American Samoa Coral Reefs

Climate Change Vulnerability Assessment Summary

***An Important Note About this Document:** This document represents an initial evaluation of vulnerability for coral reefs based on workshop input and existing information. The aim of this document is to expand understanding of habitat vulnerability to changing climate conditions, and to provide a foundation for developing appropriate adaptation responses.*


Photo by National Park Service

Habitat Description

Coral reefs in American Samoa include three zones: reef flat, reef crest, and reef slope. Reef flats are shallow and narrow (50-500 m) systems extending from shore to the reef crest. Reef crests are shallow systems representing the highest point of the reef system and dividing reef flat from slope; they are occasionally exposed during high tides. Reef slopes descend 20-30 m in depth on the oceanic side from the reef crest. Differences in temperature, salinity, wave action, water depth, and sedimentation between these three zones affects coral community composition. However, American Samoan coral reef communities are generally dominated by crustoce corraline algae with live hard corals being less dominant, and brown macroalgae occasionally occurring on reef slopes and flats.[1,2] Unique coral communities occur at Rose Atoll and Swains Island.[1,3] In general, coral reef systems harbor high biodiversity.[1]

Habitat Vulnerability

Moderate Vulnerability

Low → High

High Confidence

Workshop participants evaluated coral reefs in American Samoa to have a moderate relative vulnerability to climate change due to moderate-high sensitivity to climate and non-climate stressors, moderate exposure to future climate changes, and moderate-high adaptive capacity. Coral reefs are sensitive to numerous climate stressors, including ocean acidification, sea surface temperature, tropical storms, runoff/streamflow, coastal erosion, and currents, mixing, and stratification. These stressors directly affect coral survival, recruitment, and growth, as well as alter water quality by affecting sediment, pollutant, and nutrient delivery. Climate stressors may also increase coral susceptibility to disturbance regimes, including disease and crown-of-thorns starfish outbreaks, which elevate coral mortality. Coral reefs are sensitive to several non-climate stressors, including dredging, land use change, overwater/underwater structures, nutrient loading, seawalls, and fishing. Non-climate stressors can directly degrade and destroy coral communities, and will likely compound declining water quality trends occurring with climate change. Coral reefs in American Samoa are generally healthy and continuous around islands, and have been able to recover from a variety of past environmental disturbances, although they are less resilient to human disturbances. High coral biodiversity enhances overall resilience, but future functional group shifts may occur as many reef-building coral species are vulnerable to climate change, which will impact overall reef stability. Coral reefs provide important commercial and subsistence fishing opportunities, as well as other ecosystem services such as biodiversity, coastal protection, and recreation. A variety of marine protected areas protect a small percentage of existing reef habitat, but protective regulations vary between sites.

Sensitivity

Moderate-High Sensitivity

Low → High

High Confidence

Coral reefs are sensitive to several climate stressors, including ocean acidification, sea surface temperature, tropical storms, runoff/streamflow, coastal erosion, and currents/mixing/stratification. Several stressors (e.g., ocean acidification, temperature) directly affect coral survival, growth, and recruitment, while other stressors affect coral communities indirectly by altering salinity and sediment, nutrient, and pollutant delivery.[2,4] Disturbance regimes, including disease and crown-of-thorns starfish outbreaks, contribute to regional coral mortality.[4] Coral reefs are also sensitive to a variety of non-climate stressors, which aside from destroying, displacing, and altering reef communities, can exacerbate reductions in water quality occurring with climate change.[1,2,4]

SENSITIVITY FACTORS AND IMPACTS*	
CLIMATE STRESSORS	High sensitivity; High confidence
FACTOR	**IMPACT**
Ocean acidification/ pH	• Reduced coral calcification, impairing coral growth and skeleton density and increasing vulnerability to damage, erosion, and mortality,[1] reducing reef stability.[4] • Reduced fitness and recruitment.[4] • May lead to functional group shifts (e.g., macroalgae may become more abundant as coral declines), altering reef structure and complexity.[4]
Warmer sea surface temperature	• More frequent and intense coral bleaching events and enhanced coral mortality,[4] particularly amongst shallow-water *Acropora*, *Millepora*, and *Porites* communities; shallow habitats (flat, crest) are typically affected earliest and most strongly, while reef slopes have historically bleached only during major events.[2] • Increased likelihood of annual bleaching, which can inhibit growth and sexual reproduction and lead to declines in genetic diversity and/or shifts in habitat structure and complexity.[2,4] • Altered coral distribution (e.g., cause colonization of deeper zones, offshore areas, or areas with enhanced water flow).[4] • Impaired coral larval development and enhanced larval mortality, particularly in summer.[4] • Potential shifts in coral phenology (e.g., spawning timing).[4]

* Factors presented are those ranked highest by workshop experts.

