

FAGATELE BAY



State of the Sanctuary Report

2002



2003



NATIONAL MARINE
SANCTUARIES TM

FAGATELE BAY

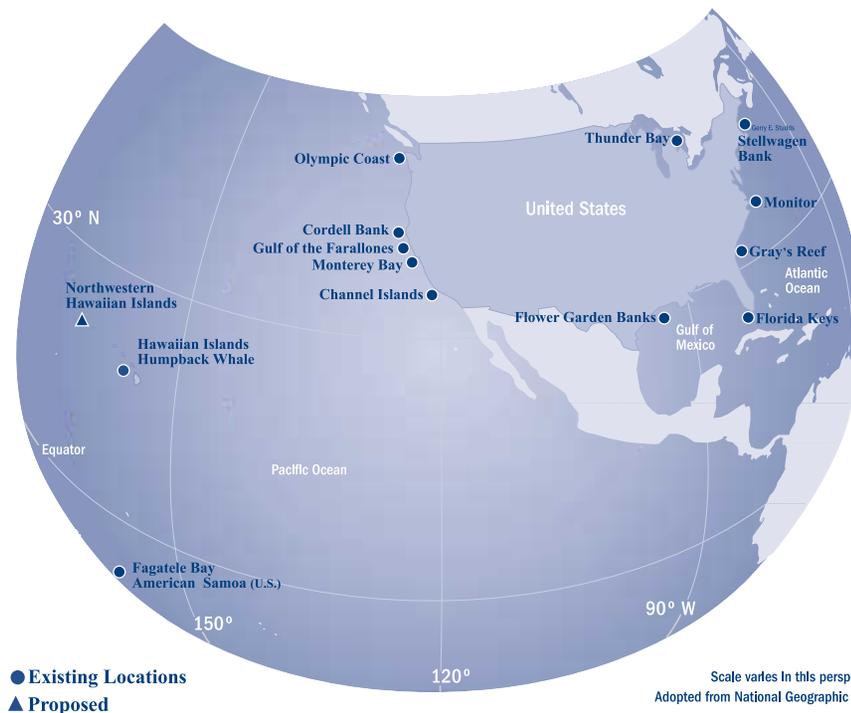


The National Marine Sanctuary Program

The National Marine Sanctuary Program, a network of 13 marine protected areas, encompasses marine and freshwater resources from Washington State to the Florida Keys and from Lake Huron to the Gulf of Mexico, American Samoa, and places in between. The National Oceanic and Atmospheric Administration's National Ocean Service has managed marine sanctuaries since the passage of the Marine Protection, Research, and Sanctuaries Act of 1972. Title III of the Act is now called the National Marine Sanctuaries Act.

Today, our marine sanctuaries contain deep ocean gardens, near-shore coral reefs, whale migration corridors, deep-sea canyons, and underwater archaeological sites. They range in size from one-quarter square mile in Fagatele Bay, American Samoa, to more than 5,300 square miles off Monterey Bay, California — one of the largest marine protected areas in the world. Together, these sanctuaries protect nearly 18,000 square miles of coastal and open ocean waters and habitats. While some activities are managed to protect resources, certain multiple uses, such as recreation, commercial fishing, and shipping, are allowed to the extent that they are consistent with a sanctuary's resource protection mandates. Research, education, and outreach activities are other major components in each sanctuary's program of resource protection.

The National Marine Sanctuary Program is a world leader in effective management, placing a primary emphasis on the protection of living marine resources and our nation's maritime heritage resources.



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Fagatele Bay National Marine Sanctuary [FBNMS]

At 163 acres [0.25 square miles / 0.65 square kilometers], Fagatele Bay is the smallest and southernmost of the National Marine Sanctuaries [NMS]. The American Samoan Government and the National Oceanic and Atmospheric Administration [NOAA] co-administer the Sanctuary. Fagatele Bay NMS sits in the American Samoan Department of Commerce's Natural Resource Management Division. The main office is located in the village of Utulei, near the mouth of Pago Pago Bay.



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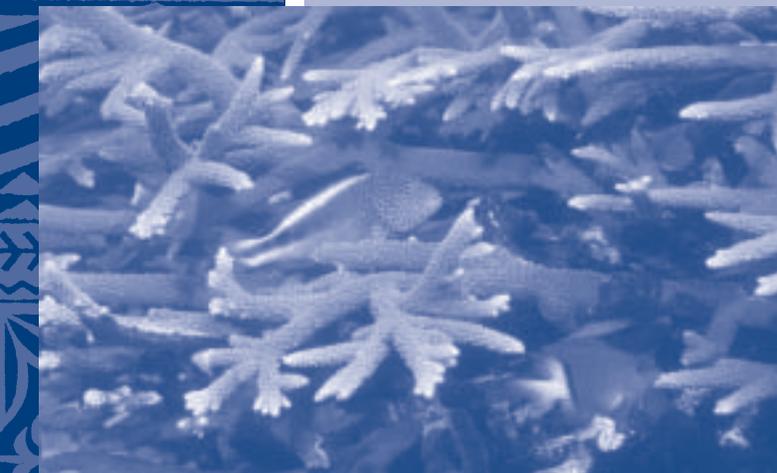
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An Unequaled Beauty



A panoramic view of Fagatele Bay. When something possesses a rare quality that is unequalled, Samoans will say *O le manu sina e le soa*: The beauty of the white tern has no match.
Nancy Daschbach



Branching coral. Mike White

Fagatele Bay National Marine Sanctuary

In March of 1982 the American Samoan Government submitted a proposal to the National Oceanic and Atmospheric Administration [NOAA] to create a National Marine Sanctuary at Fagatele Bay. Featuring an extensive coral reef ecosystem, Fagatele Bay is the only subequatorial sanctuary in the United States. The bay's relative isolation from the rest of the rapidly developing island make it an important refuge for threatened and endangered species. Its protected waters house over 600 species of fish, coral, macro-invertebrates and algae.

The designation process included a series of public workshops, an Environmental Impact Assessment [which discovered no significant adverse impacts], and the development of a draft management plan. When these were completed, Fagatele Bay was designated a National Marine Sanctuary on April 29, 1985.

From the beginning, the American Samoa Government and NOAA have collaborated on management of the sanctuary. This joint administration provides sanctuary staff with close links to both territorial and federal agencies. These links have proven integral to Fagatele Bay's success at implementing its management goals.

Migrants from South East Asia arrived in the Samoan archipelago roughly 3,000 years ago. The descendants of these original inhabitants eventually explored and settled islands across the Pacific Ocean, from Hawai`i to Rapa Nui to New Zealand. Samoa is thus considered to be the cradle of Polynesian culture. Samoan oral histories begin around 1250 CE, when the *aitu*Nafuna [a spirit, or goddess] assisted Samoan armies in driving out Tongan invaders. In the 15th century Salamasina, a female *matai*, or chief, united the islands for the first time.

A civil war broke out in 1899, and the subsequent Western intervention divided the nation into two separate political entities. Today the independent nation of Samoa has jurisdiction over the islands west of 171 degrees longitude, and the Territory of American Samoa comprises the islands to the east. American Samoa's five high volcanic islands and two small atolls total 76 square miles [197 sq km]. Approximately 90% of the territory's 65,400 inhabitants reside on Tutuila, the territory's largest island at 54 square miles [140 sq km].

Samoa culture proved to be extremely resilient in the face of Western contact. The *matai* system of village and family leaders dominates Samoan politics, and day-to-day life still revolves around one's obligations to one's *aiga*, or extended family. Communal values also remain strong, and over 90% of the land in American Samoa remains in *aiga* hands.

American Samoa enjoys a tropical climate, with year-round temperatures averaging over 80 degrees Fahrenheit [27 degrees Celsius]. Rainfall totals almost 200 inches [508 cm] annually at the harbor, and 125 inches [318 cm] a year in the relatively drier Tafuna Plain. The hurricane season extends from November to March. The Samoas lie outside the regular storm track, although hurricanes do occasionally strike shore. The El Nino - Southern Oscillation [ENSO] significantly impacts weather patterns in the archipelago.

Fagatele Bay lies on the southwestern portion of Tutuila. The bay itself is the flooded caldera of an extinct volcano. Steep cliffs bound its waters: Seumalo Ridge rises vertically over 400 feet [122 meters] on the northern and western sides of the bay, and Matautuloa Ridge rises to 200 feet [61 meters] on the eastern side. The cliffs make the bay relatively inaccessible by foot – the only terrestrial access is by a footpath leading to a small sand and rubble beach below Matautuloa Ridge. Fagatele Bay's orientation also shelters it from the main brunt of the large winter swells that pound the island's shores. Thanks to its protected nature, the bay has developed into one of the most vibrant of Tutuila's coral reef ecosystems.

