U.S. PACIFIC REMOTE INSULAR AREAS

The U.S. has sovereign Federal jurisdiction over eight low coral islands, atolls, and reefs in the central Pacific that are not under the control of other U.S. territories or states. They are Rose Atoll (see American Samoa Section's Figure AMSAM-1), at the east end of American Samoa; Wake Atoll, north of the Marshall Islands; Johnston Atoll, southwest of the Hawaiian Islands; Kingman Reef, Palmyra Atoll, and Jarvis Island, all in the northern Line Islands; and Howland Island and Baker Island, northwest of the Phoenix Islands (Figure PRIA-1). The U.S. Pacific Remote Insular Areas (PRIAs) span latitudes from 19°N to 14°S, include three islands on the Equator, and serve as natural reef laboratories to monitor the effects of oceanic processes and climate over time and space because of minimal anthropogenic impacts. All of the PRIAs were free of human habitation at the time of their discovery by Americans and Europeans two centuries ago, although Rose and Wake Atolls have local island names (Nu'u O Manu and Enen Kio, respectively) and were periodically visited by Samoans and Marshallese, respectively. These eight remain among the most remote and pristine coral reefs in the world.

All eight PRIAs except Wake Atoll are NWRs administered by the FWS, and are among the Nation's most important MPAs. Rose Atoll is under the joint jurisdiction of the FWS and the Department of Commerce in cooperation with the Territory of American Samoa (WPRFMC 2001).[15] Wake Atoll is under the jurisdiction of DOI and presently serves as a military base under the administration of the U.S. Air Force.

The PRIAs provide key habitats for many native species of plants, insects, birds, reptiles, marine mammals, and thousands of reef species. Many nationally and internationally recognized threatened, endangered, migratory, vulnerable, and depleted species thrive and are protected at the PRIAs, including the green turtle, hawksbill turtle, coconut crab, pearl oyster, giant clams, reef sharks, groupers, humphead wrasse, bumphead parrotfish, whales, and dolphins.

Although historically spared of impacts that degrade reefs near more populated U.S. areas, these remote oceanic and reef ecosystems have suffered from a variety of human impacts since the mid 19th century, including guano mining, feather gathering, sea turtle harvest, alien species predation, fishing, temporary settlements, ship groundings, World War II era military occupation, and atmospheric missile and nuclear weapons testing. Remoteness was a blessing in past centuries, keeping these areas generally free of anthropogenic effects, but now they are the targets of fishers and trespassers beyond the watchful eye and reach of enforcement and surveillance authorities, and threatened by unauthorized harvests and the invasive species that accompany them (J. Maragos, personal communication). Derelict debris, ship groundings, fuel spills, hazardous/toxic waste, and climate change are additional impacts. Although the FWS has been successful in eradicating alien rats and cats from most PRIA refuges, rats and mice remain at Palmyra, and invasive ants and scale insects are now decimating rare beach forest stands at Rose and Palmyra.

Lagoon, reef, and island habitats at Palmyra, Wake, Johnston, and Baker still suffer from the residual effects of coastal construction and dumping of contaminants, toxics, and debris, exacerbating some of the adverse effects of climate change and degrading the resilience of resident species, populations, and habitats.

The remoteness of the PRIAs has also thwarted access to and scientific characterization of these areas, including terrestrial, shallow reef, and deep sea habitats surrounding the islands. Before NOAA-sponsored research cruises began in 2000, there was little information available for proper management, recovery of species, and restoration of habitats, especially in marine waters. Even today very little is known about marine habitats below diving depths of about 30 m. Scuba diving at the PRIAs is also constrained by the great distance to the nearest medical facilities, and scuba divers must emphasize safety and accident prevention via limitations on maximum depth, duration, and frequency of diving. Hence, future data collection must rely more on alternatives to scuba, especially remote sensing data collection. Moreover, FWS terrestrial wildlife biologists, coral reef biologists, and ecotoxicologists have relied on NOAA research vessels and the U.S. Coast Guard to provide access to evaluate, monitor, and restore wildlife and habitats, which presently is the only reliable means of access to the PRIAs.

15 Note: Elements of the American Samoa regional sections of this plan may apply to Rose Atoll, if they are consistent or complementary to the research needs identified in this section.

