NATURAL HISTORY GUIDE TO AMERICAN SAMOA

3rd Edition

2009

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National Park of American Samoa

Department of Marine & Wildlife Resources

American Samoa Community College

Sport Fish & Wildlife Restoration Acts

American Samoa Department of Commerce

Pacific Cooperative Studies Unit, University of Hawaii

American Samoa Coral Reef Advisory Group

National Oceanic and Atmospheric Administration

Natural History is the study of all living things and their environment.

Cover: Ofu Island (with Olosega in foreground).

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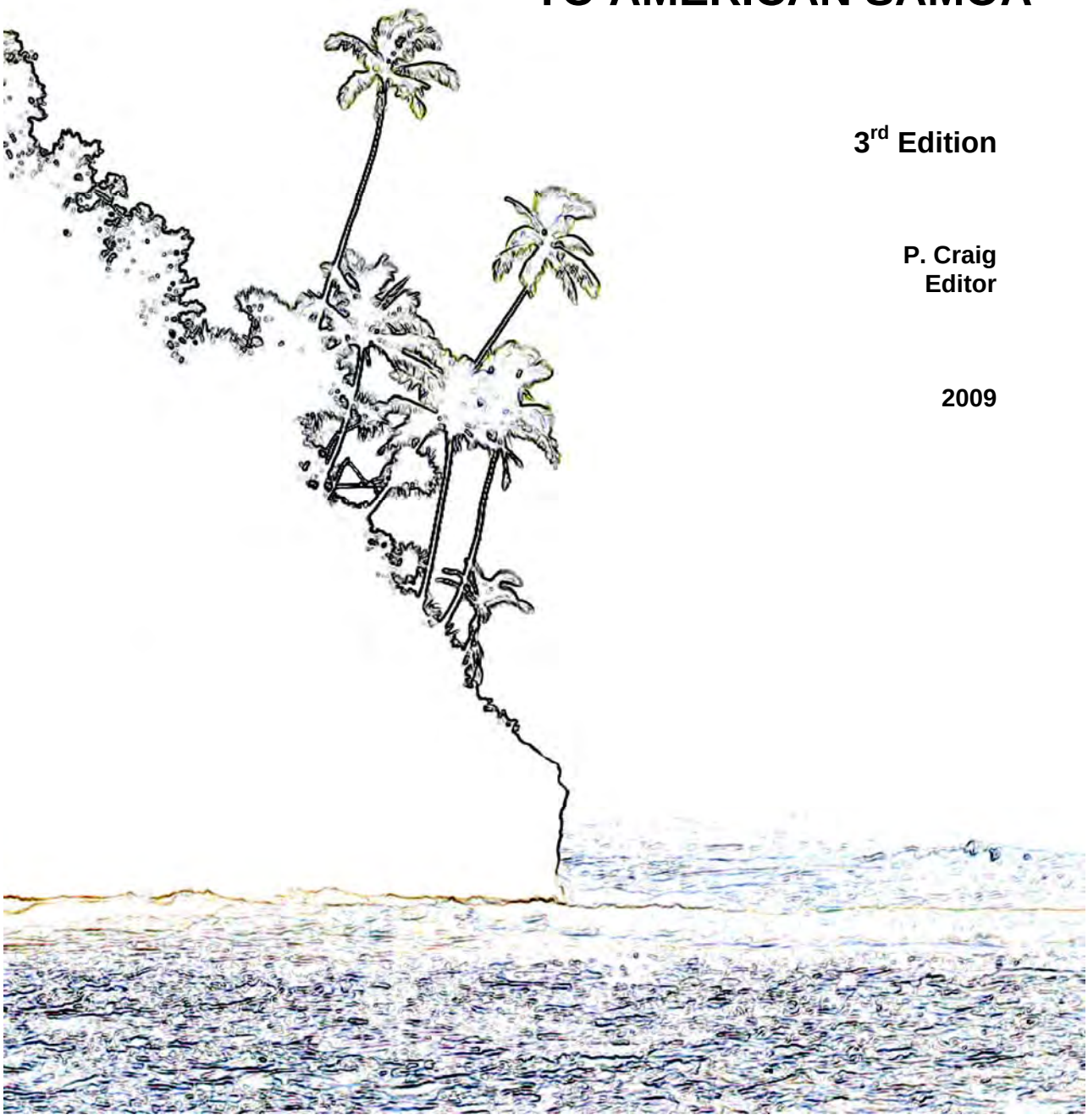

3rd Edition

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2009

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Preface & Acknowledgments

This booklet is the collected writings of 30 authors whose first-hand knowledge of American Samoan resources is a distinguishing feature of the articles. Their contributions are greatly appreciated.

Tavita Togia deserves special recognition as contributing photographer. He generously provided over 50 exceptional photos. Dick Watling granted permission to reproduce the excellent illustrations from his books “Birds of Fiji, Tonga and Samoa” and “Birds of Fiji and Western Polynesia” (Pacificbirds.com). NOAA websites were a source of remarkable imagery. Other individuals, organizations, and publishers kindly allowed their illustrations to be reprinted in this volume; their credits are listed in Appendix 3.

Matt Le'i (Program Director, OCIA, DOE), Joshua Seamon (DMWR), Taito Faleselau Tuilagi (NPS), Larry Basch (NPS), Tavita Togia (NPS), Rise Hart (RCUH) and many others provided assistance or suggestions throughout the text. Dr. George Zug (Smithsonian Inst.) provided an updated list of reptiles. Lelei Peau (DOC) spearheaded the effort to translate the Guide into the Samoan language.

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The use of English, Samoan and scientific names varies among chapters, so the reader is referred to cross-referenced lists in the species checklists in Chapters 33, 34, 56 and Appendix 2.

Acronyms used above: ASCC (A. Samoa Community College), DOC (AS Dept. Commerce), DOE (AS Dept. Education), DMWR (AS Dept. Marine & Wildlife Resources), NOAA (National Oceanic Atmospheric Administration), NPS (National Park Service), OCIA (Office of Curriculum, Instruction & Accountability), RCUH (Research Coop., Univ. Hawaii), USDA (US Dept. Agriculture).

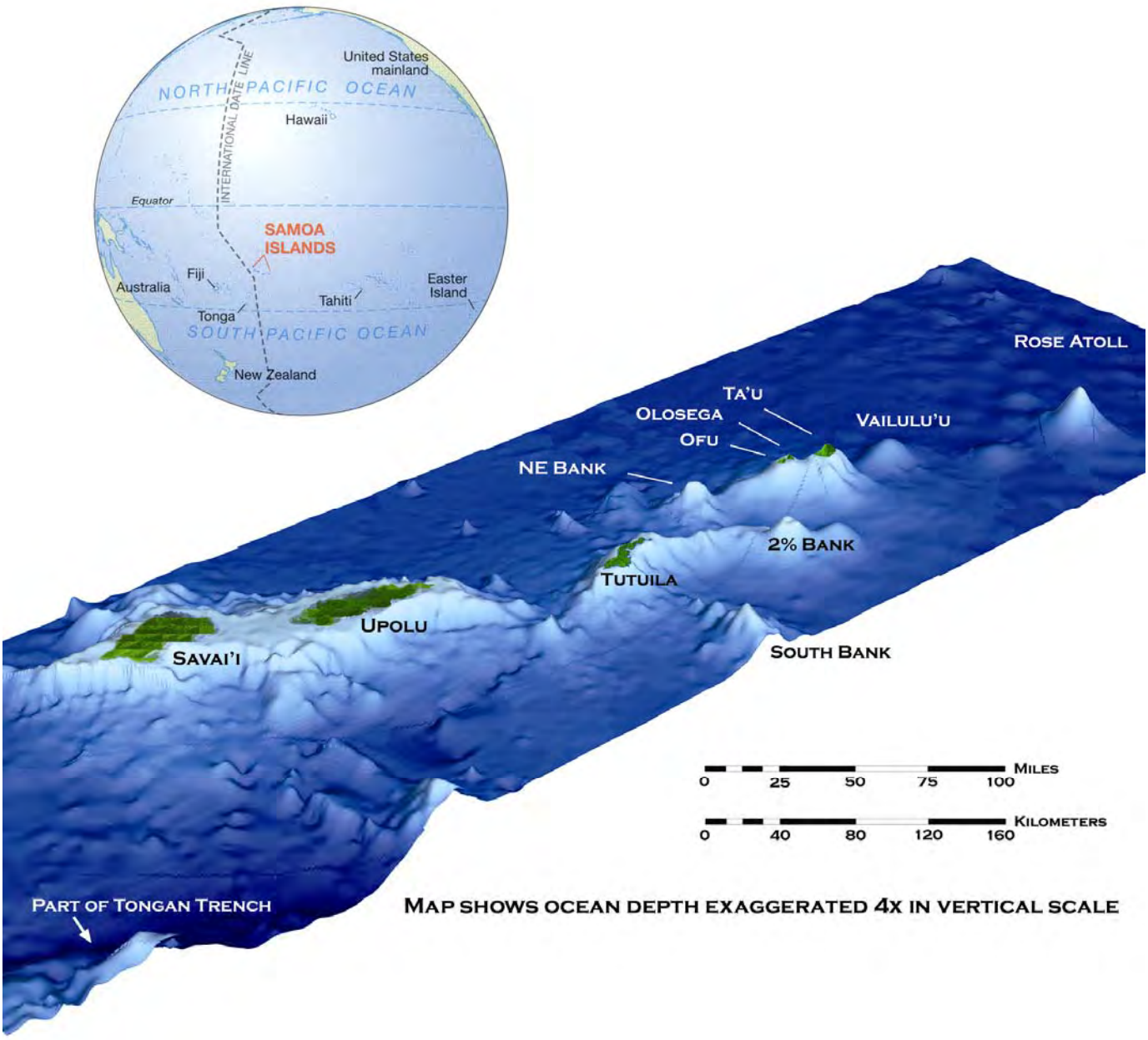
GENERAL TOPICS

MARINE ENVIRONMENT

TERRESTRIAL ENVIRONMENT

INTRODUCED PEST SPECIES

BIRDS



Island	Land area km²	Land area mi²	Marine[a] km²	Island type	Highest Pt. (m)	Population[b]
American Samoa						
Tutuila	136.2	52.6		volcanic	652	55,400
Ta'u	45.5	17.6		volcanic	965	873
Ofu	7.3	2.8		volcanic	494	494
Olosega	5.4	2.0		volcanic	639	216
Swains	3.6	1.4		atoll	5	37
Aunu'u	1.5	0.6		volcanic	88	476
Rose	0.1	0.1		atoll	5	0
Totals	199.6	77.1	304,300			57,496
Samoa						
Savai'i	1718	663		volcanic	1858	41,826
Upolu	1125	434		volcanic	1100	131,279
Manono	3	1.2		volcanic	107	955
Apolima	1	0.4		volcanic	168	80
Totals	2847	1099	120,000			174,140