Two major sections characterize the reef: the first is a platform that extends out as far as 650 feet [200 meters] from shore. The second is a steep sloping section that descends down 650 feet [200 meters]. Non-reef features include submarine cliffs, deep holes, and volcanic rock outcroppings. The cliffs surrounding the bay are home to one of America's rare paleotropical rainforests.

An invasion of the crown-of-thorns starfish [*Acanthaster planci*] severely damaged the reef in the late 1970's. These voracious predators devoured close to 90% of the living coral in the bay. At the time scientists viewed this as an ecological disaster, and believed that it would take the reef centuries to repair itself. The opportunity for researchers to study how a coral reef ecosystem recovered from such incidents drove the nomination of Fagatele Bay as a National Marine Sanctuary.

There was a small village at Fagatele until the mid-1950's. Futiga and Taputimu are the closest existing villages to Fagatele Bay. The villagers primarily used the bay for sport and subsistence fishing - practices that continue today.

Fagatele Bay staff actively participate in both the local and international communities, and support numerous scientific and educational initiatives. Sanctuary management values the integral nature of *fa'asamoa*, the traditional Samoan way of life, and all programs reflect the influence of the culture.



Staff and participants at EnviroDiscoveries Camp Tifitifi.

FBNMS file photo.



Large coral shelf.
Kip Evans

CORAL FORMS

Coral may be broadly identified by the various shapes that they take. While there is no universally accepted standard, the United Nations Environmental Programme and the Australia Institute for Marine Science suggest these categories:

Genus Acropora



Branching



Encrusting



Submassive



Submassive



Digitate



Tabulate

The Environment of Fagatele Bay

The Coral Reef

The coral reef of Fagatele Bay dominates the seascape, and the sanctuary boasts one of the most diverse marine ecosystems in American Samoa. Major reef elements include the following:

Hard Corals

Hard [scleractinian] corals are colonies of small, immobile polyps that remove calcium and carbonate from the ocean water to form a hard skeleton. These colonies are the main building blocks of the reef. The reef grows as the polyps divide and build on top of older skeletons. The polyps extend tentacles at night to capture plankton for food, although most of their energy comes from algae living in their tissues. There are over 200 recorded species of hard corals in the Samoan archipelago.

Algae

Zooxanthellae are the microscopic algae that live inside coral polyps, forming a symbiotic relationship with the polyps. The algae find shelter within the coral tissue, and the coral receive energy from the algae's natural photosynthetic process. These algae are what give the transparent coral its vibrant colors.

Coralline algae grow on the nonliving substrate of dead coral skeletons or rack. These algae, which look like a pink crust on the rocks, help build reefs by cementing rubble together and providing a base for new coral colonies.

Turf algae (*limu*) are a major food source for small fish and green sea turtles. *Limu* also provides a habitat for many species of invertebrates. Some types are also an important traditional food in Samoa.

Invertebrates

Giant clams (*faisua*) [*Tridacna maxima* and *T. squamosa*] can grow to 12-15 inches [30-38 cm] in length. They live in shallow water on the reef and, like coral, get much of their energy from algae that live in their flesh. They are a prized food in Samoa, and are increasingly rare due to overharvesting. One species [*Hippopus hippopus*] is already extirpated, or locally extinct.

Crown-of-thorns starfish (*alamea*) [*Acanthaster planci*] are coral-predators that generally exist only in low numbers on the reef, although their numbers occasionally explode into the millions.

Other echinoderms include a variety of herbivorous starfish (*aveau*) and urchins (*tuitui, vaga*).

Snails and clams belong to a large group of animals called gastropods [subclass *prosobranchia*]. Common ones in American Samoa include the limpet (*matapisu*) and many varieties of sea snails, such as the large and edible *Trochus sp.* and *Turbo sp.*, and the smaller *sisia* and *alili*. Giant clams are members of this group.

Octopus (fe`e) [*Octopus sp.*], along with squid and nautilus, are the most evolutionary advanced of the mollusks. These predators feed primarily on crustaceans and other mollusks. Octopus is a favored food in Samoa

Palolo (palolo) are moving packages of the sperm and egg of a bristle worm [*Eunice iridis*] that live as adults in dead coral. Each October and November, seven days after the full moon, the palolo spawn en masse, and the waters off Samoa teem with millions of palolo. Everyone in Samoa looks forward to the few spring nights when the palolo rise, and each village knows from experience when ‘their’ palolo will rise.

Sea Anemones (matamalu) [class *Anthozoa*] are close relatives of the hard corals. Clownfish families shelter among their poisonous tentacles, one of many types of symbiosis found on the reef.

Spiny and Slipper Lobsters (ula, papata) [*Panulirus pencillatus* and *Parribacus antarcticus*] live on the reef flats and in the cracks and crevices of the reef front, and come out at night to scavenge for food.

Popular food items, their catch is regulated by Samoan law, although overfishing occurs and spiny lobster populations are low. All invertebrates, including lobsters, are fully protected in the sanctuary.

Reef Fish

Butterflyfish (tifiifi) [fam. *Chaetodontidae*] are carnivores that feed on coral polyps. Some researchers have suggested using these fish as indicator species to monitor the health of the reef, although their effectiveness as such has not been studied thoroughly.

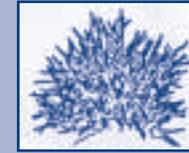
Damselfish (tu`u`u) [fam. *Pomacentridae*] are among the most common and diverse of the reef fish at Fagatele. Most are algae eaters, although a few species feed on plankton. The majority are also highly territorial, zealously guarding their patch of reef from other fish.

Parrotfish (galo, laea, and fuga) [fam. *Scaridae*] are large, brilliantly colored fish with teeth that have been fused into a beak-like shape. They nip algae from off the coral. Small pieces of coral that are also swallowed are excreted as sand, making these fish a major builder of sandy flats.

Tangs (pone and palagi) [fam. *Acanthuridae*] possess a rigid spine located just front of their caudal fin, which can be raised and used as protection against predators. Most are algae eaters. The convict tang may graze on algae growing on the backs of sea turtles.

Wrasses (sugale) [fam. *Labridae*] vary greatly in size, from small cleaner wrasses that feed on parasites living on other fish to larger carnivores that feed on benthic invertebrates. Wrasses, like parrotfish, are protogynous hermaphrodites, meaning that juvenile females become males later in life.

Other Corals



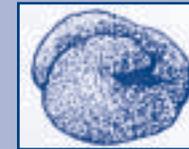
Branching



Encrusting



Submassive



Massive



Foliose



Mushroom



Millepora
“Fire Coral” is
in the class
hydrazoa, and is
not a true coral

An International Ecosystem

Many of Fagatele Bay's inhabitants are highly migratory. Fish and coral larva are swept into the open ocean after they are spawned. Young juveniles returning to Fagatele Bay may have come from thousands of miles away - or from the bay itself. The green sea turtles that nest in American Samoa actually spend most of their adult lives to the west in Fiji's extensive sea grass beds. The humpback whales that calve in Samoa's waters spend the summer feeding in Antarctica, 8,000 miles to the south. Fagatele is part of an international trans-Pacific marine ecosystem. Conservation efforts at Fagatele Bay impact ecosystems across the Pacific.



Green sea turtle. NOAA Library

Pelagic Species

There are several pelagic species that enter Fagatele Bay's waters to feed, calve, and find shelter. Many of these are threatened and endangered species that find the bay an important refuge.

Green sea turtles (*laumei*) [*Chelonia mydas*] grow up to 4 feet long [1.2 meters], and weigh up to 320 pounds [145 kg]. The U.S. Endangered Species List classifies them as a threatened species. Much of the turtles' life cycle remains a mystery, although a recent tagging study at Rose Atoll suggests that they are highly migratory. Many of the turtles that nested at Rose traveled afterwards to Fiji, presumably to feed in the extensive sea grass beds around the archipelago. A few headed in the opposite direction, traveling as far as French Polynesia. Hunting in Fiji and independent Samoa poses a serious threat to sea turtle populations, and bycatch numbers are on the rise with the increase in long-line fishing boats operating in territorial waters.

Hawksbill turtles (*laumei una*) [*Eretmochelys imbricata*] are an endangered species that forage for sponges and crustaceans on Fagatele's rocky undersea ledges and coral reefs. Hawksbill turtles are smaller than the green turtle, averaging only 26-36 inches [66-90 cm] in length.