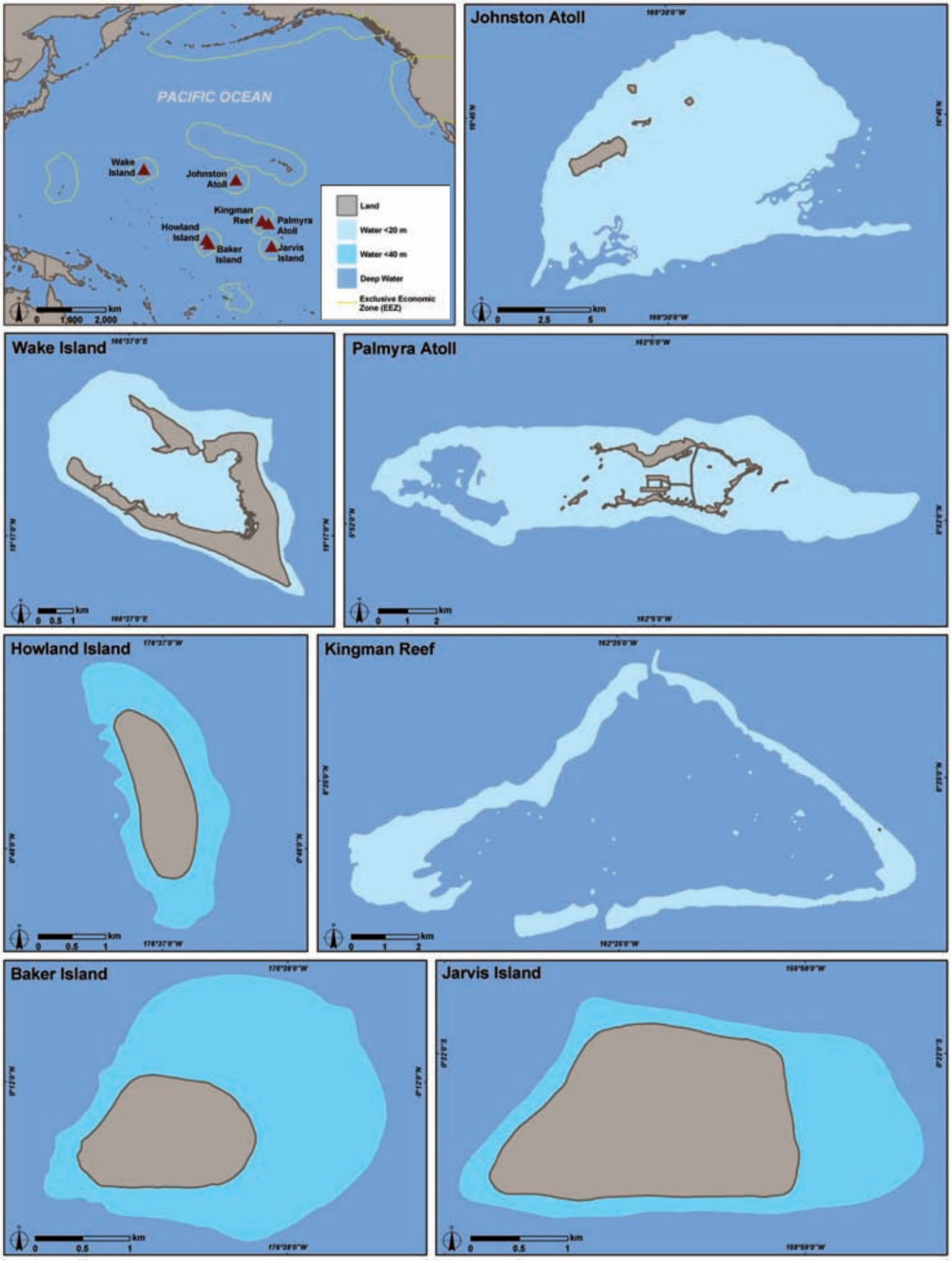

Figure PRIA-1. Locator map for the U.S. Pacific Remote Insular Areas. (See Figure 5 for geographical context.) Map: A. Shapiro. Source: Brainard et al. (2005).

The research needs for the PRIAs address the issues of reduced access, surveillance, enforcement, research, monitoring and management capacity, and takes advantage of NOAA research vessels, satellites, bathymetric mapping platforms, oceanographic buoys, instrumentation, remotely operated and towed vehicles, deep-diving submersibles, and other NOAA assets to address these deficiencies in a spirit of cooperation with FWS, DOI, the U.S. Department of Defense, and other collaborating institutions.