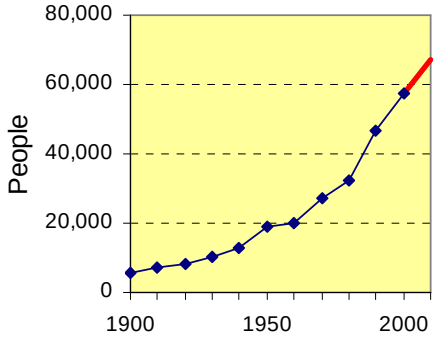
[a] EEZ (Exclusive Economic Zone).
[b] Census years: 2000 (American Samoa), 2001 (Samoa).

1. Local facts and maps

Samoan Archipelago. This remote chain of 13 islands (9 inhabited) and two atolls is located 14^0 south of the equator near the International Date Line. It is divided into two political entities, the US Territory of American Samoa and the neighboring independent country of Samoa, formerly known as Western Samoa. The land area of (western) Samoa is approximately 15 times larger than the land area of American Samoa.

Territory of American Samoa. The total land area of 76 mi^2 (197 km^2) includes five volcanic islands (Tutuila, Aunu'u, Ofu, Olosega, Ta'u) and two distant atolls (Rose, Swains). When marine waters out to 200 mi are included, the Territory is 117,500 mi^2 (nearly the size of the state of Oregon).

Population. Polynesians arrived here about 3,000 years ago. The current population (69,000 in 2009) is growing about 1.5 % per year, which equates to an addition of more than 1,000 babies and/or immigrants per year. The median age is 21 years, so continued growth is expected. Most people (96 %) live on Tutuila Island. The ethnic composition is Samoan (88.2 %), Tongan (2.8 %), Asian (2.8 %), Caucasian (1.0 %), and mixed or other (5.2 %). There is a sizeable demographic shift as (western) Samoans migrate into American Samoa and American Samoans migrate to the United States. About half of the people currently living in American Samoa were not born there. Over 128,000 Samoans live outside the territory.



Topography. The main islands are steep volcanic mountains that emerge from the ocean floor 2-3 miles below the sea surface. Peak elevations are 2,142 feet on Tutuila Island (Matafao Peak) and 3,170 feet on Ta'u Island (Lata Mountain).

Climate. Hot, humid and rainy year-round, but there is a long, wet summer season (October - May) and a slightly cooler and drier season (June - September). Total rainfall is 125 inches at the Tafuna airport and 200+ inches in mountainous areas.

Ocean. Nearshore waters are usually warm (82-86^0 F, 28-30^0 C) and clear (60-90 ft visibility). Fringing coral reefs surround the islands.

Tropical cyclones (hurricanes). While very destructive, cyclones are a natural but erratic feature of the environment in this part of the world. The most recent ones have occurred here at intervals of 1-13 years: 1981, 1987, 1990, 1991, 2004, 2005. Not all islands were damaged each time.

Native flora and fauna. Most native species are closely related to those in Indonesia, but due to our small size and remote location in the Pacific Ocean, the diversity of terrestrial species here is low: 343 flowering plants, 135 ferns, 25 resident or migratory land and water birds, 20 resident seabirds, 3 mammals (all bats), 3 skinks, 1 gecko, 2 sea turtles, and other occasional visitors. In contrast, the diversity of marine species here is high: 961 coral reef fishes, over 250 corals, and several whales and dolphins. Insects and other invertebrate species here are not well known.

Endemic species. Species found only in the Samoan Archipelago include one bird (the Samoan starling), one stream fish, several land snails, and about 30% of local plant species. Five flowering plant species are endemic to American Samoa itself. Few marine endemic species have been identified.

Threatened or endangered species. Federally listed species here include humpback and sperm whales, and the green and hawksbill sea turtles. Additional species "of concern" in the Territory include the sheath-tailed bat, 3 birds (Spotless Crake, Friendly Ground Dove, Many-colored Fruit Dove), several fishes (humphead wrasse, bumphead parrotfish, reef sharks), native land snails, and others.

Pests and weeds (invasive non-native species). There are many: rats, 3 bird species (2 mynas and bulbuls), feral pigs, dogs, cats, toads, house gecko, tilapia and molly fishes, African snails, tropical fire ants and other insects, about 250 alien vascular plants (many of them weed species), and others.

Dangerous species. Few. On land, no poisonous snakes, but a bite from a large 8-inch centipede can be extremely painful. In the ocean, sharks are generally not a problem but stepping on the poisonous spine of a stonefish can be a serious medical emergency although this rarely happens. Consumers of fish should note that ciguatera poisoning has been found (infrequently) in several snappers (locally called *mu*) and a few other fish species. Also, avoid eating any fish or invertebrate caught in Pago Pago Harbor, because they may be contaminated with heavy metals and other pollutants.

Tropical diseases. Malaria is not present, but two other mosquito-transmitted diseases can occur here: dengue fever (caused by a virus) and filariasis (elephantiasis, caused by a parasitic nematode worm). However, the chance of a visitor getting either is slight (see page 89). Leptospirosis, a common tropical bacterial disease spread through contact with the urine of infected animals (pigs, dogs, cats, rats), is fairly common among local residents; most infected people get mild flu-like symptoms, but it can be fatal.

Noteworthy environmental events by year. See Appendix 1.

Conservation areas as of 2009:

Site[a]	Year	Location	km^2	acres
Rose Atoll National Wildlife Sanctuary	1973	Rose Atoll	158.8	39,251
Rose Atoll National Monument[b]	2009	Rose Atoll	34,838.0[b]	8,608,470[b]
Fagatele Bay National Marine Sanctuary	1985	Tutuila	0.7	161
National Park of American Samoa	1988	Tutuila, Ofu, Ta'u	42.6	10,520
Vaoto Territorial Marine Park	1994	Ofu	0.5	120
Sea Turtle/Marine Mammal Sanctuary[c]	2003	All territorial waters (0-3 miles offshore)		
Community-based marine protected areas	-------	several villages	---	---

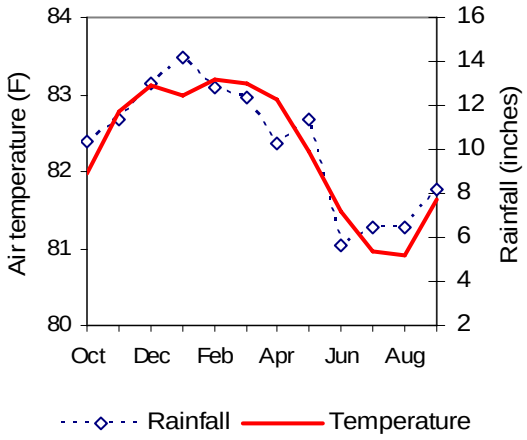
[a] Fishing is prohibited at Rose Atoll, but traditional subsistence fishing is permitted at most other sites listed. Village marine protected areas have been periodically opened to fishing.
[b] Includes deep ocean waters extending from Rose Atoll seaward for 50 miles.
[c] Governor's Executive Order No. 005-2003 established the turtle/marine mammal sanctuary.

Other "special management areas" in the territory are Pago Pago Harbor, Nu'uuli Pala Lagoon and the Leone wetlands.

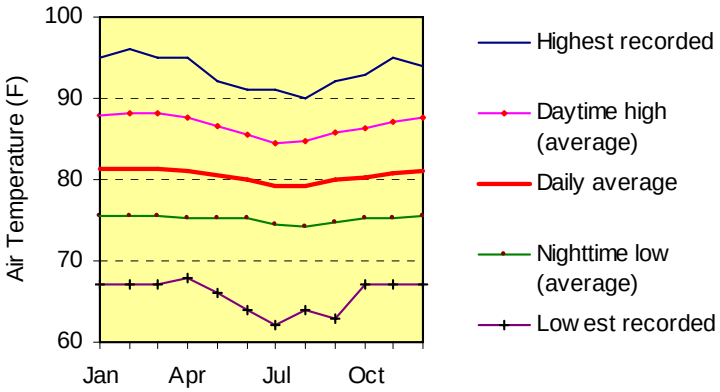
P.Craig, NPS

2. Seasons, weather and climate change

Samoa's weather is warm, wet and humid year round, but there are two seasons. Not exactly summer and winter, because Tutuila is a small dot in a vast tropical ocean, so the ocean strongly moderates our weather. Our seasons are sometimes referred to as tropical wet and dry periods, although it is never dry here for very long. The somewhat cooler, drier period is also referred to as the tradewind season when winds from the southeast blow more consistently, causing rougher waters on the south side of the islands.