Humpback whales (*'a manu*) [*Megaptera novaengliae*] are large mammals, reaching 50 feet [15 meters] in length and weighing upwards of 39 tons [40 metric tons]. Samoa's whales belong to the Group-5 Antarctic Stock, one of six 'tribes' which feed in Antarctic waters during the summer, and calf and breed in Samoa, Tonga, and Australia during the winter. Whalers killed almost 95% of Southern Hemisphere whales before hunting was banned in 1963 [Tonga continued to hunt humpbacks until 1978]. Recovery has been slow, and the total population numbers only 2500 today, down from a peak of 100,000.

Spinner dolphins (*manua*) [*Stenilla longirostris*] travel in large herds of up to 1000 animals, although most groups are under 200 individuals. They often travel above large schools of yellowfin tuna, making them vulnerable to the purse seiners that follow the dolphins to track the tuna.

Occasional visitors to Fagatele Bay include the endangered leatherback turtle [*Dermochelys coriacea*], and the threatened olive ridley [*Lepidochelys olivacea*] and loggerhead [*Caretta caretta*] turtles. Pilot whales [*Globicephala melas*] and false killer whales [*Pseudorca crassidens*] probably make occasional forays into the bay, but are more commonly seen offshore.

Apex predators are not common in the bay. Researchers are unsure what the baseline population levels of predators is, given that Samoa has been inhabited for thousands of years. Divers occasionally spot sharks (*mali'e*), most often the black tip [*Carcharhinus melanopterus*] and white tip [*Trienodon obesus*] reef sharks.

Paleotropical Forest

A paleotropical rainforest drapes the cliffs surrounding Fagatele Bay, providing a largely undisturbed refuge for American Samoa's indigenous and endemic plants. Significant fauna include:

Fruit bats (*pe'a* and *pe'a vao*) [*Pteropus tonganus* and *P. samoensis*], also known as flying foxes, nest in the trees above the bay. These large bats, with wing spans of 3.5 feet [1 meter], contribute to the pollination of many of the native trees in Samoa. They are the only known pollinator of several plants and trees, including the kapok [*vavae*]. The two species of fruit bat, along with a smaller cave dwelling bat, are Samoa's only native land mammals. Of the two, *pe'a* live in large colonies of one hundred to several thousand, and hunt by night; the rarer *pe'a vao* are more territorial and will forage by day. The bats were once hunted and exported to Guam for food, and ecologists feared that the bats were headed to extinction in Samoa after two hurricanes destroyed much of their habitat. Their numbers have recovered to safe levels thanks to legislative protection in the early 1990's.

Seabirds roost in the cliffs above Fagatele Bay at night, and fly out to sea to feed during the day. Agriculture and development has destroyed much of their environment.

Seabirds that nest at Fagatele include the brown booby (*fua`o*) [*Sula leucogaster*], the brown [common] noddy (*gogo*) [*Anous stolidus*], the white [fairy] tern (*manu sina*) [*Gygis alba*], the blue-gray noddy (*laia*) [*Procelstrena cerulea*], the white-tailed tropicbird (*tava'e*) [*Phaethon lepturus*], and the great frigate bird (*atafa*) [*Fregata minor*]. The first five feed on fish in the open ocean. The frigate birds steal fish from other birds, a feeding strategy known as kleptoparasitism.

Forest bird populations declined dramatically after hurricanes Ofa and Val destroyed much of their food sources. After the hurricanes the American Samoa Government instituted legislative protection for a number of vulnerable bird species, including the rainbow fruit dove (*manuma*) [*Ptilinopus perousii perousii*], the purple capped fruit dove (*manutagi*) [*P. porphyraceus*], and the Pacific imperial pigeon (*lupe*) [*Ducula pacifica microcera*].

Coconut crabs (*u'u*) [*Birgus latro*] hold the title as the largest terrestrial invertebrates in the world, growing to 39 inches [1 meter] from leg to leg and weighing as much as 30 pounds [13.6 kg]. These nocturnal relatives of the hermit crab remain in their burrows during day, leaving at night to scavenge for fruit, fish, coconuts, and other crabs. They have been extensively hunted on many Pacific islands, and their populations are considered to be vulnerable.



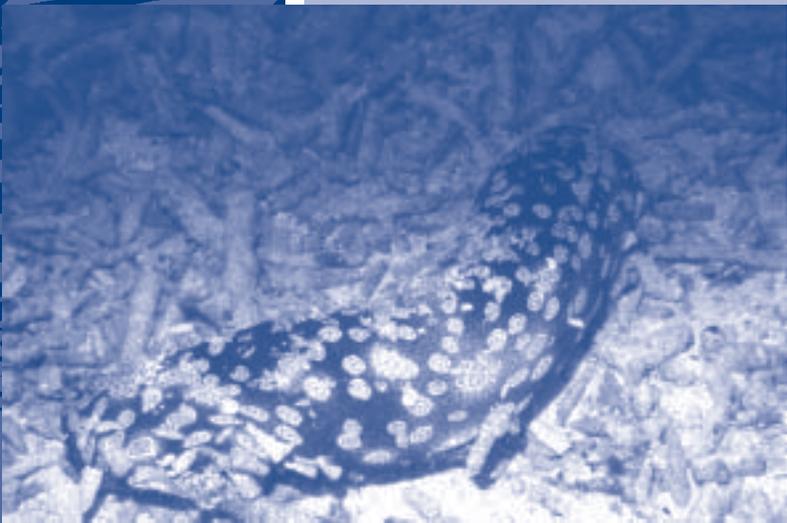
The large humphead wrasse (*malatea*) [*Cheilinus undulatus*] can grow up to seven feet long [note relative size of the trevally in the background]. Scientists consider them an 'at-risk' species, meaning that it is not yet endangered but could potentially be so. Jim Maragos, USFWS



The bumphead parrotfish (*uluto'i*) [*Bolbometopon muricatum*] is another at-risk species found in Fagatele's waters. Jim Maragos, USFWS



A crown-of-thorns working its way across a patch of reef. Jim Maragos, USFWS



A sea cucumber moves through coral rubble following a storm. Kip Evans

Threats to the Environment

Numerous natural and human-induced [anthropogenic] events have impacted the coral reefs of Fagatele over the past few decades. The reef, however, has shown an amazing capacity to regenerate itself after each disaster. The cycle of 'boom and bust' - periods of damage followed by periods of strong growth and resilience - is characteristic of tropical ecosystems. This section details the natural and anthropogenic threats to Fagatele's marine environment. The division between 'natural' and 'anthropogenic' is often blurry, as many natural events are exacerbated by pollution and global warming [this is discussed more on pages 14-15].

Natural Threats

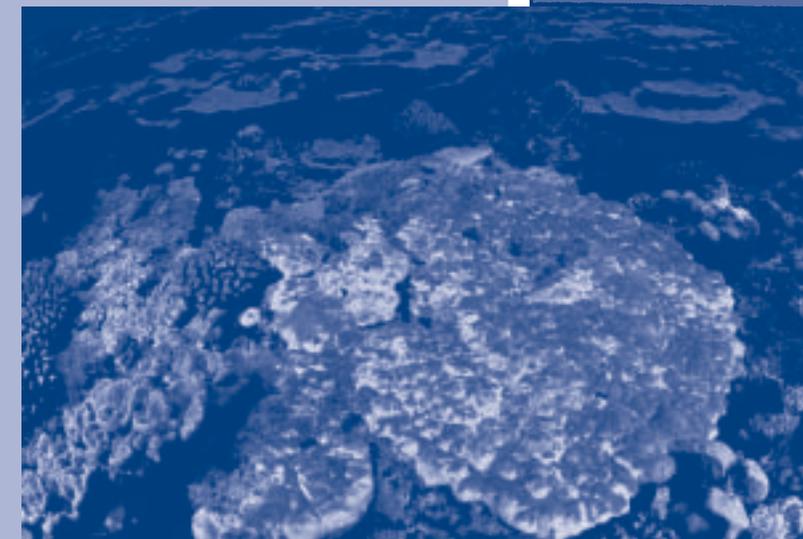
Crown-of-Thorn (*Alamea*) Outbreaks: In 1978 and 1979 there was a devastating outbreak of the crown-of-thorns starfish [*Acanthaster planci*] in Tutuila. These large predators, named for the venomous spines that cover their dorsal side, devour coral by disgorging their stomachs onto the reef, digesting the coral polyps, then withdrawing their stomachs back into their bodies. While crown-of-thorns are always present in low numbers on reefs throughout the Pacific region, their population occasionally explodes into the millions. During the 1978 outbreak, a cleanup effort removed over 600,000 of the starfish from Tutuila's reefs. Even this had a negligible effect on the outbreak; the remaining starfish destroyed 90% of the island's coral cover. Much of the coral that survived was on the wave- and current-swept reef margins, where the turbulent conditions made it difficult for the starfish to feed. According to local oral histories similar outbreaks occurred in 1916 and 1932.