Research Needs

U.S. Pacific Remote Insular Areas	FISHING
Management Objective	***Research Need***
Conserve and manage fisheries to prevent overfishing, rebuild stocks, and minimize destructive fishing.[16] *See Jurisdiction-Wide Section for additional research needs.*	Determine the natural fluctuation of fishery species in the PRIAs to enable comparison with exploited populations outside the NWRs.
	Compare fishery-independent assessments of species in the Samoan archipelago to non-fished stocks at no-take Rose Atoll NWR.
	Evaluate the feasibility of the low-level, catch-and-release recreational bone-fishery at Palmyra NWR[17] and recommend measures to sustain the fishery.
	Assess the recovery of fish populations at Johnston Atoll NWR since closure of the recreational fishery in 2004 when the U.S. military abandoned its presence at the atoll.
Evaluate and improve the effectiveness of MPAs as a fisheries management tool. *See Jurisdiction-Wide Section for additional research needs.*	Develop and establish visual and sonic sensors that can be remotely activated and monitored via satellite to document and discourage unauthorized access and harvest of fish and wildlife resources within the no-take PRIAs, and for application to manage fisheries outside refuges.
	Assess targeted fishery species within and outside refuges to demonstrate the values of no-take areas in replenishing overfished stocks outside the refuges.

U.S. Pacific Remote Insular Areas	POLLUTION
Management Objective	***Research Need***
Reduce the impacts of pollutants on coral reef ecosystems by improving the understanding of their effects. *See Jurisdiction-Wide Section for additional research needs.*	Characterize the ecological impacts of land-based discharges on lagoon water quality at Palmyra Atoll NWR, and evaluate potential ecological benefits of restoration alternatives.
Improve water quality by reducing land-based pollutant inputs and impacts on coral reef ecosystems. *See Jurisdiction-Wide Section for additional research needs.*	Determine the need for remediation of contaminants (i.e., unexploded ordnance, fuel spills, other toxic and hazardous waste, material disposal, and historic sewage discharges in lagoon, reef, and coastal areas) on Johnston, Palmyra, and Baker NWRs, and at Wake Atoll.
	Evaluate the impacts of pollutants at Palmyra, Johnston, Midway, and Baker NWRs, and at Wake Atoll, and evaluate the efficacy of alternative measures to restore habitats.
	Assess, model, and monitor planned restoration of water quality and circulation within the lagoon at Palmyra Atoll NWR degraded by World War II military construction.

16 Note: commercial fishing is prohibited within the eight remote Pacific NWRs.

17 Researchers working at Palmyra Atoll should consult with the FWS, NOAA, the Western Pacific Regional Fishery Management Council, The Nature Conservancy, and researchers at Scripps Institution of Oceanography.

U.S. Pacific Remote Insular Areas	POLLUTION
Management Objective	***Research Need***
Monitor coral reef condition to understand and address unexpected changes or events related to land-based and atmospheric pollution.	Implement a detailed monitoring program, in collaboration with FWS at the eight NWRs and Department of Defense and DOI at Wake Atoll, including multiple depth regimes and permanently-marked sites to determine the impact of previous disturbances and characterize future changes.

U.S. Pacific Remote Insular Areas	COASTAL USES
Management Objective	***Research Need***
Assess the impacts from former recreational use and coastal development on coral reefs.	Assess lagoon and shoreline impacts attributed to World War II era military construction on Johnston and Wake Atolls, and evaluate the efficacy of possible remedial measures.
Balance resource use to minimize user conflicts, provide equitable uses, and ensure optimal benefits to present and future generations.	Provide data to support the preparation and coordination of comprehensive conservation plans by the FWS for the eight PRIAs refuges.
Reduce impacts from and restore habitat damaged by vessel anchoring and groundings.	Evaluate the use of deep sea in situ assets to survey possible shipwreck sites at Baker and other PRIAs.
	Develop a response plan with the FWS and U.S. Coast Guard to conduct initial damage assessments of fuel spills and ship groundings in the NWRs.
	Assess the impacts of fuel spills and ship groundings on PRIA reefs during and after shipwreck removal and other restoration actions.
	Assess the ecosystem recovery after the completion of wreckage removal in 2005 of a 1993 fishing vessel grounding offshore at Rose Atoll.
	Assess the ecosystem recovery of the 1991 fishing vessel grounding at Palmyra Atoll.
Protect, conserve, and enhance the recovery of protected, threatened, and other key species.	Conduct research aimed at the protection, conservation, and recovery of protected species (i.e., marine mammals, sea turtles, and birds) that utilize coral reef ecosystems.
Restore injured and degraded coral reef habitats. *See Jurisdiction-Wide Section for additional research needs.*	Evaluate the deep sea World War II era dumping of military material off Baker Island NWR, and possibly off other refuges.
Manage coral reef ecosystems and their uses in a holistic manner. *See Jurisdiction-Wide Section for additional research needs.*	Describe species diversity, trophic structure, and associated dynamics of shallow coral reef ecosystems in the eight islands in the PRIAs.