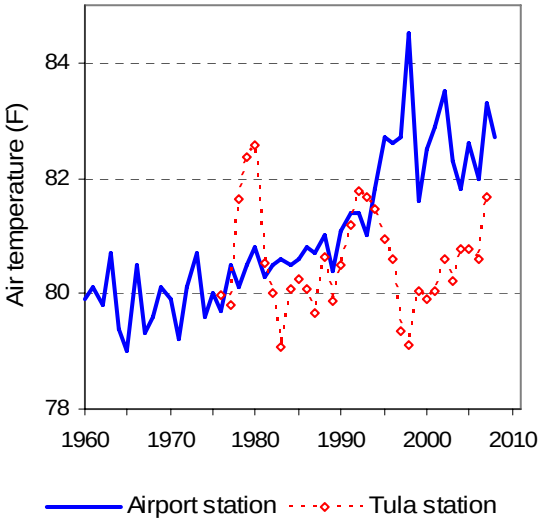


October through May is our 8-month hot and wet summer. Air temperatures in recent years have fluctuated from nighttime lows around 77^0 F to afternoon highs in the upper 80s. The relative humidity makes it feel hotter -- it fluctuates in the 80s (daily range 73-90% at the airport). We now average 60 days per year at 90^0 F or above. Record highs and lows here have been 96^0 and 62^0 F.



Average air temperatures (over a 24-hour period) during the warm season are $82\text{-}83^0$ F. Our cold spell occurs from June through September when average air temperatures plummet to 81^0 F and rainfall is reduced by half.

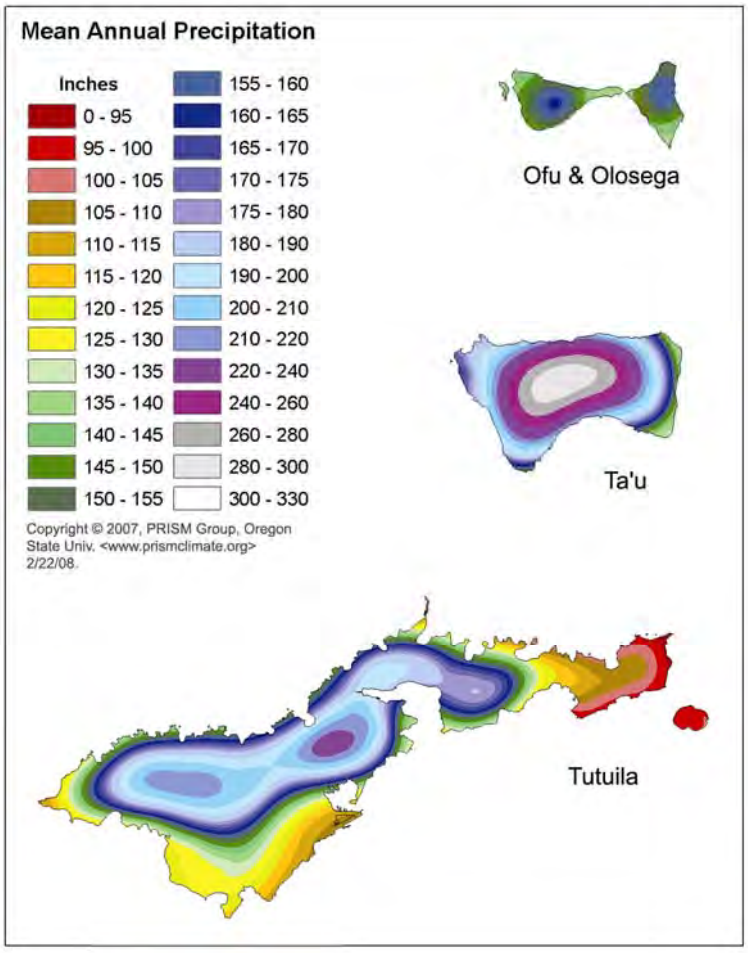
In the warmer months, nearshore ocean water temperatures are about $84\text{-}86^0$ F in shallow waters (0-30 feet deep) and 82^0 F in deeper waters (100 feet). In the cooler part of the year, the ocean is about 82^0 F.



If it feels like our climate it is getting warmer, it is, but the picture is a bit complicated. We have two long-term records of local air temperature, the NOAA weather stations at the Tafuna airport and Tula. Temperature trends at these two sites are quite different due to local conditions where the temperatures are actually measured. Temperatures measured at the airport weather station have risen dramatically over the past 20 years. The airport station measures air temperatures at a height of about 5.5 feet above the ground and near the runway (not an ideal location) on the Tafuna Plains, so it is unclear whether the rise is due to urbanization (more buildings and roads that absorb more heat) or to an increasing ground-level temperature. Whether other parts of Tutuila are warming in a similar fashion is not known. In contrast, the Tula station is on the

upwind side of the island, so it is less affected by near-ground conditions. It shows no systematic increase in temperature, as would be expected at our remote oceanic location.

Rainfall at the Tafuna airport weather station is about 6-14 inches per month, but the amount of rainfall we receive depends largely on where we are standing (see illustration). The eastern end of Tutuila and the Tafuna plains are the drier parts of the island with 125 inches per year or less. The mountains and harbor area are very wet -- they receive about 200-250 inches of rainfall per year. Lata Mountain on Ta'u receives over 300 inches (25 feet) per year.

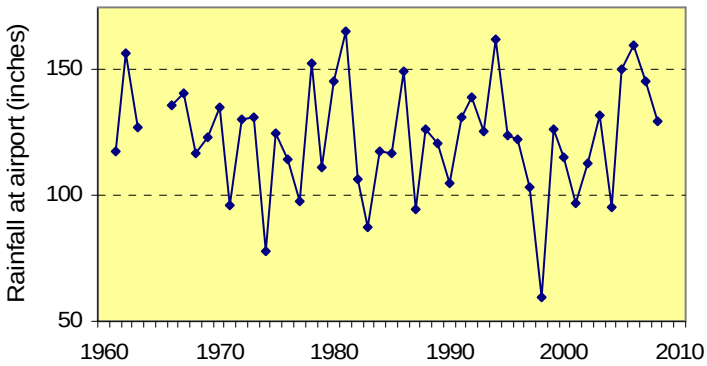


If it seems like it rains every day here, it almost does. In most years, the airport weather station detects at least a trace of rain 300 days per year. A noticeable amount of rain (at least one tenth of an inch) occurs on about 50% of the days of the year. But note that the airport, where these measurements are taken, is one of the driest parts of our island.

While land temperatures are warming, annual rainfall remains highly variable with no apparent long-term trend. The average rainfall over the past 47 years has been 123 inches (range 60-166 inches).

Returning to the topic of seasons, some plants and animals in American Samoa schedule their activities, such as flowering or spawning, according to the seasons. These biological events tend to occur over a much longer period in the tropics compared to colder regions of the world because the distinction between our two seasons is not great and growing conditions here are generally good year-round. Nevertheless, seasonal patterns of flowering and fruiting mean times of abundance or scarcity for some of our native wildlife, particularly the fruit bats (*pe'a*) and Pacific pigeon (*lupe*).

A few animals schedule their seasonal migrations to these islands to avoid winters elsewhere in the world. We see more golden plovers (*tuli*) during the October to March period when they flee winter in the northern hemisphere, while humpback whales (*tafolā*) visit us in August-October when they escape winter in the southern hemisphere.



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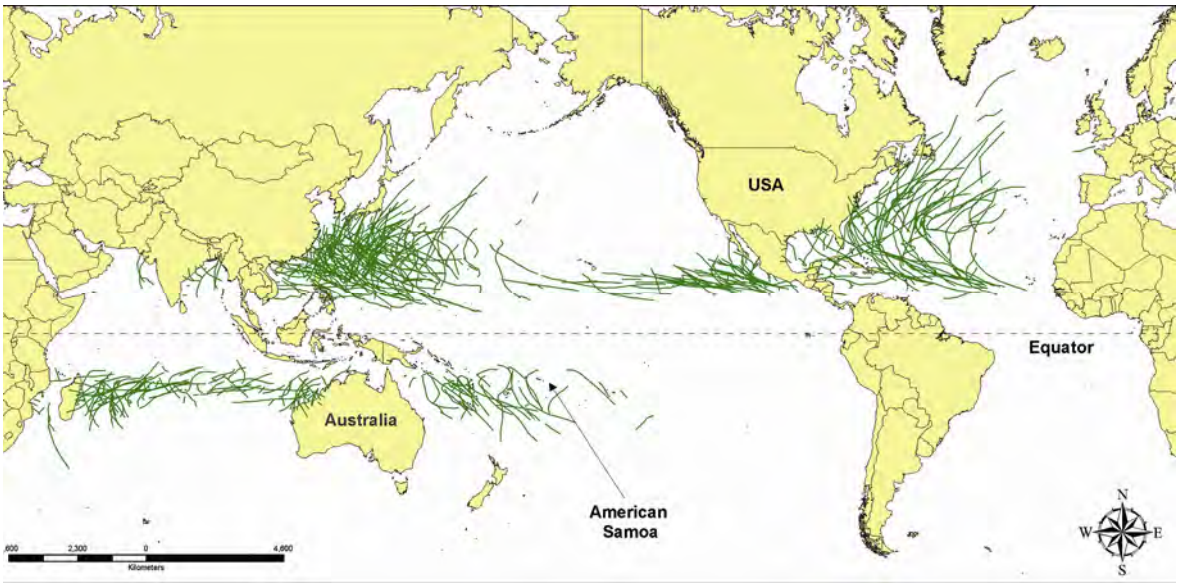
3. Cyclones (*afā*)

As our tropical summer progresses, the temperature of the ocean's surface waters increases by about 3^0 F. Warmer ocean temperatures help provide the energy to start tropical cyclones, so the chance of a cyclone here is greatest between November and April. Cyclones have hit American Samoa at intervals of 1-13 years during the past 30 years: 1981 (Esau), 1987 (Tusi), 1990 (Ofa), 1991 (Val), 2004 (Heta) and 2005 (Olaf). Their severity varied -- Tusi was particularly damaging to Manu'a, the back-to-back cyclones Ofa and Val hit Tutuila hard, Heta's overall impact was moderate, and Olaf slammed into Manu'a with Category-5 force.

Tutuila Island after Cyclone Val in 1991.
Also note loss of forest foods for wildlife.

Damage to Onenoa in 2004 (Cyclone Heta).

A world map of cyclone tracks helps put some perspective on American Samoa's susceptibility to tropical cyclones. This map shows the tracks of all cyclones greater than 74 mph during the 10-year period 1994-2003. It shows that cyclones are generated primarily in two bands that lie north and south of the earth's equator at latitudes of about $10\text{-}30^0$. American Samoa lies near the edge of the cyclone band in the southern hemisphere where cyclone activity begins to fade.