Researchers are unsure what causes these population explosions. Some hypotheses suggest that the outbreaks are naturally occurring events. They might occur when environmental conditions, possible linked to ENSO events, provide the right conditions for a higher than normal survival rate among crown-of-thorns larvae. Other hypotheses suggest that the outbreaks are increasing in number and severity due to human disturbance of the environment. These hypotheses postulate that overfishing and/or toxins in the environment have reduced the number predators of the starfish, allowing their numbers to grow unchecked.

Hurricanes: Hurricane Ofa struck Tutuila in February 1990, and Hurricane Val followed almost two years later in December 1991. Both hurricanes hit the north shores of the island hardest, although they also caused a significant amount of damage to Fagatele and other south-facing shores. Post-hurricane surveys found that much of the reef in shallower waters [under 18 feet / 5.5 meters] had been reduced to rubble. Corals in deeper waters [over 36 feet / 11 meters] appeared to have escaped severe damage.

ENSO EVENTS

Weather patterns in the Samoa are directly affected by El Nino - Southern Oscillation [ENSO] Events. El Nino - and it's sister event, La Nina - are the extreme phases of ENSO events. El Nino refers to a warming of ocean currents of the coast of Peru, and La Nina to a cooling. The oscillation affects wind, rain, and storm patterns throughout the world. In El Nino years the trade winds, which normally blow east to west across Samoa, slacken and occasionally reverse. This, in turn, causes the mean sea level to drop up to 1.6 feet [0.5 meters] in the western South Pacific. La Nina years, meanwhile, show a slight decrease in rainfall across the Samoas.



Sick coral. Jim Maragos, USFWS

Sedimentation: Frequent storms and heavy rains occur year round in American Samoa. The island's steep topography and porous soil contribute to brief but heavy bouts of flooding. The floodwaters carry large amounts of sediment out to sea, which later settles out and covers the reef. Poorly planned development has led to an increase in erosion, resulting in a parallel increase in sedimentation.

Coral Bleaching: Environmental stressors can cause coral to expel the algae - or zooxanthellae - that live in their tissue, giving the reef a white, bleached appearance. Zooxanthellae provide the energy for coral polyps; without them the coral's growth and reproductive rates slow, and they become more susceptible to disease. If bleaching events are prolonged the coral will die. A bleaching event between 1993 and 1994 affected over 95% of the coral, and many died. Another significant event has begun as of this writing, so far affecting close to 50% of the corals in American Samoa.

A variety of stressors can trigger bleaching. The most common cause is higher than normal water temperatures, often coupled with the higher ultraviolet exposure that the reefs face during the summer. Coral polyps live and reproduce in a limited range of temperatures, and the higher average temperatures attributed to climate change result in an increase in bleaching that threatens the long-term recovery of the reefs.. Other bleaching triggers include lower than normal water temperatures, exposure to air, higher than normal salinity, disease, and sedimentation.

Extreme Low Tides: Strong westerly winds during a 1998 ENSO event pushed masses of waters eastward, effectively lowering the sea level in the western South Pacific. American Samoa witnessed some of its lowest tides in local memory. The upper parts of the reef were exposed to the air, and the exposed coral polyps bleached and died. This brief bleaching event effectively cropped the tops of the reef flat.

Diseases: Coral are susceptible to a variety of pathogens, tumors, and parasitic worms. There has been a troubling increase in the past decade in the distribution, frequency, and mortality rates of coral diseases. A 2002 survey of Tutuila's reefs revealed higher levels of coral and coralline algae diseases than expected. Our knowledge of the etiology and causes of these diseases is still limited, although researchers have shown that environmental stressors make coral much more vulnerable to pathogens. Some hypothesize that there is an anthropogenic component to the increase in coral diseases, with global climate change and/or marine pollution contributing to their spread.

The Earth Weeps

The coral reef has not adapted to modern threats, and human impacts threaten its very survival. Protecting and preserving these ecosystems is an ongoing challenge. There have been successes, but also setbacks: species going extinct, reefs destroyed beyond their capacity to regenerate, traditions lost as the land that fostered them is forever altered. A Samoan saying that acknowledges such unrealized hopes and desires is *Ua tagi le fatu ma le 'ele'ele*: The stones and the earth weep.



Litter washed ashore at Fagatele Nancy Daschbach

Anthropogenic Threats

Poaching: Illegal fishing poses the most immediate and visible threat to Fagatele Bay's ecosystem. While coral communities recovered rapidly from the various natural disasters, fish populations remain at low levels. The slow recovery of fish stocks suggest that poaching and illegal fishing methods remain a significant threat to the sanctuary. Dynamiting the reef is the most damaging of the illegal practices – the shock waves crack coral, kill fish, damage invertebrates, and interfere with the calving of local whale and dolphin populations. While less common, fish poisoning - using either bleach or traditional poisons like *futu* and *ava niu kini* - also causes long-term damage to the reef by killing the slow growing coral.

Sewage Outflow: Sewage discharge up current of Fagatele Bay poses a potential threat to the area's ecosystem. Tutuila's sewage only undergoes primary treatment before being discharged into the ocean. The ocean was able to dilute the sewage to safe levels when the island's population was relatively small, but an increase in both population and piggeries has increased the outflow. The effluent drifts with the currents along the coast, and may enter Fagatele Bay. Formal studies are planned to determine what risks the sewage poses. The high level of nutrients in the outflow could contribute to the growth of harmful algae species; however, recent studies in the Caribbean and Hawai`i have not found a correlation between the two. In the mid-1990's a team of scientists performing an algal survey of the island found a bed of green algae in the outer parts of the bay at a depth of 130 feet [40meters]. The bay would not normally support algal growth at this depth, suggesting that some source of nutrients is coming into the sanctuary. Follow-up studies are needed to confirm this.

Watershed Issues: There is one regular stream that flows into Fagatele Bay. The stream runs through plantation land, and could potentially carry herbicide and pesticide runoff and sediments into the Bay. More evidence needs to be gathered to support this. While sanctuary boundaries only go to the high water line, sanctuary regulations prohibit discharges into the bay that may impact its resources. Fortunately, most local farmers do not engage in 'high tech' practices, and few use commercial fertilizer or herbicides routinely.

Marine Debris: Marine debris litters all of the oceans. In American Samoa frequent storms and flooding carry large amounts of waste and litter downstream and into the ocean. Heavier objects accumulate on the benthic substrate, while lighter objects float on the currents. Some of the debris washes ashore, while other objects become entangled in the reef. Although the streams in Fagatele Bay carry little solid waste themselves, ocean currents carry trash from upstream sources into the bay.

Other Direct Threats: Dredging, sand mining, shoreline modification, vessel groundings, and invasive alien species all pose a threat to American Samoa's reefs. Fagatele Bay's remoteness has protected it from many of these human-caused insults to our reefs. However, Fagatele Bay's status as a sanctuary may not always prevent a vessel grounding or an alien species invasion. The sanctuary management's role in the larger coral reef issues in American Samoa, largely facilitated through its partnership with the local Department of Commerce, contributes to the efforts to minimize these threats to both within Fagatele Bay and in all of American Samoa's islands.

Global Climate Change: The earth's climate is changing, something that the scientific and political community has been slow to recognize. Scientists now state that there is increasing evidence that industrialization is raising the overall ambient temperature of the environment through the trapping of greenhouse gasses in the atmosphere. This can potentially bring about a number of negative effects on the marine environment, including

- an increase in the frequency and intensity of storms and hurricanes.
- more dramatic ENSO events.
- an increase in bleaching events due to higher sea levels, higher sea temperatures, and more frequent extreme low tides.
- an increase in coral mortality caused by rising sea levels. Corals are specific to certain depths, and reefs might not be able to grow fast enough to match the higher sea levels.
- slower reef formation caused by an increase in atmospheric carbon dioxide. As carbon bonds with ocean water, the ocean water becomes more acidic, and there is subsequently less carbonate available for reef formation.
- an increase in coral diseases as a result of the increased environmental stressors mentioned above.

There will be other impacts, and combinations of impacts, that scientists have not yet anticipated. Given that coral reefs worldwide already show signs of stress from these changes, the reefs may be the first victims - the proverbial canary in the coal mine - of a planet-wide disaster.

Threat Mitigation: One of the biggest challenges that marine sanctuaries encounter is enforcing regulations. Fagatele Bay has approached enforcement in various ways over the past 15 years. The sanctuary has had contractual agreements in the past with various federal and territorial agencies, including the Marine Patrol [Public Safety] and the Department of Marine and Wildlife Resources [DMWR]. Currently the sanctuary employs the enforcement oversight of the National Marine Fisheries Service's Office of Law Enforcement [NOLA]. The NOLA agent works in partnership with conservation officers from DMWR to patrol the sanctuary's waters. Territorial-wide and international efforts are needed to address many of the wider threats facing the bay.