U.S. Pacific Remote Insular Areas	INVASIVE SPECIES[18]
Management Objective	***Research Need***
Minimize the introduction and spread of alien species.	*See Jurisdiction-Wide Section for research needs.*
Control or eradicate invasive species that have potential to cause damage to coral reef ecosystems.	Document the diversity, distribution, and abundance of invasive species, identify impacts on coral reef ecosystems, and identify ways to prevent their spread.

U.S. Pacific Remote Insular Areas	CLIMATE CHANGE
Management Objective	***Research Need***
Minimize the effects of climate change on coral reef ecosystems. *See Jurisdiction-Wide Section for additional research needs.*	Collect and analyze coral cores for past climatic events, and conduct assessments to identify active coral bleaching events denoting bleached vs. non-bleached species.
Mitigate the impacts from climate change on coral reef ecosystems.	Restore lagoonal circulation at Palmyra degraded by World War II construction and track the ability of these actions at preventing a repeat of the massive bleaching event and coral die-off on the western terrace that was associated with the discharge of heated lagoonal waters.
	Model the effectiveness of various measures to maximize lagoon circulation and flushing at Palmyra and reduce water residence time in the lagoon to reduce heating of lagoon waters before exiting the lagoon.

U.S. Pacific Remote Insular Areas	EXTREME EVENTS
Management Objective	***Research Need***
Identify causes and consequences of diseases in coral reef ecosystems and mitigate their impacts. *See Jurisdiction-Wide Section for additional research needs.*	Evaluate the impacts of episodic wave events and the role of these events in forming and maintaining spatial and vertical distributions of corals, algae, and fishes.
	Characterize the prevalence of disease, and document affected species and the types of diseases present at each site to serve as a baseline.

18 To prevent introduction of alien species during research activities in the PRIAs, the hulls of NOAA research ships should be scrubbed and cleaned of fouling organisms just prior to departure to the PRIAs. Also, scuba gear should be decontaminated when diving in different areas to prevent introduction of pathogens.

Jurisdiction-Wide Research Needs

Broad overarching research needs that apply to all jurisdictions (except where noted) are based on the discussion in Part I of this Plan and are presented below. Research needs that are specific to a jurisdiction are detailed under the sections entitled *Jurisdiction-Specific Research Needs*.

RESEARCH SUPPORTING MANAGEMENT

Fishing

ALL JURISDICTIONS	FISHING
Management Objective	***Research Need***
Conserve and manage fisheries to prevent overfishing, rebuild stocks, and minimize destructive fishing.	Determine the population status of managed reef species using fishery dependent and independent programs.
	Determine the level of fishing pressure and the distribution of effort for subsistence, recreational, and commercial fisheries, and the impact of these activities on fisheries resources and coral reef habitats.
	Determine the effects of habitat degradation and loss of coral on fish community structure and stability.
	Determine the effects of various fisheries (gear and techniques) on coral reef ecosystems, including physical impacts on habitat, trophic effects, and incidental catch; and identify alternatives to minimize impacts.
	Determine the effectiveness of fishery management actions, including size limits and seasonal closures.
	Determine the current status and locations of reef fish spawning aggregations.
	Characterize fish movements and habitat utilization patterns of different life stages to assist in the identification of essential fish habitat.
	Characterize the life histories of important fish species and their movement patterns within and among different habitats.
	Characterize recruitment patterns for commercially and ecologically important species.
	Quantify fish community structure including size, diversity, and abundance among reefs and across multiple habitat types.