Tracks of tropical cyclones during the 10-year period 1994-2003.

It is curious that there are no cyclones along the equator or around South America. This occurs because cyclones require two general conditions to develop: (1) warm ocean waters at least 80^0 F (26.5^0 C) to fuel the cyclone, and (2) enough Coriolis force (caused by the earth's rotation) to provide stability and spin to

a developing storm. Coriolis force is weakest along the equator, so storms there remain unstable and do not develop into cyclones. South America has few cyclones due to cool water temperatures (upwelling along the west coast) or other climatic conditions (on the east coast) that are not conducive for cyclone development.

Patchy brown areas stripped of leaves and fruit by Cyclone Heta in 2004 (Tutuila Is.)

Fitiuta after Cyclone Olaf in 2005. In some areas, every tree was uprooted, snapped or lost its crown. (Ta'u Is.)

Cyclones are a regular but erratic feature of the environment in our part of the world, so it is likely that native species here are able to cope with cyclone impacts and recover, given enough time and assuming that their recovery is not jeopardized by human-related conditions such as habitat loss due to urbanization, competition by invasive alien species, or changing environmental conditions due to global warming.

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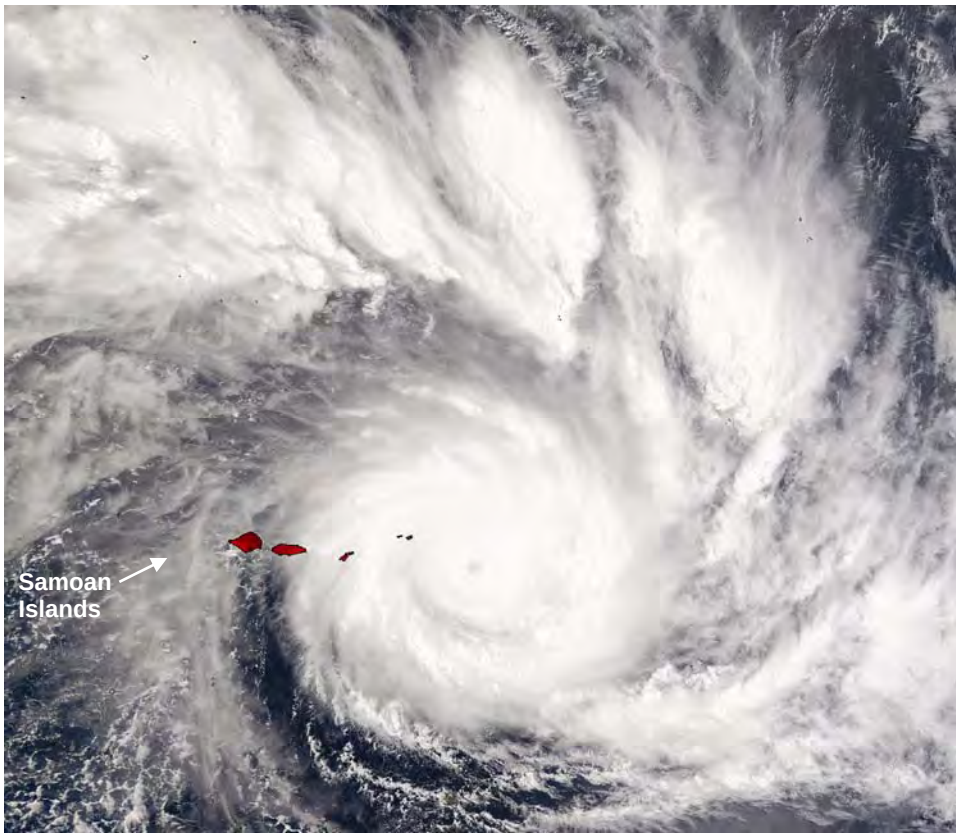


Satellite photo of Cyclone Olaf (Category 5) moving southward through the Samoan islands (dark red spots) in February 2005.

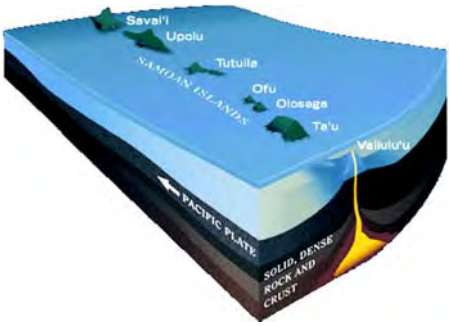
4. This volcano we live on

The geology of the Samoan islands is surprisingly interesting. First, we are living on a volcano, which is resting at the moment. Second, our volcano is on the move -- it's traveling towards China. And, finally and most unfortunately, our volcano will eventually sink back into the dark ocean depths.

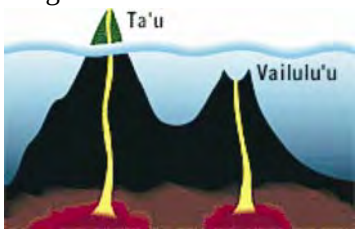
About 1.5 million years ago, our volcano spewed forth enough lava to rise up out of the ocean and become “Tutuila Island”. Actually, just the tip of the volcano is visible to us -- most of the mountain is underwater. While the tallest mountain peak on Tutuila is about one half mile high, the mountain extends another 2-3 miles below the sea surface.

It is not much of an exaggeration to call the Samoan islands 'active volcanoes'. These islands were formed by volcanism, and the volcanoes are still active, in a geologic timeframe of course, and due to some unusual circumstances as described below. The most recent volcanic eruptions were not that long ago. In Samoa, major eruptions occurred in 1905 when lava flows destroyed a village. In the Manu'a islands, subsurface volcanic eruptions and earthquakes occurred in 1866, causing dense clouds of smoke and pumice to erupt from the ocean surface for several months. 100 years ago is just a blink of the eye to a volcano, which measures time in the millions of years. We tend to forget how briefly people have lived upon these shores. Human habitation on Tutuila, even considering the whole 3000-year period that Samoans have dwelt here, represents a mere 0.2% of the time since the sun first shone on this new land.

To explain our volcano's slow-motion march towards China, we first need to review the nature of the earth's surface or crust. The earth's outer layer, the one we live on, is several miles thick, but that is a thin skin compared to the total size of the earth. This outer layer is made up of many separate sections that seemingly float on top of the earth's molten core and move about in very slow motion. Geologists call these outer sections “plates”. You may recall, for example, that the continents of Africa and South America were once joined together when the earth first formed, but the two continents slowly drifted apart to where they are today. The same process applies to the plates under the Pacific Ocean. The plate we're on is called the Pacific Plate and it is moving westward (towards China) at a leisurely speed of about 3 inches per year. At this rate, in one million years we will be 50 miles closer to China.

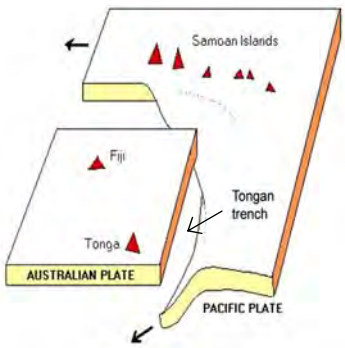


It is not accidental that the islands of American Samoa and western Samoa lie in a rather straight line. Directly underneath us is what geologists call a “hot spot” of thermal activity in the earth's core. It's a volcano just waiting to happen. When the pressure builds up at the hot spot, molten magma bursts up through the Pacific Plate and forms a volcanic island. Then the hot spot calms down for awhile, perhaps a million years or so. During this peaceful interval, the Pacific Plate keeps marching onward, so when the hot spot acts up again, it forms a new volcanic island rather than building upon the previous one. In other words, the hot spot stays in one place but the plate above it keeps moving. The islands generally lie in a straight line that is oriented in the direction the plate is moving. The new islands form on the eastern end of the chain, so the islands become progressively older as you move westward. For that reason, the islands in western Samoa are about 1 million years older than the islands in American Samoa. The newest volcanic eruption in our island chain is forming about 30 miles east of Ta'u Island, but it will probably be another few hundred years before this sub-surface volcano, named Vailulu'u, breaks the sea surface (in 2005 it was 1800 feet below the surface and growing).

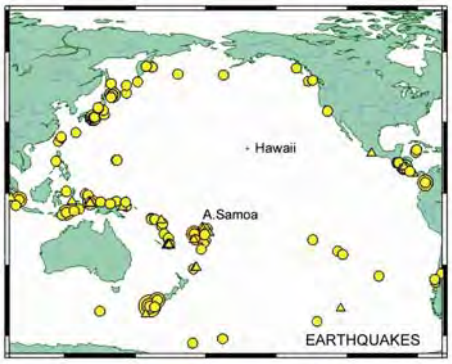


But something else really exciting happens in our area. As Tutuila Island glides westward, a part of our plate collides with another plate to the west of us (the Australian Plate), and our plate actually rips in two at this point (see diagram on next page). One piece of our plate continues moving towards China, but the other piece slides down into the 6-mile deep Tongan Trench and under the Australian Plate, never to be seen again. The collision of these two colossal pieces of the earth's surface causes the seafloor to bend and rip, which in turn causes some earthquakes. This is shown on the map (next page) which pinpoints all earthquakes (magnitude 6.0 or greater) in the Pacific region in 2004 -- the Samoan islands and the Tongan Trench are geologically active areas. Recent surveys suggest how this might be

happening. Long cracks in the seafloor have been discovered between our islands and the Tongan Trench. The cracks are oriented in an east-west direction and seem to be formed as the seafloor bends southward down into the top of the Tongan Trench. Perhaps these cracks make it easier for the hot magma beneath the crust to spew upward and emerge as young lava on top of our old islands. And all this is happening a mere 100 miles south of Tutuila Island. We live in a unique area.