The USS Chehalis, a WWII Navy tanker, sank at the mouth of Pago Pago Harbor in 1949. Researchers are currently surveying the wreck to find if it is leaking fuel into the environment. NOAA Library.



A diver surveys reef damaged by dynamite. Kip Evans

Natural Systems

The reef has evolved over the millennia to cope with natural threats and catastrophes. A Samoan saying is '*E fofo e le alamea le alamea*'. The cure for crown-of-thorns is crown-of-thorns. Nature, if left alone, will take care of itself.

Unfortunately, the marine environment has not evolved to cope with newer threats posed by man. Sanctuary managers are constantly deciding when to intervene, and when to let nature take its course.



Reef view, Fagatele. Kip Evans

25 Years of Boom and Bust at Fagatele



Moorish idols. Jim Maragos, USFWS

In 1978 and 1979, the crown-of-thorns population explosion destroyed over 90% of the living coral on Tutuila, including Fagatele Bay. Only the reef margins were spared – waves crashing against the reef prevented the starfish from grazing there.



Algae growing on coral rubble. Kip Evans

Coralline algae cemented the rubble together, forming a base for new colonies. Fish and coral larvae in the open ocean metamorphosed into juveniles and returned to the reef in a process known as 'recruitment.' A 1985 survey showed that 12% of the substrate was covered in coral, and that numerous small colonies has established themselves.

Coral reefs are dynamic systems; they constantly change and adapt to shifting environmental conditions. In the 1970's Fagatele Bay's coral cover was extensive, covering almost 100% of the benthic substrate.



Crown-of-thorns starfish. Kip Evans

Algae eventually grew to cover the coral skeletons. Populations of coral eating fish and large predators declined, while populations of algae-eating fish prospered. Small animals moved into the coral skeletons and began excavating. The weakened structures easily broke in storm waves, and large piles of coral littered the shoreline.



Small coral colonies. Jim Maragos, USFWS



Sunset in the eye of a hurricane. NOAA Library

A 1988 survey showed that recruitment was still strong. Coverage remained low, but the number of new colonies suggested that full recovery could be reached by 1992. Fish abundance, however, dropped.

Hurricanes hit American Samoa in 1990 and 1991. The storms destroyed many of the fast growing corals, and corals in shallow waters. There was less damage to corals in deeper water, and to the slower growing 'massive' corals.



The benthos after a hurricane. Nancy Daschbach



Bleached coral. Kip Evans

Bleaching events caused by higher than normal water temperatures in 1993 and 1994 killed many of the corals, and again set the recovery process back. Overall things continued to improve. A 1995 survey showed that fish diversity was at its highest level since the crown-of-thorns outbreak.

Small, coral-associated fish appeared to have also recovered from the past disasters, although the total biomass remained low. In 2001, the scientists who had been following the recovery of the reef since the mid-1980's declared that the coral reefs of Tutuila had totally recovered.



Larger coral colonies. Kip Evans

Fagatele in 2003

Coral growth and coverage is high. Fagatele's reef has recovered from the natural disasters of the past 25 years. Many marine researchers were surprised by the resiliency of the reef. They had previously assumed that it would take up to a century for the reef to recover from the events.

Fish populations, however, remain lower than expected. This suggests that illegal fishing continues to be a serious problem. Humans cause all the main dangers the reef faces today: pollution, overfishing, sediment washout, and global warming.



Coral cover. Kip Evans



Goatfish. Jim Maragos, USFWS

Fagatele Bay Management Plan

Management plans are site-specific documents required by law for all National Marine Sanctuaries. They describe sanctuary boundaries and jurisdictions, regulations, research and educational programs, and staffing and budget needs. In addition, they set out a series of goals and objectives for sanctuary staff. Fagatele Bay's current management plan dates from the sanctuary's establishment in 1985.

The National Marine Sanctuary program now requires that each sanctuary update their management plan every five years. Updating the plan is a multipart process whose elements include the production of this State of the Sanctuary report, the formation of a sanctuary advisory council, and a formal management plan review and revision.

Sanctuary Advisory Council

Fagatele Bay staff are currently in the process of setting up a sanctuary advisory council. The council will comprise government representatives, professional resource people, and community members who have an interest in protecting American Samoa's marine ecosystem. The council will act as a referral and advisory body for sanctuary management.

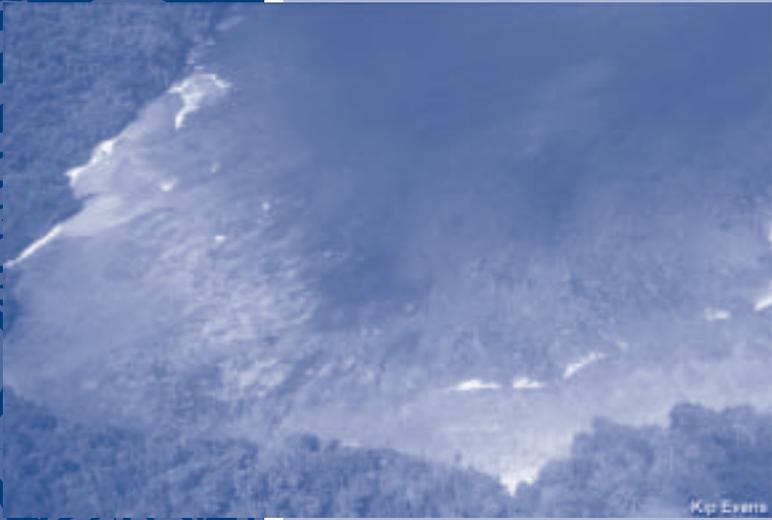
Public Participation

Public participation is an integral part of this process, and Fagatele management encourages community members to take part. They can do so by contacting the sanctuary office at 663-7354. Fagatele staff will also be actively seeking community participation for a series of public scoping meetings that will kick off the review process. The draft of the revised plan will also be available for public review and comment.

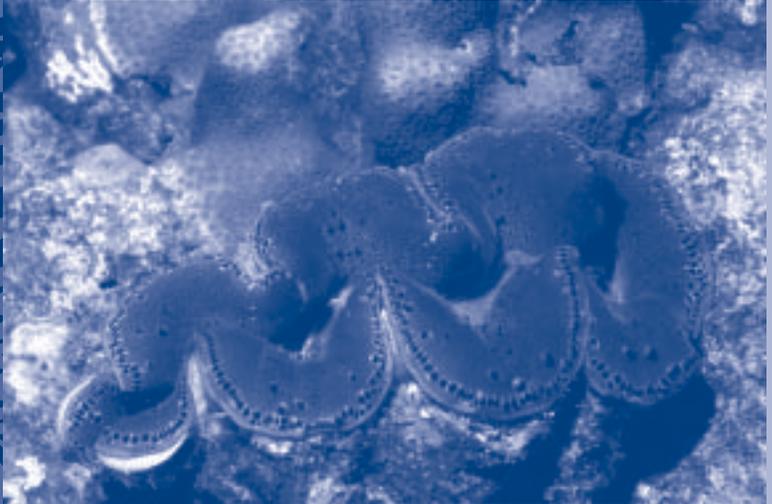
Management Plan Review

The following sections of this report contain information that sanctuary management, the advisory council, and the public can use as part of the management plan review. It outlines management plan goals in the four arenas of resource protection, public education, scientific research, and public recreation, and examines the successes and challenges Fagatele staff have had in implementing these goals over the past 25 years.

Our understanding of coral reef dynamics has also evolved considerably since the original plan was written for Fagatele Bay, and the new management plan will reflect this increase in knowledge.



Aerial view of Fagatele's near-shore waters. Kip Evans



Close-up view of a giant clam, one of the many protected and threatened species that shelter in Fagatele's waters. Jim Maragos, USFWS

Management Plan Goals

As part of the management plan review, the sanctuary advisory council will review the four goals set out in the original management plan. The four goals are:

1. To protect and preserve Fagatele Bay's natural resources and pristine character.
2. To expand public awareness and understanding of the marine environments found in the warm waters of the South Pacific Ocean, and thereby foster a marine conservation ethic.
3. To expand scientific understanding of marine ecosystems found in the warm waters of the Pacific Ocean, especially coral reefs that have been infested by the crown-of-thorns starfish, and apply scientific knowledge to the development of improved resource management techniques.
4. To allow uses of the sanctuary that are compatible with Goals 1-3 above; give highest priority to subsistence and public recreational uses.

The primary tools that sanctuary staff use to achieve these goals are education, science, and enforcement.

Management Plan Activities, on pages 22-28, discusses how sanctuary staff use these tools as part of their strategy to achieve the goals outlined in the management plan.