† Relevant references for regional climate projections can be found in the Climate Impacts Summary Table.

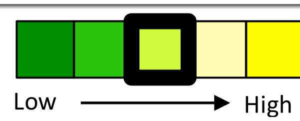
‡ Please note that the color scheme for adaptive capacity has been inverted, as those factors receiving a rank of "High"

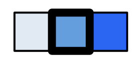
SENSITIVITY FACTORS AND IMPACTS*	
	• Increased susceptibility to disease as corals become thermally stressed. Environment may become suitable for enhanced bacterial growth and for novel coral diseases previously limited by temperature.[4]
Tropical storms	• Wave activity associated with tropical cyclones can overturn corals, causing mortality.[4] • Heavy precipitation associated with tropical cyclones increases sediment and nutrient delivery, which can cause coral mortality via smothering, reduce fecundity, and/or promote algal blooms.[4]
Runoff/ Streamflow	• Altered salinity;[4] flats and lagoons experience strongest salinity changes during high precipitation events. • Impaired water quality due to enhanced sedimentation and pollutant delivery, negatively affecting fitness and potentially increasing coral mortality.[2,4] Impacts are most severe on reef flat and crest, but non-point source pollution can reach the reef slope during rain events.[2] • Impaired water quality due to enhanced nutrient delivery, potentially increasing the likelihood of crown-of-thorn outbreaks.[4]
Coastal erosion	• Enhanced reef sedimentation.
Currents/ mixing/ stratification	• Altered larval dispersal, affecting colonization and colony persistence;[4] coral larval dispersal may increase. • Altered nutrient delivery.[4]
DISTURBANCE REGIMES	High sensitivity High confidence
FACTOR	**IMPACT**
Disease	• Increased coral susceptibility and mortality, particularly as sea surface temperatures rise.[4] • Potential shifts in reef species composition, structure, and complexity.[4]
Crown-of-thorns outbreak	• As coral predators, crown-of-thorns starfish (*Acanthaster planci*) outbreaks can decimate coral communities.[4] • Without rapid recovery, wave action destroys dead corals and reef is lost; recovery may be impaired by climate change.[4]
NON-CLIMATE STRESSORS	Moderate-high sensitivity High confidence
FACTOR	**IMPACT**
Dredging	• Destroys and degrades coral communities.[4] • Equipment use may increase likelihood of invasive species introductions.[1]
Land use change	• Land use changes that reduce vegetative cover (e.g., agriculture, urban development) will likely increase sediment runoff to nearshore coral communities, undermining water quality, fitness, and survival.[1,2,4] • Some activities (e.g., piggeries) increase nutrient and pollutant delivery.[1]
Overwater/	• Can damage or displace corals.

SENSITIVITY FACTORS AND IMPACTS*	
underwater structures	
Nutrient loading	• Impairs water quality and may increase likelihood of crown-of-thorns starfish outbreaks.[4]
Seawalls	• May increase erosion and sedimentation of fronting reefs.[1]
Fisheries	• Indirect effects on coral structure and function by affecting reef ecological processes and food webs (e.g., by removing herbivorous fishes and top predators). It is unknown how these changes will interact with climate change impacts on corals.[5,6]

Exposure†

Moderate Exposure





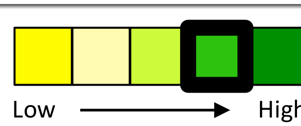
Moderate Confidence

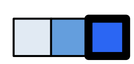
Under future climate conditions over the next 20 years, coral reef communities in American Samoa will likely experience warmer sea surface temperatures, more intense but less frequent tropical storms, increased runoff, and continued coastal erosion. These changes will likely affect coral fitness, recruitment, and survival.[1,2,4]