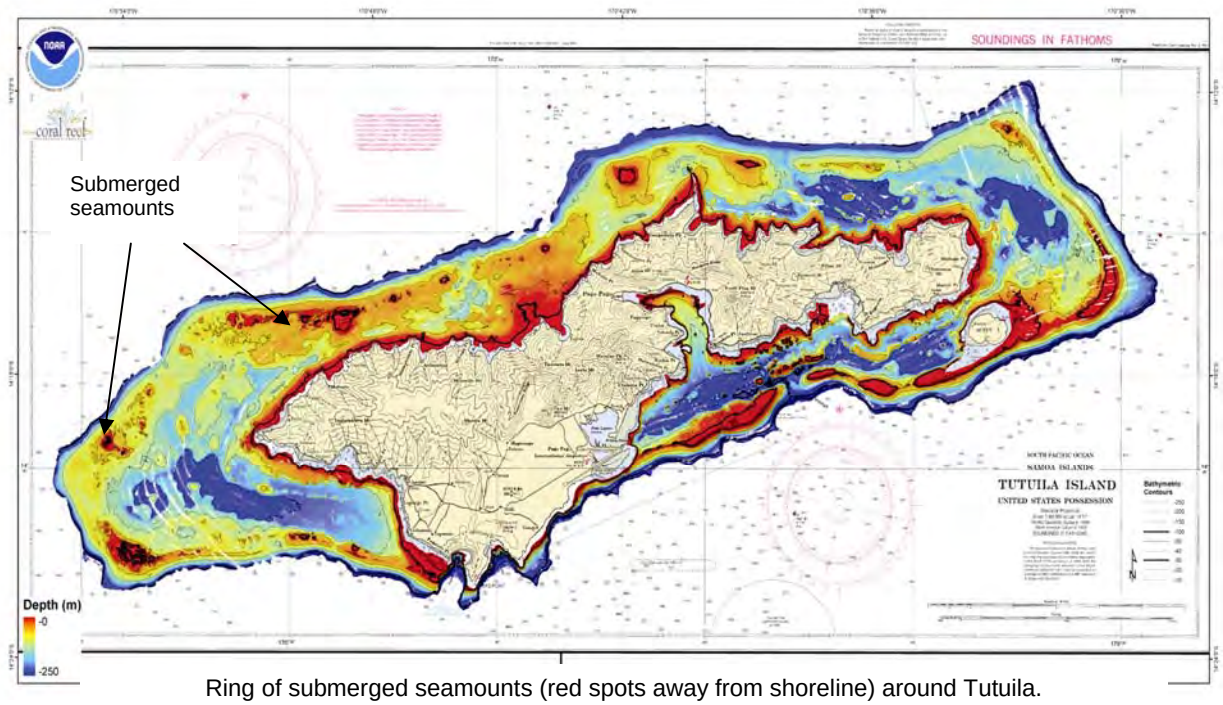


Eventually most oceanic volcanoes disappear. As time passes, two things happen. The volcano erodes continuously as ocean waves attack its shorelines and rivers gouge into its terrain. Additionally, the weight of a newly formed volcano is so heavy that it causes the volcano to sink slowly back down into the sea. Rose Atoll and Swains Island are good examples of sunken volcanoes. In the distant past, Rose and Swains may have been magnificent mountainous islands with beautiful rainforests and coral reefs. But that's ancient history now, because those islands, over a period of several million years, eventually sank out of sight. All that remains are tiny amounts of coral that grew up from the peaks of the mountains as they slipped below the sea surface.



There is an additional factor to consider – a major change in sea level occurred during the last ice age over 10,000 years ago. At that time the world's sea level was about 390 feet lower than it is today because vast quantities of water were locked up in glaciers and in the polar ice caps. We can see evidence of this locally. New benthic mapping by NOAA indicates that Tutuila was somewhat larger when the sea level was lower, and it was surrounded by a ring of barrier islands that were separated from Tutuila itself by lagoons (see map below). Taema Bank across from Pago Pago Harbor was one of these barrier islands. It must have been gorgeous. But later, as the glacial ice melted, the growth of these coral reefs was unable to keep pace with the rising water so the reefs "drowned". They are now a necklace of submerged seamounts around Tutuila. Not to worry. Tutuila Island should be around for a few more million years.

P.Craig, NPS



Ring of submerged seamounts (red spots away from shoreline) around Tutuila.
These were probably barrier islands when sea levels were lower.

5. Biodiversity in our rainforests and coral reefs

There's a certain mystique about the word 'biodiversity' that seems to be associated with images of steamy jungles or wondrous new medicines, but the word more specifically refers to the number of species or 'species richness' of an area. One reason why tropical areas are so fascinating is that they contain the highest numbers of plant and animal species found anywhere on earth.

American Samoa sits squarely in the tropics, so we should have a high biological diversity here, but we do and we don't. There is a sharp contrast between the number of plant and animal species that live on land here (few) versus those that live in our coastal waters (many). Most small islands in the South Pacific share this characteristic.

To start at the beginning, when our islands emerged as fiery volcanoes from the depths of the sea, they were devoid of plants or animals. As time passed and the terrain became more hospitable, life for organisms became possible, but the plants and animals still had to cross vast ocean distances to get here from someplace else.

A quick look at a map will show one reason why few land species got here. We are really quite isolated in the Pacific Ocean, far from potential sources of plants and animals. To reach our shores, organisms would either have to blow in on the wind, drift for hundreds or thousands of miles on some piece of floating debris, or be carried in by another organism like plant seeds in a bird's stomach. The species that were successful probably got here by 'island hopping' across the Pacific, spreading from island to island over the course of many thousands or millions of years.

The difficulty in getting here is best illustrated by the sparse representation of native mammal species. Over the past 1.5 million years that Tutuila Island has existed, only 3 mammal species (all bats) got here and established viable populations. Our native species list also includes about 478 flowering plants and ferns, 18 resident or migratory land and water birds, 20 resident seabirds, 3 skinks, 1 gecko, 2 sea turtles, and occasional other visitors (this list does not include any species presumably introduced by early Polynesians or all the recently introduced non-native species like rats, dogs, pigs, toads, myna birds, and many weeds).

There's a second reason for our low diversity on land -- the small size of our islands. In general, the smaller the island, the fewer the species on it. For example, tiny Rose Atoll (0.4 sq mi) supports only 5 native plant species, 21 birds (virtually all seabirds), 2 geckos, and 2 sea turtles.

So, although American Samoa technically has 'tropical rainforests' due to our high level of rainfall (200-300 inches per year in some mountainous areas), we lack the high species richness found in the jungle rainforests of Indonesia, Africa or South America that are filled with hooting monkeys, poison dart frogs, pythons, and flesh-eating piranhas.

On the other hand, because of our isolation, some terrestrial species in Samoa have evolved over many thousands of years to such an extent that they have become distinctly different species found nowhere else but here. For example, 30% of our plant species and the Samoan starling (*fuia*) occur only in the Samoan archipelago (which includes western Samoa); and the Samoan fruit bat occurs only in the Samoan and Fijian islands. So, our rainforests may lack diversity, but they contain some species found nowhere else on earth.

Turning to our marine environment, we find the opposite situation. There is an incredibly diverse ecosystem just beneath the waves. Coral reefs are among the most species-rich ecosystems in the world. We have, for example, 961 nearshore fish species which is an amazingly high number compared to many other coastal areas. To get a sense of this species-rich environment, if you were to dive on our reefs once a week, you could in theory see a new fish species on every dive for 18 years.

Although coral reefs are limited to shallow waters, usually around the fringes of islands, most coral reef species have eggs and larvae that can survive for weeks or months in the open ocean and get dispersed by ocean currents to new locations (see Chapter 11). As a result of this genetic exchange of marine organisms between islands, there are probably few marine species that are unique to the Samoan islands.

Finally, superimposed over the South Pacific region is a large-scale pattern of species distributions. Most of our marine and land species can be traced back to the same or related species inhabiting mainland and insular southeast Asia. From that center of remarkably high diversity, rainforest and coral reef species radiated out, spreading eastward across the South Pacific islands. But like ripples in a pond, the farther away one gets from that 'center', the fewer the species (see map below). This same pattern applies to corals, fishes, sea turtles, seagrasses, mangroves, land birds, and plants. Very few species reached here from the opposite direction (South America) probably due to the much greater distance and fewer islands in that direction to facilitate 'island hopping'.

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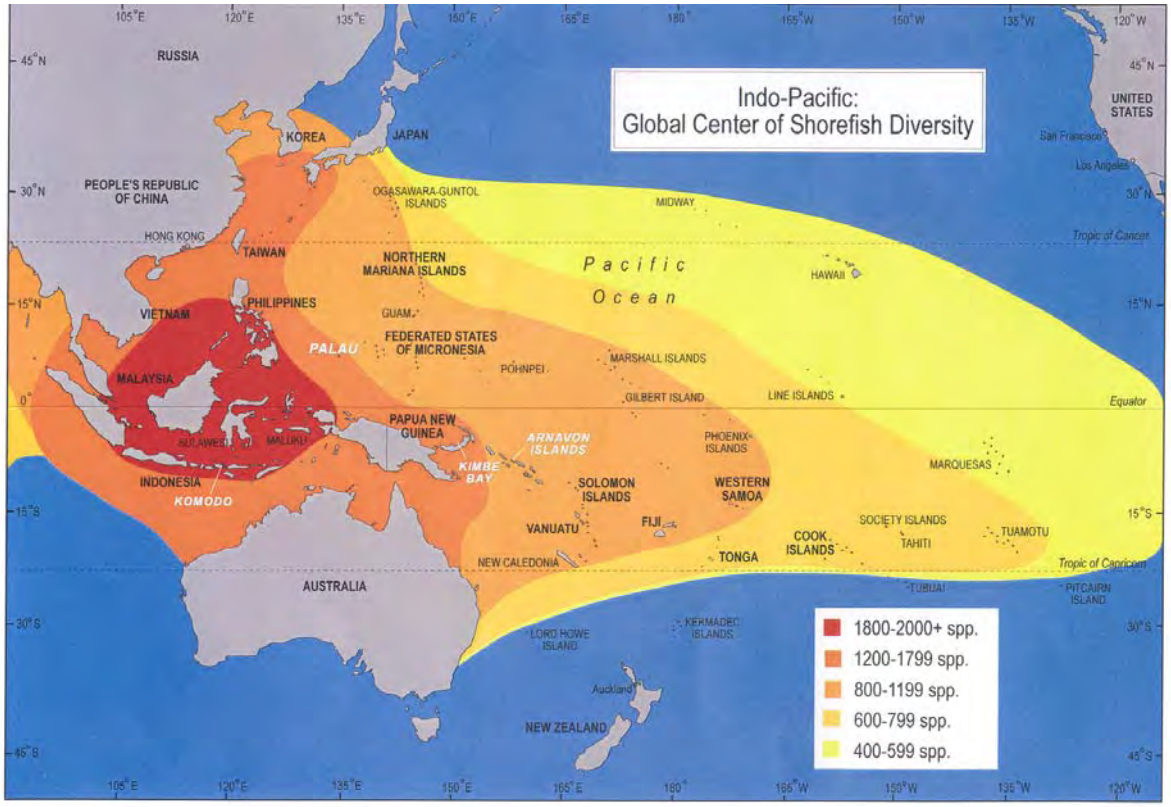

Contours represent the number of tropical fish species (reef, inshore and epipelagic species).