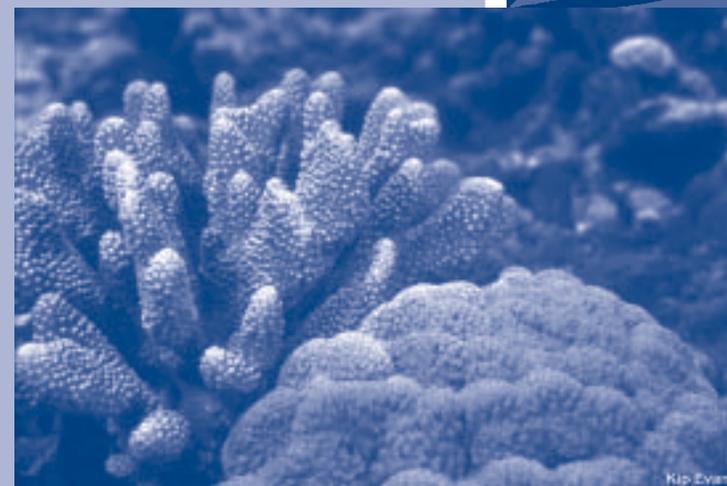
2002 NOAA Sanctuary Evaluation

The National Marine Sanctuary Program conducted a comparative evaluation of status and information needs for each of the nation's sanctuaries in 2002. The evaluation criteria were based on how well scientific research at the sanctuaries contributed to the information needs of sanctuary managers. The complete report contains a number of recommendations for increasing the understanding of environmental processes at Fagatele Bay, and can be found online at sanctuaries.nos.noaa.gov/library/National/science_eval.pdf. The evaluation's priority recommendations include:

- studying the physical criteria, such as ocean currents, that affect the success of biological resources.
- studying the biological criteria, such as growth, recruitment, reproduction, and mortality, that affect the success of biological resources.
- studying the impact of fishing on important species.
- predicting, verifying, and tracking events and disturbances of various types within and adjacent to the sanctuary.
- studying and planning responses for significant environmental events.



Divers place mooring buoys at Fagatele. Mike Smith



Coral heads. Kip Evans

A Soft Breeze

Protecting the resources of American Samoa and Fagatele has to be a community effort. Samoan culture has always placed a high value on consensus decision-making. Reaching consensus can be a slow process. Currently there is widespread awareness in Samoa that the threats to the environment are increasing, and a growing willingness to take action. There is a Samoan saying when preparations for a sea trip have been completed, and the travelers only wait for the proper winds: *Ua tofa i tino matagi lelei*. This translates as: A soft breeze is felt on the body. The soft breeze indicates that the time is right for action.



A humpback whale diving. NOAA Library

Management Challenges

Some of the more significant challenges facing sanctuary management are:

Illegal Fishing

Poaching is the most immediate threat to Fagatele's resources. The bay's isolation has made it difficult to enforce existing regulations.

Land Tenure

Traditional Samoan land ownership extends to the reef edge, while the territorial government claims legal ownership of all submerged lands from the high water mark to three miles offshore. This jurisdictional overlap, combined with federal land regulations, creates an environment in which diplomatic skill and respect for *fa'asamoa* are necessary for success.

Isolation

The logistics of setting up a scientific expedition to American Samoa make it difficult to attract scientists and researchers. Researchers are challenged by the distance from any large research institution, the island's lack of a marine laboratory, and the remoteness of Fagatele itself – the bay is a 45 minute boat ride from the harbor at Pago Pago, and the seas are often too rough for travel between May and October.

Population Growth / Resource Pressures

American Samoa's population has more than doubled in the past two decades, growing from 32,300 in 1980 to 65,400 in 2000. Most of the growth and corresponding development is occurring in the Tafuna-Leone Plain area of Tutuila, which lies right outside Fagatele Bay. This level of growth puts stress on all of American Samoa's natural resources, as human-caused environmental impacts increase commensurate with population growth. Indeed, as more people require more land for homes and plantations, it becomes more likely that the Fagatele Bay watershed will lose its relatively isolated status. The natural protection it enjoys because no one lives in the watershed will be threatened.

Enforcement Alternatives

Fagatele Bay management is exploring creative alternatives to traditional enforcement in their attempts to preserve the bay's resources.

Summary of Regulations

These regulations were developed to support the goals and objectives outlined in the Management Plan. This is only a summary; the complete regulations can be found in Section 922.102.

The following are prohibited within the sanctuary boundaries:

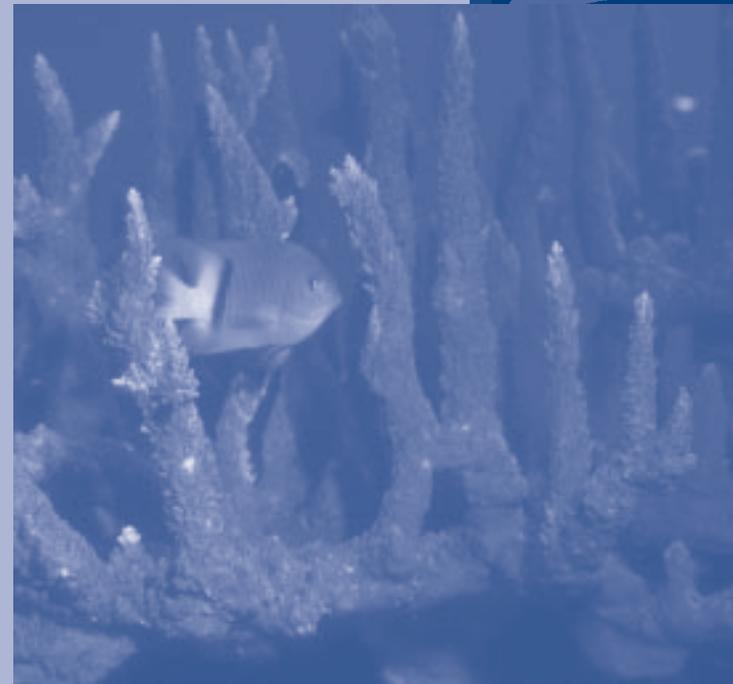
- (1) (A) Gathering, taking, breaking, cutting, damaging, destroying, or possessing any invertebrate, coral, bottom formation, or marine plant.
 - (B) Taking, gathering, cutting, damaging, destroying, or possessing any crown-of-thorns starfish.
 - (C) Possessing or using poisons, electrical charges, explosives, or similar destructive methods.
 - (D) Possessing or using spearguns, including Hawaiian slings, pole spears, arbalettes, pneumatic and spring-loaded spearguns, bows and arrows, bang sticks, or any similar taking device.
 - (E) Possessing or using a seine, trammel net, or any type of fixed net.
- (2) Operating a vessel closer than 200 feet [60 meters] from another vessel displaying a dive flag at a speed exceeding three knots, and operating a vessel in a manner which causes the vessel to strike or otherwise cause damage to the natural features of the sanctuary.
- (3) Diving or conducting diving operations from a vessel not flying the international code flag alpha "A."
- (4) Littering, depositing, or discharging, into the waters of the sanctuary, any material.
- (5) Disturbing the benthic community by dredging, filling, dynamiting, bottom trawling, or altering the seabed.
- (6) Removing, damaging, or tampering with any historical or cultural resource.
- (7) Ensnaring, entrapping, or fishing for any sea turtle listed as a threatened or endangered species.
- (8) Except for law enforcement purposes, using or discharging any explosives or weapons. Distress signaling devices and knives generally used by fishermen and swimmers shall not be considered weapons.
- (9) Marking, defacing, or damaging in any way, or displacing or removing or tampering with any signs, notices, placards, monuments, stakes, posts, or other boundary markers related to the sanctuary.

In addition the following activities are prohibited and thus are unlawful for any person to conduct or to cause to be conducted landward of the straight line connecting Fagatele Point and Matautuloa Benchmark.

- (1) Possessing or using fishing poles, handlines, or trawls.
- (2) Fishing commercially.



Aerial view of Fagatele Bay. FBNMS Library



A damselfish takes shelter among the coral branches. Kip Evans

Management Plan Activities: Resource Protection

Management Goal Number One: To protect and preserve Fagatele Bay's natural resources and pristine character.

The Importance of Marine Refuges

Modern fishing technology, rapid increases in population, increased land-based pollution, and decreases in traditional controls over fishing have all had a serious impact on American Samoa's coastal resources. Studies have shown that overfishing alone has caused a significant decline in both the number of and average size of reef fish in the archipelago.