Pollution

ALL JURISDICTIONS	POLLUTION
Management Objective	***Research Need***
Reduce the impacts of pollutants on coral reef ecosystems by improving the understanding of their effects.	Ascertain pollutant loads, their primary sources, flow rates, and transport pathways, and net flow rate (flux) to coral reef communities.
	Determine atmospheric deposition rates and concentrations of pollutants on coral reefs.
	Identify the component(s) in air samples from dust sources (e.g., Africa and Gobi Desert) and downwind sites that are toxic to coral reef organisms.
	Identify target concentration loading rates and develop bioindicators for pollutants to detect organismal and ecosystem stress at sublethal levels.
	Develop and test indicators for land-based pollutants and prioritize their use in environmental and injury assessments.
	Identify, evaluate, and track anthropogenic activity through the use of biogeochemical and biological tracers, and indicator organisms.
	Investigate algal community dynamics in response to pollutant level changes to determine their utility as an indicator of future changes in coral reefs.
	Investigate microbial organisms as indicators of nutrient, sediment, and chemical pollutants in coral reef ecosystems.
	Integrate current biological monitoring techniques with water quality monitoring data to assess potential affects of water quality on various habitat types and associated organisms.
Improve water quality by reducing land-based pollutant inputs and impacts on coral reef ecosystems.	Quantify, characterize, and prioritize the land-based sources of pollution that need to be addressed based on identified impacts to coral reefs and develop strategies to eliminate, reduce, and mitigate these impacts.
	Evaluate changes in water quality to determine the success of management actions to reduce sediment, nutrient, and chemical pollutants and other factors that degrade water quality.

Coastal Uses

ALL JURISDICTIONS	COASTAL USES
Management Objective	***Research Need***
Reduce the impacts from recreational use, industry, coastal development, and maritime vessels on coral reef ecosystems.	Quantify and characterize, both spatially and temporally, threats from commercial and recreational non-extractive activities and the impact of these activities on coral reef ecosystems, and develop strategies to eliminate, reduce, and/or mitigate these impacts.
	Develop scientific criteria to determine the carrying capacity of the reef ecosystem, and determine the level of recreational use (e.g., diving, snorkeling, and boating) that specific areas can support.
	Design and conduct demonstration projects to evaluate science-based management options for improving shoreline stability, while maintaining coral reef ecosystem functions.
	Identify and apply biological indicators toward quantification and characterization of impacts associated with coastal uses.
	Develop new technologies, construction practices, and management measures to eliminate, reduce, and/or mitigate impacts from coastal uses.
	Conduct research to better understand the economic and social factors of the human dimension and their impact on coral reef ecosystems.
	Quantify and track vessel discharges, spills, and anchor damage, and their impacts on coral reef ecosystems; and recommend mitigation measures.
Protect, conserve, and enhance the recovery of protected, threatened, and other key species. *Research needs related to acroporids are for the Atlantic Ocean only.*	<u>Acroporids</u>
	Identify the historical and current distribution of acroporids, compile this into a GIS database, and analyze spatial changes and relationships with physical, environmental, and anthropogenic factors.
	Assess (region-wide) the abundance and condition of acroporids incorporating colony size and counts per unit area of the different life stages (i.e., colonies, fragments, and new recruits).
	Evaluate the efficacy of measures to reduce anthropogenic stressors (including sedimentation, pollution, eutrophication, climate change, overfishing, and ship groundings) in enhancing recovery of existing populations of acroporids and promoting sexual recruitment.
	Evaluate the effects of storms and other natural stressors (e.g., coral predators) on the destruction and recovery of coral populations, and determine how anthropogenic disturbances may affect these natural processes.
	Evaluate the costs and benefits of various acroporid restoration strategies at promoting recovery of degraded populations, including efforts to reseed areas with larvae, optimal reattachment methods for fragments, and strategies to treat colonies affected by disease, predators, and other natural stressors.
	Identify microbial communities associated with diseased and healthy acroporid colonies; identify how these microbial communities change spatially, temporally, and under varying environmental conditions; and determine relationships between these communities and the health and mortality of colonies.
	Characterize the genetic structure and conduct demographic modeling of acroporid populations to predict population response to future disturbances and stresses encompassing a range of spatial and temporal scales.

ALL JURISDICTIONS	COASTAL USES
Management Objective	***Research Need***
Manage coral reef ecosystems and their uses in a holistic manner.	Assess the extent and condition of deep-water hermatypic coral reef ecosystems and their importance as essential fish habitat.
	Expand ecological and taxonomic understanding of functionally important, but understudied, coral reef ecosystem groups, such as sponges, octocorals, mollusks, polychaetes, crustaceans, echinoderms, tunicates, seagrasses, algae, and microbial diversity.