6. Status of species in American Samoa

Taxonomic Group	Native species	Archipelago endemics (in AS)[1]	Rare, threatened or endangered species[2]	Incidental species	Locally extinct[3]	Introduced & invasive* species	Ref. next page
TERRESTRIAL FAUNA AND FLORA							
Mammals	3 bats	Samoan fruit bat[4]	Sheath-tailed bat (C1)		Sheath-tailed bat?	rats*, feral pigs*, dogs, cats, house mouse	1
Birds	18 land/water birds, 7 regular migrants, 20 seabirds	Samoan starling	Spotless crake (C1), Friendly ground dove (C1), Many-colored fruit dove (C1)	See bird checklist	*Mao* , Megapod	mynas*, Bulbul*, Rock dove, Red junglefowl	1,2
Land reptiles, etc.	1 gecko, 3 skinks		Pacific boa snake (R)			cane toad*, 4 geckos, 5 skinks, 2 snakes	1
Fish: freshwater	8-12 fishes[5]	*Stiphodon hydoreibatus*				Mexican molly, mosquitofish, tilapia	3
Crustaceans	9 stream shrimps, several land crabs		coconut crabs rare in urban areas				4
Insects	2,523+ insects[6]					probably many	5
Snails	47 land snails, 17 freshwater snails	16 land snails	8 land snails (C1, SC), several others rare		*Diastole matafaoi*	African snail*, rosy wolf snail*, 3 slugs, 22 others	6
Plants	343 flowering plants, 135 ferns	30%	109 species (R)			over 250 alien species, many invasive	7
MARINE FAUNA AND FLORA							
Marine mammals	11 whales,7 dolphins[7]		Humpback, Sperm whales (E)			none known	1,8
Marine reptiles	Hawksbill & green sea turtles		Hawksbill turtle (E), Green sea turtle (T)	Leatherback turtle, Olive ridley turtle, Banded sea snake		none known	1
Fish/sharks	961 coral reef species, 101 deep or pelagic species	see note in Reference 9	large species not common	whale shark		none known	9
Invertebrates	250+ corals, 352 snails		giant clams are rare in some areas		giant clam (*Hippopus hippopus*)[8]	2 giant clams (*Tridacna derasa, T. gigas*) & 30 misc. species	6, 10
Marine plants	239+ algae, 2 seagrasses, 2 mangroves					4 algae species	11

Footnotes: [1]Additional endemic species occur in (western) Samoa. [2]Abbreviations: E (endangered), T (threatened), C1 (candidate listing), SC (species of concern), R (rare). [3]Recent extinctions. [4]Distribution includes Fiji. [5]Excludes brackish water species near stream mouths. [6]Includes (western) Samoa. [7]Includes species probably common in region but have not yet been documented in Am. Samoa. [8]Re-introduced in 1997. *Invasive non-native species that harm native ecosystems. Note: blank spaces mean no known species or no data available.

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Selected references for "Status of species" table (previous page)

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7. An environmental snapshot of American Samoa in 2009

How healthy is our environment in American Samoa? We can get a sense of this by looking at the status of some parts that make up our island environment in 2009. In the boxes below, an upward arrow indicates an environmental improvement. A downward arrow indicates a resource problem. These ratings will, of course, change as the years go by.

THE MARINE ENVIRONMENT

Coral reefs. The status of coral reefs in American Samoa is mixed. One the positive side, the corals are currently in generally good condition, having recovered from massive cyclone damage in 1991. Some recent damage occurred in Manu'a during cyclones in 2004 and 2005, but given the observed resilience of corals in the territory and the generally low level of human stressors here, regrowth is expected. There have also been improvements to local reefs: the removal of a shipwreck at Rose Atoll, a ban on the export of "live rock" (coral rubble), a ban on scuba-assisted fishing (at night) due to overfishing, and the establishment of a sanctuary for sea turtles and marine mammals in all territorial waters (0-3 miles offshore). At the same time however, local reefs show signs of fishing pressure (there are few large fish or sharks). A major looming issue is global warming which warms nearshore waters causing the corals to bleach and/or die. Some warm-water bleaching now occurs annually and significant bleaching events occurred in 1994, 2002 and 2003. Recent episodes of coral disease are also of concern. Additionally, some coastal pollution continues – high counts of bacteria (mostly from streamside piggeries) often make swimming near streams unsafe, and the unsightly dirt and rubbish flowing from the streams after heavy rainstorms is harmful to corals.

Pago Pago Harbor. For decades, our harbor has been an environmental write-off due to its degraded condition (frequent fuel spills, toxic fish, contaminated substrates, extensive sedimentation, eutrophication, noise, air pollution). In recent years things have gotten better. In 1991 the canneries were required to stop dumping their wastes into the inner harbor. Now their fish wastes are piped to the outer harbor and discharged in deep water (176 ft depth) where there is better circulation, and the cannery's high strength wastes are hauled daily to a dumping zone 5 miles offshore. This has made a noticeable improvement in water quality and we are now seeing some corals growing there again. Another improvement is that the 9 shipwrecks in the harbor were finally removed in 2000 after rusting on the reefs for 9 years. Bear in mind that harbor recovery has a long way to go. Harbor sediments and some fish and invertebrates are still contaminated with heavy metals, and an old sunken ship still contains a cargo of fuel. Excessive quantities of dirt and plastics flood into the harbor after heavy rainstorms. Swimming in the inner harbor is not recommended.

Reef fish. Our reefs support large numbers of small to moderate-size fish (surgeonfish, parrotfish, damselfish, butterflyfish), but large fish and sharks are not often seen. To help reduce fishing pressure, the use of scuba-assisted fishing at night was banned in 2001. Consideration now needs to be given to developing effective Marine Protected Areas to provide long-term protection to fish stocks.

Sea turtles. Green and hawksbill turtles are the main species here, but their populations are in serious decline, both locally and throughout the South Pacific due to harvest, habitat loss of nesting beaches and incidental catches in fishing gear. Surprisingly, "our" green sea turtles are also vulnerable to harvest in Fiji. Tagging data show that most green sea turtles nesting at Rose Atoll migrate to feeding grounds in Fiji 800 miles away. Sea turtles are now officially listed as "threatened or endangered species", and the hawksbill is "rapidly approaching extinction" in the South Pacific, according to a scientific review.

Whales. Humpback whales migrate here to mate and give birth to their young, mostly in September and October. Local populations are still few in number, probably because 95% of their stock was killed by whalers in the 1800's and 1900's. Although commercial whaling was banned in

1966, the recovery of southern-hemisphere populations has been slow, probably due to continued whaling in the Antarctic by Soviet factory ships as late as 1972.

THE TERRESTRIAL ENVIRONMENT

↑ **Rainforests**. 30% of our plants are endemic to the Samoan Archipelago. The island's steepness currently protects much of the rainforest from ever-expanding human activities, but the lowland rainforests that formerly covered the Tafuna plains have been mostly replaced by houses, roads and plantations. Tutuila's rainforests have recovered from severe cyclone damage in 1991, but a growing concern now is that invasive, non-native plant species are beginning to out-compete native species in some areas. More recently, rainforests in Manu'a took a direct hit by Cyclone Olaf in 2005. Although there was massive damage to the landscape, recovery is underway.

↑ **Wildlife**. In general, wildlife populations on Tutuila have recovered from previous cyclone damage in 1990 and 1991 when birds and fruit bats (flying foxes) were decimated. Their recovery was greatly aided by DMWR's ban on hunting that's been in effect since those cyclones. But some terrestrial species are not doing very well. The sheath-tailed bat was wiped out by the 1991 cyclone and has not been seen in recent years. Other rare birds include the many-colored fruit dove, friendly ground dove and spotless crake. The Pacific boa snake is also rare and now found only on Ta'u Island. Native land snails are disappearing due to an introduced species, the pink predatory snail.

↓ **Pest and weed species**. Invasive pest and weed species are doing quite well. These are newly introduced species that out-compete the native species because the pests and weeds have no natural enemies on our islands. Some examples are the *tamaligi* (*Falcataria moluccana*) trees that overtop the native forests, the noisy myna birds that populate our urbanized areas, the weedy vines that drape over the landscape, the toads that are everywhere, tropical fire ants, feral pigs, African snails, rats, etc.

↓ **Wetland loss**. Wetlands are special habitats that occur in only a few places around the Territory. They support mangroves, fish, shellfish and other species not found elsewhere on the island, and wetlands are important in moderating stormwater runoff and sedimentation that would otherwise flow onto our coral reefs. The island's wetland areas continue to dwindle in size as people fill them in for other uses. The former mangrove areas in Pago Pago Harbor are long gone, and the other main wetlands at Pala Lagoon and Leone are threatened by human activities.