PROJECTED CLIMATE AND CLIMATE-DRIVEN CHANGES	
CLIMATE STRESSOR	**PROJECTED CHANGES**
Sea surface temperature	Sea surface temperatures in the Pacific Islands are projected to increase +1.1 to +1.7°F by 2030, +1.8 to +2.3°F by 2055, and +2.5 to +4.7°F by 2090.
Runoff & Coastal erosion	Streamflow will likely fluctuate with precipitation patterns, but extreme rainfall events in the Central South Pacific are likely to increase in frequency and intensity. No erosion projections are available.
Tropical storms	Potential reduction in cyclone activity in American Samoa as storm tracks shift toward the Central North Pacific, but potential increases in storm intensity over the next 70 years.

Adaptive Capacity

Moderate-High Adaptive





High Confidence

American Samoa hosts fairly healthy and continuous coral reef communities around its different islands.[1-3] Regional coral communities have been able to recover from some past natural disturbances, but are less resilient to human activities.[2] Coral reefs in American Samoa are incredibly biodiverse,

† Relevant references for regional climate projections can be found in the Climate Impacts Summary Table.

which enhances overall resilience, but many foundational reef-building coral species are particularly vulnerable to climate change, creating the potential for functional group shifts and altered reef stability.[1-4] Coral reefs provide many ecosystem services and are culturally valued for commercial and subsistence fishing.[1,4] Marine protected areas encompass roughly 10% of existing reef habitat, but regulatory goals and protective measures vary between sites.[3]

ADAPTIVE CAPACITY FACTORS AND CHARACTERISTICS‡	
FACTOR	**HABITAT CHARACTERISTICS**
Extent, integrity, & continuity Moderate-high adaptive capacity High confidence	• Tutuila hosts approximately 17.2 square miles of coral reef habitat. An additional 12.3 square miles of habitat occurs amongst the Manua Islands, Rose Atoll, and Swains Island.[1] • Coral reef habitats are continuous around the islands, but fragmented between islands. • Roughly 22% of the coast has high coral cover. Swains Island has high coral cover, but cover is lower on Tutuila and Rose Atoll.[3] • The archipelago's steep topography makes reef slopes more abundant than the shallower reef flat and crest systems.[1] • Overall, American Samoan reefs appear to be in fairly good condition.[2]
Resistance & recovery Low-moderate adaptive capacity High confidence	• American Samoa corals have somewhat been able to recover from past natural disturbances, including crown-of-thorns starfish outbreaks, coral bleaching, hurricanes, and extreme low tide events; recovery begins with crustoce corraline algae followed by hard corals.[2] • Some coral species in Ofu Island backwater pools appear resilient to pH swings and short periods of elevated temperatures.[4] • Corals are less resilient to human-induced stressors (e.g., conversion for human development).
Habitat diversity High adaptive capacity High confidence	• American Samoa hosts over 250 coral species;[1] crustoce corraline algae is dominant, followed by live hard corals, dead corals (not abundant) and brown macroalgae (rare).[1,2] • Corals are keystone species of this habitat, and particularly vulnerable to climate change.[1,2,4] • Some unique coral communities occur on Swains Islands and Rose Atoll; Pago Pago Harbor also has a unique coral community, but this may be an indicator of a community degraded by human activity.[3] • Fagatale Bay National Marine Sanctuary coral reefs provide habitat for 271 fish species and 1400 algae and invertebrate species.[1]
Management potential	• Coral reefs are culturally valued for the subsistence and commercial

‡ Please note that the color scheme for adaptive capacity has been inverted, as those factors receiving a rank of "High" enhance adaptive capacity while those factors receiving a rank of "Low" undermine adaptive capacity.

ADAPTIVE CAPACITY FACTORS AND CHARACTERISTICS‡	
Moderate adaptive capacity High confidence	fisheries they provide. Coral reefs also provide a variety of other ecosystem services, including biodiversity, coastal protection, and recreation. [1,4] • 10% of existing American Samoan coral reefs reside in marine protected areas (MPAs). There are 23 MPAs in American Samoa, including federal, territorial, local, and combined agency MPAs. Regulatory parameters vary between sites: only 3% of existing reef area has no-take restrictions, while an additional 7% has additional regulations (e.g., gear limits, development restrictions).[3] • Workshop participants identified the following management options for coral reefs: reduce runoff, farm resistant corals

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