Invasive Species

ALL JURISDICTIONS	INVASIVE SPECIES
Management Objective	***Research Need***
Minimize the introduction and spread of alien species.	Identify possible vectors and pathways of alien introductions and develop prevention measures, where applicable.
	Determine the threat and impact of hull fouling and ballast water as mechanisms for introducing and dispersing invasive species.
Control or eradicate invasive species that have the potential to cause damage to coral reef ecosystems.	Quantify the presence and evaluate the impact of invasive species on coral reef ecosystems.
	Establish protocols for early detection and eradication of invasive species.
	Develop methods to mitigate impacts of invasive species on coral reef ecosystems and evaluate the efficacy of these methods.
	Develop and evaluate methods to monitor, contain, and sterilize ballast water to prevent introduction of invasive species to coral reef ecosystems.

Climate Change

ALL JURISDICTIONS	CLIMATE CHANGE
Management Objective	***Research Need***
Minimize the effects of climate change on coral reef ecosystems.	Bleaching of Coral Reef Organisms
	Assess the spatial and temporal scales of bleaching of coral reef organisms during identified bleaching events.
	Quantify the relationships between severity of bleaching events and mortality including factors that exacerbate bleaching impacts or confer resistance and resilience.
	Quantify the socioeconomic impacts of coral bleaching events on user groups and the economy and investigate user group perceptions of coral bleaching events.
	Identify factors and their thresholds that cause coral bleaching (including physical parameters, environmental factors, and anthropogenic stressors) and investigate interactions between factors and the severity of bleaching events and the ability of corals to recover from bleaching.
	Identify the potential for coral reefs to adapt to future bleaching events through changes in clades of zooxanthellae in individual species and shifts in taxonomic composition of symbiotic organisms.
	Develop early warning systems for coral reef bleaching based on known or predicted relationships with environmental factors (e.g., temperature and light) and catastrophic pollution events (e.g., oil spills and toxic discharges).
	Develop models to predict long-term impacts to coral reef ecosystems from coral bleaching events and climate change incorporating relationships with environmental and anthropogenic stressors.
	Calcification
	Investigate variations in rates of coral calcification among species, temporally and spatially, and within different life stages, and how those variations may affect survivorship.
	Investigate how differing levels of atmospheric CO_2 will affect ocean pH, carbonate saturation state, and coral calcification and growth rates.
	Quantify the effects of temperature, pH, and aragonite saturation state on calcification, reproduction, and recruitment.
	Measure biogenic $CaCO_3$ production, seawater chemistry, $CaCO_3$ dissolution and accumulation, bioerosion, and off-shelf export of $CaCO_3$ to improve the accounting of coral reef carbonate budgets and predict how reef accretion may change in the future.
	Determine how variations in calcification rates affect associated organisms, food web dynamics, carbon and nutrient cycling, and ecosystem services.
	Examine how reduced saturation states of $CaCO_3$ affect rates of bioerosion.
	Waves
	Determine the relationships among wave energy, coral reef damage, and factors that increase or minimize damage to reefs and coastal communities.
Mitigate the impacts from climate change on coral reef ecosystems.	Determine the effectiveness of management strategies to reduce anthropogenic stressors in mitigating the severity of bleaching.
	Evaluate available tools and develop new tools to quantify and mitigate the impacts of climate change on coral reef ecosystems.
Predict the future composition and condition of coral reefs under various climate change scenarios	Quantify organism and ecosystem responses to climate change and determine their relationships with stressors and pertinent physical, biological, and chemical parameters.
	Examine the impacts of past climate fluctuations on coral community structure.
	Develop tools to detect and describe decadal changes in relation to natural and anthropogenic disturbances.