↓ **Population growth.** The growth rate of people in American Samoa is a significant issue that affects all aspects of life on Tutuila Island. The current population of 69,000 (in 2009) is growing rapidly at an annual rate of about 1.5%, which equates to an increase of 1,000 people, 400 cars, and 300 houses every year. This growth rate is simply not sustainable on our small island. Environmental issues include: traffic congestion, loss of wetlands, solid and hazardous waste disposal, soil erosion and coastal sedimentation, fishing pressure, and potential contamination of drinking water.

SUMMARY: Island environments in this part of the world are subjected to a continuing cycle of damage and recovery from cyclones (hurricanes). These storms occur irregularly here, hitting at intervals of 1-13 years over the past 30 years. The impact of each one is generally patchy, with small refugia remaining here and there, and not all islands in the archipelago are hit at any one time. Because cyclones are a predictable feature of the local environment, it is likely that most native species living here can cope with this severe disturbance and recover, given enough time, and assuming that their recovery is not jeopardized by human activities. A full recovery cycle probably takes at least 10-20 years. But we also have other serious environmental issues to deal with over the next decade, such as population growth, climate change, coral reef bleaching, invasive pest and weed species, fishing pressure, and land-based sedimentation and nutrients that flow onto our coral reefs.

P. Craig, NPS

8. The first Samoans: archaeology of Tutuila and Manu'a

Based on archaeological evidence, the first people in Samoa arrived about 3000 years ago. Archaeology is the study of the human past using evidence left by people from those days. This information can take many different forms, and archaeologists use many different tools and techniques to investigate them. In some ways archaeologists are like detectives, trying to piece together clues over time to figure out what happened in the past. This information can be important to Samoans today because this is one method for understanding the long-term history of Samoan culture.

The earliest evidence of people living in Samoa came from Mulifanua Village on Upolu Island where many pieces of broken clay pots were discovered in the 1960's. These pieces, dated back to 2700-2900 years ago, were especially important because they bore the distinctive artwork designs that belonged to an early Pacific culture called "Lapita". About 2700-3000 years ago, the Lapita people spread from the Bismarck Archipelago in Papua New Guinea to many Pacific islands. These were the first humans to find and settle places like Vanuatu, New Caledonia, Fiji, Futuna, Uvea, and Tonga. In the Samoan archipelago, the Mulifanua site is the only Lapita site that has been found anywhere, in spite of three decades of searching.

For about the next 1000 years, the ancient people of Tutuila and Manu'a made undecorated clay pottery called Samoan Plain Ware. These were mostly open bowls with round bottoms, similar in size to eating and mixing bowls that people use in their kitchens today. Villages or areas with archaeological sites where Samoan Plain Ware has been found include: Afono, Aganoa, Alega, Aoa, Asufou, Aunu'u, Auto, Faleniu, Fatumafuti, Kokoland, Leone, Malaeimi, Malaeloa, Mesepa, Pavaia'i, Puna (Pava'ia'i/Faleniu), Tafuna, Ta'u Village, Toaga (Ofu), Utumea (east), Vaipito (Pago Pago), and Vaoto (Ofu). About 1500 years ago, people in Samoa stopped making pottery for unknown reasons.

While pieces of broken pottery scattered over an area give archaeologists a great way to find archaeological sites, archaeologist can also look for large features constructed from rock by humans. These include house foundations (*fale*), terraces (*lau mafola*), walls (*pa*), grinding stones (*foaga*), and platforms (*tia*) that are visible on the ground surface (see example on next page).

Archaeologists excavate a house foundation on Ofu Island.

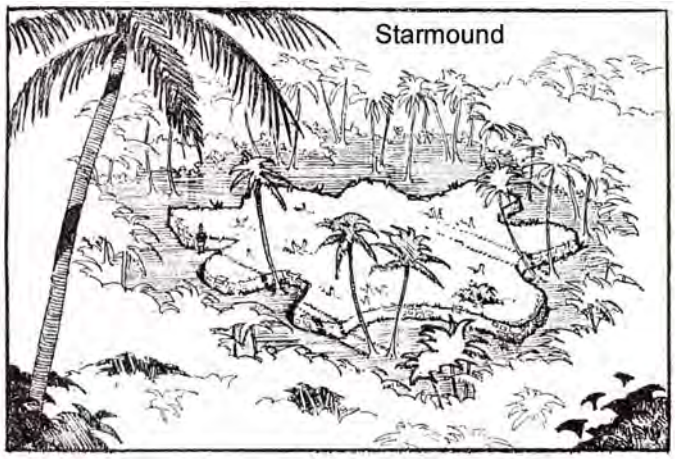
However, for the next 800 years, archaeological sites are hard to find in the period after pottery use stopped and before big surface constructions started. For this reason, these 800 years have been called the Samoan "Dark Ages". We know relatively little about this period which is ironic because this period is thought to be very important to the development of the Samoan culture and *matai* system that was in place when Europeans arrived in Samoa.

The most complete archaeological site from the Dark Ages is an ancient village buried under the ground at Fatumafuti on Tutuila. People started to use the site about 1500 years ago when sea-levels in the Pacific fell to their current level. Before this, Fatumafuti and similar coastal areas would have been open reef and water right to the edge of the mountains. It was only after sea-levels fell that sand and coral could begin to build up and form the coastal shelf we see today. After a beach developed at Fatumafuti,

people presumably began using the area and eventually they built houses there. We know from the remains of their food (shells and bones) that they ate a lot of fish and mollusks from the reef like *alili* (turban snails), *faisua* (giant clams), and *aliao* (top snails). The burial sites at Fatumafuti tell us that changes must have occurred in people's belief system, because the early burials are all oriented parallel to the beach, but the later burials are perpendicular to the beach.

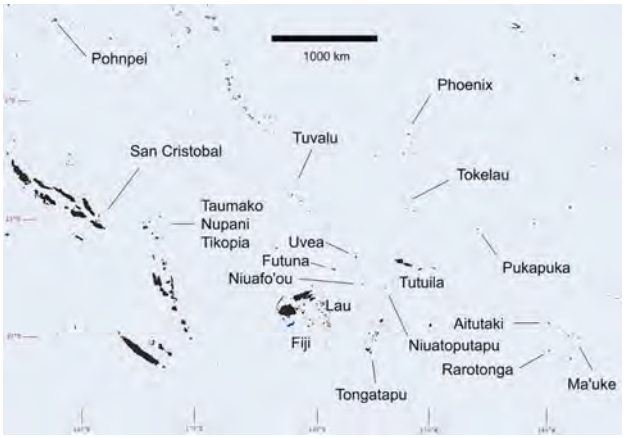

Adze

About 700 years ago, the people of Fatumafuti were involved in manufacturing stone tools, primarily the adze which was used for carving wood. An adze consists of a stone blade lashed to a wooden handle by coconut twine. The grinding stones used to sharpen the adze blade can be recognized by the bowl-shaped depressions on their surface (see photo below). Tutuila was a major export center for stone tools in the Pacific at this time. Stone tools from Tutuila have been found on islands as far away as the Solomon Islands, Pohnpei, and Cook Islands.



One of the most prominent features of the recent archaeological landscape are *tia seu lupe* (or star mounds). These appear to have been built mostly in the last 500 years. They are raised platforms from 2-15 feet high and can have many projections (star-shaped as in the illustration) or have few or no projections. In the days before Christianity came to Samoa, these platforms were used for snaring pigeons as part of chiefly ritual sport. The Tafuna Plain used to contain many of these, but as this area became urbanized, most of these ancient constructions have been bulldozed or dismantled.

Life was very different in the past on Tutuila and Manu'a. Everything people used had to come from the island. People had creative and different ways of doing things like making pots from the clay or making stone tools and trading them with people from different islands. Although archaeologists have begun to understand some aspects of the ancient history of Tutuila and Manu'a, much remains to be discovered.



Pacific islands where stone tools from Tutuila have been found.


Grinding stone featuring shallow bowls used to sharpen adzes.

David J. Addison, Samoan Studies Institute, ASCC
Epifania Suafo'a-Taua'i, NPS

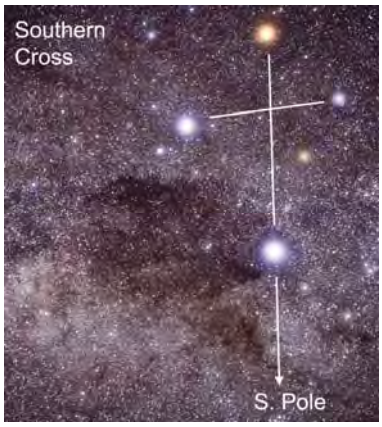
9. The southern night sky


Milky Way Galaxy above a house roof.

The southern night sky is simply stunning. We get a brighter, richer view of the Milky Way in the southern hemisphere due to our location on the globe. Earth is part of the Milky Way Galaxy. It is our home.

Earth is one of 8 plants that orbit our star, the sun. The sun, in turn, is one of at least 100 billion other stars that make up the Milky Way Galaxy. The galaxy itself is a pizza-shaped disk that contains a high concentration of stars, planets, asteroids, interstellar dust and gas bound together by gravity. It looks like a flat pinwheel with radiating arms as illustrated below. This figure also shows where our sun is located.

Because we are part of the Milky Way itself, when we look up into the night sky, we are looking at it on-edge, thus it appears as a whitish band across the sky. It's as if we held a round hand mirror at arms length and then turned the mirror to the right or left, we would then see only its straight edge.



