improved presence on the Internet and the development of classroom materials "bringing the Refuge to the people, instead of the people to the Refuge."		

2.4.8 Goal 8: Identify, protect, preserve, and interpret the Refuge's Samoan cultural resources and facilitate, where appropriate, cultural practices.

Objective 8.1 Encourage and facilitate identification, protection, perpetuation, and interpretation of Samoan cultural resources, practices, and traditions related to Rose Atoll.		
Strategies Applied to Achieve Objective:	**Alt A (Current)**	**Alt B (Preferred)**
Research the history of Samoan names for Rose Atoll and consider changing Refuge name accordingly		✓

Work with the American Samoa Historical Preservation Office to conduct an archaeological survey at Rose Atoll		✓
Consult with the OSA and local villagers to understand and perpetuate Refuge-appropriate traditional cultural practices related to Rose Atoll		✓
Work with partners to collect and compile oral histories from village leaders		✓
Work with the partners to create information materials such as videos, reports, and pamphlets regarding cultural uses and the oral history of Rose Atoll	✓	✓
Restore the cement monument erected on Rose Island during the Governor's 1920 visit		✓

Representatives from Manu'a on a 2011 cultural visit to Rose Atoll. Raymond Morse.

Rationale: During public meetings held in 2009 at the beginning of the CCP process, people expressed the desire that the oral history and cultural resources and traditions of Rose Atoll be preserved. There was also the desire that the Samoan people be allowed some access to the Refuge for cultural practices. The Service recognizes that observing and perpetuating cultural practices and resources is an essential part of Samoan heritage and we would work closely with the OSA and villages to protect these resources and manage the Refuge consistent with fa'a Samoa (the Samoan way).

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