Extreme Events

ALL JURISDICTIONS	EXTREME EVENTS
Management Objective	***Research Need***
Identify and reduce the incidence of disease in coral reef ecosystems.	Determine temporal and spatial variations in disease prevalence among reef-building coral species across habitats, depths, and varying distances from land and their relationships with environmental factors and anthropogenic stressors.
	Quantify the rates and extent of partial and whole colony mortality from diseases, the effect of partial mortality on individual colonies (e.g., effect on reproduction and growth), and long-term impacts on affected coral reef ecosystems.
	In the event of a major die-off of corals resulting from disease, quantify the ecological and socioeconomic impacts.
	Identify external sources of pathogens (e.g., human sewage and dust) and disease vectors and quantify their distribution and abundance.
	Determine the distribution, abundance, and impact of diseases affecting other ecologically important benthic coral reef invertebrates (e.g., sponges and urchins) and fishes.
	Identify factors that increase the prevalence and impact of diseases (e.g., toxins, pollutants, sedimentation, temperature, and biotic agents), including factors and processes that increase the virulence of pathogens, increase host susceptibility and/or reduce resistance, and contribute to the transmission and spread of diseases.
	Identify and characterize the etiology of key coral diseases, including identification of biotic and abiotic causes.
	Characterize microbial communities associated with corals and coral mucus; the variations among species, seasons, and locations; identify factors that cause variations in microflora; and characterize the consequences of these changes to the host (e.g., shift from a symbiotic association to a disease-causing state).
	Develop standardized nomenclature, diagnostic characteristics, standardized field and laboratory methodologies, and rapid response protocols to enhance the comparability of data, improve capacity to respond to disease outbreaks and report on findings, and to identify viable management responses.
	Develop early warning systems for disease outbreaks based on known or predicted relationships of coral reefs with environmental factors (e.g., temperature and hurricanes) and catastrophic pollution events (e.g., oil spill and toxic discharge).
	Develop models to forecast long-term effects of disease on population dynamics, community structure, and ecosystem function incorporating information on biotic agents, environmental factors, and anthropogenic stressors known or predicted to affect disease prevalence and incidence.
	Characterize healthy and diseased corals on a cellular and physiological level (e.g., histological changes, immunological responses, and production of stress proteins).
	Develop tools to reduce the prevalence of diseases, mitigate their impacts, and treat affected corals.

TECHNOLOGY SUPPORTING RESEARCH & MANAGEMENT

Marine Protected Areas

ALL JURISDICTIONS	MARINE PROTECTED AREAS
Management Objective	***Research Need***
Evaluate and improve the effectiveness of MPAs as a management tool.	Develop site-selection criteria for MPAs to assist in the conservation of coral reef ecosystems and management of commercially important fishery species, taking into account: o Species diversity, trophic structure, and abundance of economically or ecologically important species. o Habitat utilization patterns of different life stages. o Larval recruitment, dispersal, and connectivity (including sources and sinks). o Connectivity between habitat types (including seagrass beds, mangroves, and other associated communities), spawning aggregations, and nursery areas. o Environmental factors and anthropogenic stressors.
	Develop models to predict changes to coral reef resources that may occur under different zoning schemes, taking into account ways to conserve and possibly enhance marine resources.
	Evaluate the effectiveness of MPAs, including no-take reserves and other marine zoning schemes, taking into account: o Abundance of ecologically and economically important species. o Spillover of fishery species into adjacent habitats. o Improvements in the condition of the sessile benthic community and abundance of mobile invertebrates. o Cascading effects on non-target species.
	Develop useful indicators (biophysical and socioeconomic) of management effectiveness.
	Determine the socioeconomic and ecological costs and benefits of MPAs as a management tool, including relationships between levels of compliance and achieved benefits.

Habitat Restoration

ALL JURISDICTIONS	HABITAT RESTORATION
Management Objective	***Research Need***
Restore injured and degraded coral reef habitat.	Identify and test new coral reef restoration strategies, including transplantation and attachment techniques; optimal fragment size, shape, and orientation; ability to withstand high-energy events; and use of environmentally-friendly exotic materials.
	Determine the effectiveness of efforts to collect and settle coral larvae as a restoration tool.
	Design and evaluate techniques to control or eradicate organisms that may inhibit recovery of damaged or degraded habitats.
	Evaluate the effectiveness of current strategies to restore degraded reefs (e.g., culturing corals in a laboratory, transplanting fragments, and creating coral nurseries), taking into account the ability to maintain genetic variability, mitigate source(s) of the damage, maintain the historical distribution of the species within that habitat, and restore habitat function.
	Evaluate effectiveness of restoration techniques for associated habitats, including mangroves, seagrass beds, sandy beaches, and riparian habitats.
	Determine the impacts of exotic materials (e.g., iron, cement, rubber, and fiberglass) on recruitment efficiency, biodiversity, and community structure.
	Evaluate the ecological recovery of restored areas.
	Evaluate the effectiveness of restocking ecologically important species (e.g., *Diadema* and herbivorous fishes), and the costs and benefits of restocking using species raised in captivity versus wild populations.