Resource managers have tried many techniques to protect fish populations, including setting quotas and size limits, and having partial and seasonal closures. These have had only limited success in restoring fish populations. Marine refuges, however, can have a dramatic impact. Even refuges as small as 25 acres [0.1 sq km] show a significant increase in the size, number, and diversity of marine wildlife within the refuge. In addition, refuges offer protection to endangered and threatened species, and stable breeding grounds for food and game species.

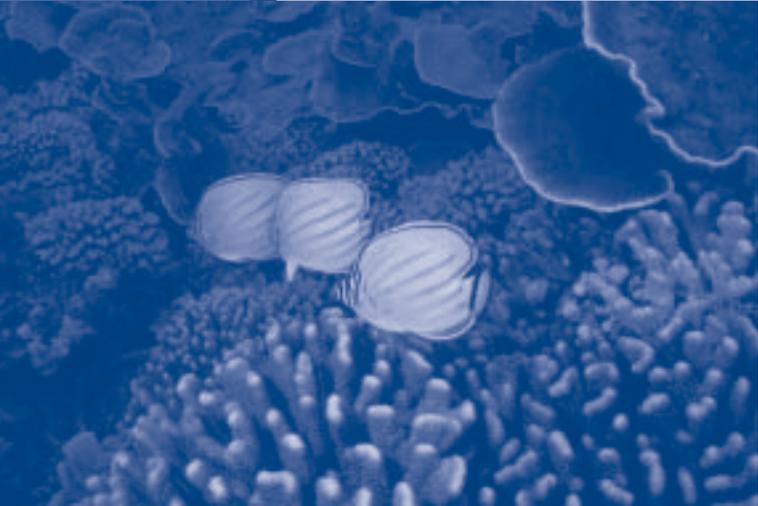
Refuges also have a large 'spill-over' effect with neighboring non-protected areas. Numerous studies have shown that fisheries adjacent to marine protected areas have significant increases in the amount and size of fish caught. With fish stocks and catches falling rapidly in American Samoa, and with stressors on its coral reefs increasing, refuges and sanctuaries like Fagatele Bay become increasingly important to both the environmental and economic health of the territory.

Sanctuary Partnerships

As a member of the Department of Commerce, which houses the sanctuary in its Resource Management Division, the sanctuary staff work in close partnership with many territorial agencies. This gives the sanctuary a link with the local government that it would not have as an independent entity. It has enforcement contracts with the Department of Marine and Wildlife Resources [DMWR] and the National Marine Fisheries Service; cooperative research projects with the DMWR; and cooperative visitor's projects with the National Park of American Samoa.

A diver in full gear, including a tank and mask, is seen underwater surveying a coral reef. The diver is holding a camera or light, and the background shows the textured surface of the reef.

Dr. Charles Birkeland surveying the reef. Kip Evans

A close-up view of several butterflyfish swimming over a coral reef. The fish are white with dark stripes and are positioned above a large, textured coral structure.

Butterflyfish [*Chaetodon ornatissimus*] grace the reef. Jim Maragos, USFWS

In addition, sanctuary staff are active in the following groups and coalitions:

Coral Reef Advisory Group [Coral Reef Initiative]: The sanctuary manager serves as an advisor on this governor appointed group. The Coral Reef Advisory Group [CRAG] is a multi-agency body responsible for the development and implementation of coral reef management in American Samoa. The local lead for the group is the Coastal Management Program, which is housed along with the sanctuary in the Department of Commerce's Resource Division. They began meeting as the Coral Reef Initiative in 1994 to address coral reef issues, and expanded and formalized their procedures in 2000. CRAG is currently developing local area strategy plans focusing on its top four priority threats

Economic Evaluation of Resources: Fagatele staff participated in a Department of Commerce-led series of workshops on the economic evaluation of environmental resources.

Hyperbaric Chamber Program: The sanctuary has been active in developing skilled chamber operators and dive emergency medical technicians to serve the local diving community. Fagatele staff continue working to obtain a large dive chamber from the mainland to be relocated to the LBJ Tropical Medical Center.

Marine Emergency Plan: Fagatele staff are working closely with other agencies that conduct marine operations to develop a marine emergency plan.

Ocean Resource Advisory Group: The sanctuary manager sat on this group that oversaw the development of a comprehensive ocean resource management plan. The plan was adopted by the American Samoan Government in August 2003. As part of the ocean plan, Fagatele Bay staff will participate on two resource-area advisory groups, one for near shore waters and one for watersheds. These groups are currently developing three to five year action plans to improve the marine resources of American Samoa.

Population Task Force: The sanctuary manager also served as an advisor on this multi-agency initiative that studied the effects of population growth on American Samoa's resources. The manager continues to act in this role in the subsequent Population Implementation Committee.



Reef fish in shallow waters. FBNMS Library



Flag Day celebrations. Jim Maragos, USFWS

The Harvest

One of the goals of environmental education is to incorporate an ecological ethos with fa`asamoa, the traditional Samoan culture. Upcoming generations will show if these efforts have been successful. Samoa has an optimistic saying reflecting the belief that it will be: *E sau le fauta ma lona lou*: When the harvest comes the *lou* will be found.

The *lou* is a tool used to harvest breadfruit; it is discarded after harvest. The *lou* is found again for the next harvest. *E sau le fauta ma lona lou* is commonly said at the death of a matai, a village chief; it represents the belief that each generation will find its own leaders to carry on the traditions of fa`asamoa.

Management Plan Activities: Education and Outreach

Management Plan Goal Two: To expand public awareness and understanding of the marine environments found in the warm waters of the Pacific Ocean, and thereby foster a marine conservation ethic.

Public education has been one of the sanctuary's primary activities since its inception. The sanctuary hired its first education coordinator in 1994, and finished its first education plan in 1995. The five objectives of the sanctuary's education and outreach plan are:

1. To increase public awareness of the value and need to protect Fagatele Bay and other coral reefs in American Samoa.
2. To increase public awareness of the human and natural impacts on Fagatele Bay and its ecosystem.
3. To provide bilingual environmental educational materials and programs.
4. To encourage community cooperation and participation in the protection and management of Fagatele Bay.
5. To develop an interest in local students who will pursue studies in marine and coastal sciences.

Fagatele Bay staff have either led or been active in the following educational programs:

EnviroDiscoveries Camp Tifitifi: The EnviroDiscoveries program began in 1991 as a cooperative effort between Fagatele Bay staff, the Coastal Management Program, the Environmental Protection Agency [EPA], and the American Samoa Community College. The program is aimed at elementary school students, who camp out on the coast for three activity filled days of exploring, sharing, and learning about the marine environment.

Reefweeks: Fagatele has been the lead agency for this program since 1993, with other agencies participating as part of Le Tausagi. Project Reefweeks brings a month of marine science education to the territory's fourth graders. Components of the program include presentations, contests, and reef walks.

Save-A-Beach: An AmeriCorps volunteer who worked for Fagatele developed this program aimed at middle school students. Now managed by Sanctuary education specialist Allamanda Amituana`i, a former AmeriCorps volunteer herself, the program involves bimonthly beach cleanups, cleanest beach competitions, and poetry, essay, and art competitions.

EnviroDiscoveries Camp Tifitifi. FBNMS Library

Beach Cleanups: Two other beach cleanups are held each year. In 2002 snorkelers, divers, and beachcombers collected several hundred pounds of trash.

Educational Products: Over the years the sanctuary has published posters, brochures, a video, and bumper stickers designed to increase awareness of the marine environment.

Ocean Fest: The National Marine Sanctuary Program co-sponsored Ocean Fest, a celebration of the marine environment, in August of 2003. The festival coincided with the annual conference of Pacific region coastal zone managers.

Art and Tide Calendar: The sanctuary co-sponsors this project, along with the Department of Commerce's Coastal Management Program and the EPA. The popular calendar includes a mix of environmental and cultural information. Public and private school students compete to have their artwork included.

Coastweek: Coastweek is a large project that includes whale watching trips and workshops, coastal cleanups, community barbecues and games, and television and radio spots. High school students from the Manu`a islands are given scholarships to be able to attend. Fagatele Bay staff lead environmental education workshops for teachers.

Le Tausagi: Le Tausagi, meaning the "morning song of the bird," is a collaborative educational effort among American Samoa's environmental educators. By combining their resources, and utilizing AmeriCorps volunteer interns, Tausagi members are able to maximize their talents and greatly improve their community outreach efforts.

Earth Day: The EPA is the lead agency for Earth Day activities. Fagatele staff participate as part of Le Tausagi, doing community skits and assisting with underwater dive cleanups in Pago Pago Harbor, Utulei, and other swimming and snorkeling areas.

Arbor Week: The Community College is the lead agency for Arbor Week activities. Fagatele staff participate as part of Le Tausagi. Each Arbor Week has a theme, last year's being 'Adopt A Watershed.' The group makes presentations at schools around the island, talking about their jobs and how they relate to that year's theme.



Students at one of Le Tausagi's educational events. Kip Evans



Students snorkeling at Fagatele. Jim Maragos, USFWS.

Mysteries of the Coral Reef

Much of the biology of the coral reef ecosystem remains a mystery, and opportunities for scientific exploration and discoveries abound. A few examples:

Exploring the *Twilight Zone*: The use of rebreathers is allowing researchers to finally explore this part of the reef, and each dive brings exciting new discoveries.

Recruitment: Fish and coral larvae live among the plankton in the open ocean. It was once thought that the larvae drifted mindlessly with the currents, settling down in random spots. There is now some evidence that selection might occur - that the larvae might be able to home in on their source reef.

Indicator Species: It is difficult to monitor the health of a complex ecosystem, so scientists and managers monitor the health of certain indicator species as a way to monitor the health of the overall system. No indicator species have been identified for coral reefs. In a similar vein, it has been suggested that coral reefs themselves might be used as indicators of the health of the overall planet.

Management Plan Activities: Science

Management Goal Three: To expand scientific understanding of marine ecosystems found in the warm waters of the Pacific Ocean, and apply scientific knowledge to the development of improved resource management techniques.

Science plays a major role as one of the primary management tools used by the sanctuary program to inform decisions. Some of the more significant studies conducted at the sanctuary include:

Long-Term Biological Resource Study: Fagatele Bay's most important research project began in 1985 as a long-range study of how the coral reef would recover from the crown-of-thorns invasion of 1978 and 1979. A team of researchers led by Dr. Charles Birkeland of the University of Guam, and later co-led by Dr. Alison Green of the Great Barrier Reef Marine Park Authority, now of the Nature Conservancy, began a multi-year cycle of data collection. The team collected information on marine life in 1985, 1988, and 1995, 1998, and 2001.

One of the most significant results of the study showed that the corals of the bay are healthy, and had recovered more rapidly from the invasion than scientists had thought possible. Coral cover increased rapidly, and coral size grew at an almost logarithmic rate. The studies also showed that fish populations were not recovering as quickly. Small coral-associated fish were recovered in parallel with the coral; however, the total density and biomass of fish remains low. There were also fewer of the large predators, such as sharks and the Maori wrasse [*Cheilinus undulatus*], than one would expect. This supported the assumption that illegal fishing continues to occur at Fagatele.

The research by Birkeland and Green provide one of the few long-running studies of this type in the world, and provides invaluable data on the life cycle of the reef.

Sustainable Seas Expedition: In March 2002 a group of scientists, photographers, marine advocates, and educators met for a week of training and education. Led by Dr. Sylvia Earle, National Geographic Society Explorer-in-Residence, the team documented and photographed Fagatele's resources. Highlights included a marine education workshop for teachers, and a survey of reef fish populations. The latter will be expanded into a fish monitoring program to be conducted by the public and sanctuary staff.

GIS Mapping: In 2001 and 2002 shallow-water multibeam bathymetric surveys were conducted using equipment owned and operated by the Center for Coastal Ocean Mapping at the University of South Florida. The project was led by Dr. Dawn Wright from the University of Oregon, and Dr. David Naar and Brian Donahue from the University of South Florida. The data are available online at dusk.geo.orst.edu/djl/Samoa.

Deep Diving into the Twilight Zone: In May 2001 divers Richard Pyle and John Earle of the Bishop Museum in Hawai'i conducted a deep dive in Fagatele's waters. They used advanced 'rebreather' diving technology, which allowed them to take a 3 ½ hour dive to a depth of 372 feet [113 meters]. This brought them into an area of the reef known as the 'twilight zone.' Traditional scuba gear allows most divers to descend to only 150 feet [45 meters]. While this covers the most biologically diverse sections of the reef, coral extends down to depths of 500 feet [150 meters]. These deeper regions have been almost completely unexplored. On their dive Pyle and Earle observed twelve possible new species of fish, seventeen species new to Samoa, and numerous others seen for the first time at Fagatele. Their videos and dive log are available online at www2.bishopmuseum.org/PBS/Samoatz01.

Other Studies: Fagatele staff take every opportunity to assist scientific research in American Samoa. As a result, the sanctuary has become a place for researchers to add to their sampling sites. In time, the sanctuary management hopes to see the bay become a scientific focal point for the region, drawing scientists from around the world to study coral reefs. Most recently, the sanctuary has supported surveys of coral disease and invasive species, and studies on coral health and long-term reef health.

Upcoming Projects

Humpback Whale Census: In the late summer of 2003 David Matilla of the Hawaiian Islands Humpback Whale Sanctuary will lead a census of humpback whales throughout American Samoa. This will be the first survey of the territory's whales.

Dive Sites Mapping: A college intern will develop a searchable GIS geogroup database of dive sites around American Samoa in conjunction with a local dive club. The intern will also develop an atlas of FBNMS's database.

Cultural Resource Inventory: A second intern will conduct a cultural resources inventory for Fagatele Bay and the surrounding area.

More Mysteries of the Reef

Ofu Corals: Corals at one bay in Ofu, in the Manu'a islands, can handle temperature variations that would kill most other corals. Reef observers are unsure why. It is possible that such hardy corals could be used to restock other reefs damaged by global climate change.

Turtle Migration: Recent tagging studies have shown that individual sea turtles range over vast areas of the ocean. The life cycle of many such migratory and pelagic species remains poorly understood.

The Life Cycle of the Reef: Researchers are unsure of what events [such as bleaching and crown-of-thorns outbreaks] are part of the reef's natural life cycle, and what are being caused by or exacerbated by human impacts.

Management Issues: Science can inform decisions that resource managers must make when faced with issues that may call for mitigation, intervention - or letting nature take its course.

Management Plan Activities: Subsistence and Public Recreation

Management Goal Four: To allow uses of the sanctuary that are compatible with goals one through three above; giving highest priority to subsistence and public recreational uses.

The sanctuary places a high priority on preserving the bay's unique character, and advocates for those uses that are compatible with its goals of protecting the bay's marine resources and of using the sanctuary to advance public education and scientific understanding of coral reef ecosystems. In order to maintain the bay in its most natural state, there are few infrastructure changes planned within the sanctuary boundaries. The trail into the sanctuary is rough, and the main route in and out remains, as in traditional times, by sea.

Recreational use of the bay is thus limited. Sanctuary staff host picnics, reefwalks, and educational field trips for students. Local divers from American Samoa's dive and snorkeling club are the occasional users of the sanctuary. Subsistence fishing continues, although sport fishing is not encouraged. Neighboring landowners also occasionally use the bay for picnics. This represents a sustainable level of use that Fagatele staff does not see increasing in the near future.



A view of Fagatele from Seumalo Ridge. Kip Evans



The sanctuary manager examining corals. Kip Evans



Coral outcropping. Kip Evans

Future of the Sanctuary

The past 25 years have seen some notable achievements in public environmental education. Thanks to the efforts of Fagatele Bay and other Le Tausagi members, the upcoming generation is much more aware of the need to protect American Samoa's natural resources. Fagatele staff foresee a continuing emphasis on education in their efforts to create an environmental ethic in the territory.

Scientific understanding of the coral reef ecosystem has increased significantly in recent years. The Coral Reef Advisory Group currently plans to develop a marine laboratory, which will make it much easier to attract researchers to the bay. The opportunities for research should continue to grow, as each answered question opens the door to more questions.

From American Samoa Coastal Management Program's
2000 Art and Tide Calendar
Artist: Patrick Mafo'e



The partnership between the National Oceanic and Atmospheric Service and the American Samoan Government in managing the sanctuary continues to evolve, and the collaboration should continue. Fagatele Bay National Marine Sanctuary is unique among the nation's sanctuaries in being both federally and locally managed. The joint federal and territorial management of Fagatele Bay presents a unique model, creating a sanctuary singularly tailored to local needs.

The 2000 year old Samoan culture endures as a strong and vibrant force that informs sanctuary management. Although it has adapted to modernity, the essence of *fa'asamoa* continues to be passed down to each generation. *'E tu'utu'u taliga tala a Manu'a e le tusia.* Island knowledge is not written, yet it has been passed down.

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Close-up of a coral polyp skeleton. NOAA Library



Reef sharks patrolling the benthos. Jim Maragos, USFWS

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A traditional Samoan dance. Kip Evans

You lie on a mat in a cool Samoan hut and look out on the white sand under the high palms and gentle sea, the black line of the reef a mile out with the moonlight over everything. And then amongst it all are the loveliest people in the world, moving and dancing like gods and goddesses. It is sheer beauty, so pure it is difficult to breathe it in.

- Robert Louis Stevenson