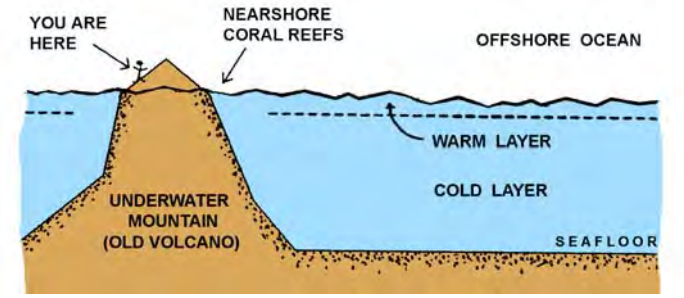
Some groups of stars called constellations have been given fanciful names like the Big Dipper or Orion the Hunter. Several of these constellations provide important navigational guides to travelers, including the early Polynesians who crossed vast expanses of open ocean. But one key reference point is missing in the southern sky -- there is no South Pole Star to act as a compass point like there is a North Pole Star (Polaris) in the northern hemisphere, so an important southern constellation is the Southern Cross (*sumu*). Its long axis always points toward the south celestial pole even as the cross itself changes position hourly through the night as the earth rotates and the stars appear to pivot around the South Celestial Pole. The pole is found by extending the length of the long axis of the cross by 4 lengths, but not all the way to the ground because the South Celestial Pole lies above the horizon. At our latitude, the distance above the horizon is equal to about a one-foot ruler held upright at arm's length. To help locate the Southern Cross (during the hours that it is visible), two visual aids are that it lies within the Milky Way band and it sits adjacent to a rather large dark spot in the Milky Way. The Southern Cross is prominently featured on the national flag of Samoa.

To see the Milky Way, choose a clear, moonless night away from the glow of town lights. The size of our galaxy is almost beyond comprehension. The Milky Way is 2,000 light years thick and 100,000 light-years in diameter. A light-year is the distance light will travel in one year at a speed of 186,000 miles per second, so one light year equals 6 trillion miles.

P.Craig, NPS

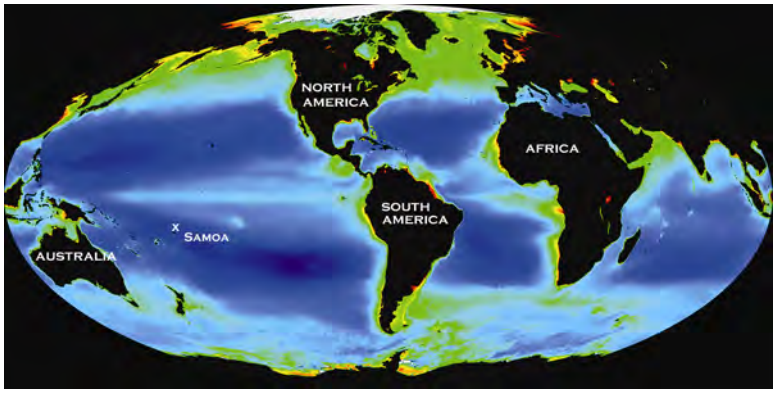
10. Our deep blue ocean (*vasa*)

American Samoa is larger than you might guess. The whole Territory covers 117,500 square miles, which is about the size of New Zealand or the state of Oregon. The Territory is big because we claim jurisdiction of the ocean that surrounds American Samoa, from the shoreline out to 200 miles offshore. That is standard procedure around the world because each country with a marine coast wants to protect its coastline and marine resources from others.



Most of the Territory is open ocean, of course -- only a minuscule 0.1% of the area consists of dry land (all 7 islands total only 76.1 square miles). The other 99.9% marine portion consists of two main habitats -- the shallow coastal waters adjacent to the islands (*a'au, aloalo*) and the deep waters offshore (*vasa*). Shallow coastal habitats, with their coral reefs and colorful fish, are quite limited in total area because our islands slope steeply down into deeper water and depths of 2000 feet are reached within 0.5-2 miles from shore. So, most of our coral reefs are restricted to a narrow ring around each island. There is also some coral on the tops of several offshore seamounts in the Territory.

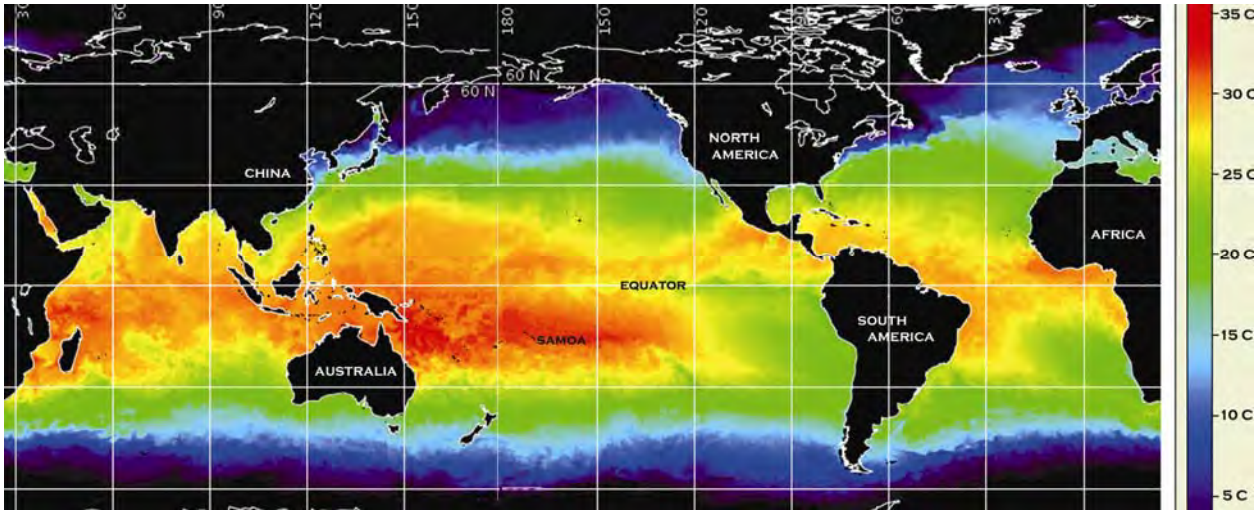
The rest of our marine environment consists of deep blue ocean with a fairly flat seafloor 2-3 miles below the sea surface (see map on page 4). The reason for the blue color of the ocean is an interesting one and it is a key factor to understanding our ocean ecosystem. Water by itself is highly transparent with a bluish tinge. What adds other colors to the ocean are, in large part, small marine plant-like cells called phytoplankton. The more phytoplankton in the water, the greener the water becomes. Phytoplankton require two main ingredients to grow well: sunlight and nutrients (fertilizers). If they have both, they grow in abundance. This, in turn, supports a productive food web: phytoplankton provide food for the small shrimp-like animals (zooplankton), and the zooplankton provide food for the fish to eat.



Phytoplankton abundance in the oceans: high (green areas) and low (blue areas).

Tropical oceans are not green because conditions are generally not good for phytoplankton growth. Although phytoplankton have all the sunlight they could ever want in the surface layer, nutrient levels in the surface layer are too low to support much plant growth. This occurs because the deep tropical ocean is typically stratified into two layers with very different temperatures. The sun heats up the surface layer, which is about 300 feet deep, to a pleasant 84^0 F, but the deeper layer remains a chilly 42^0 F. Because warm water is lighter than cold water, the warm ocean water generally stays on top, the cold water stays on the bottom. The two layers do not mix.

That's the rub. The bottom layer is where the nutrients are, but because of the 2-layer stratification, the nutrients can't get up to the surface layer where they are needed to combine with sunlight for plant growth. So, conditions for phytoplankton are not very good in the tropical ocean. The surface layer has lots of light but few nutrients, while the bottom layer has lots of nutrients but no light. It's pitch black down there. This arrangement doesn't support a very productive foodweb, so there are generally fewer fish in tropical oceans than in non-tropical oceans.



Sea surface temperature (C) showing warm surface waters (red, orange) in the tropics and cooler surface waters (green, blue) away from the equator.

How is it that non-tropical oceans are much more productive? The answer is, again, temperature. Away from the tropics, seasonal changes in water temperature cause the water to mix. Winter temperatures cool the upper layer causing it to sink and mix with the bottom layer, and when this occurs, some deep nutrients are brought up to the surface. The nutrients in shallow sunlit waters stimulate phytoplankton growth, thus fueling a more productive foodweb.

In the tropics, the 2-layer stratification of the ocean persists year-round because the hot sun keeps the surface layer warm. The tropical ocean has been called a 'biological desert' for this reason. That's an exaggeration, of course, because all the tuna out there are finding something to eat. And, many other species live out there as well: whales, dolphins, sea turtles, seabirds, and numerous species of fish and invertebrates such as jellyfish and shrimp-like crustaceans.

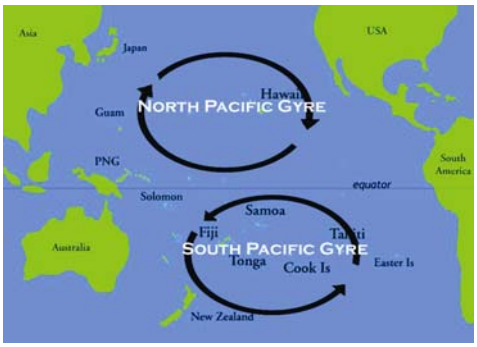

Crown jellyfish

Three ocean resources of potential interest are fish, minerals, and the water itself. Several kinds of food and sport fish are present: tuna, *masimasi*, marlin, wahoo, sharks, and flying fish. Surveys indicate, however, that the abundance of oceanic fishes within our 200-mile zone is probably not high enough to warrant significant commercial development of offshore fisheries. That's the main reason why the big tuna boats that deliver to our canneries travel far beyond our 200-mile zone to other locations where the tuna are more abundant (the canneries are located here only to gain duty-free access to US markets).

Another resource mentioned from time to time are mineral deposits, such as manganese nodules, that lie on the seafloor. However, these nodules, even if present in our waters, are too deep for economic extraction by current technologies. Perhaps a more valuable resource in the future involves the temperature of the ocean's cold bottom layer. Scientists are working on a technology that extracts energy (to produce electricity) through a heat-exchange mechanism that is made possible by the large temperature difference between the tropical ocean's warm surface and cold bottom layers. A demonstration facility for this technology has been operating in Hawaii since the 1970's, but it has not been an economical venture so far. The two requirements for this technology -- a large temperature differential in the ocean, and easy access to this temperature difference by land-based facilities -- are met in American Samoa. Will our future electricity needs be powered by our own blue ocean?

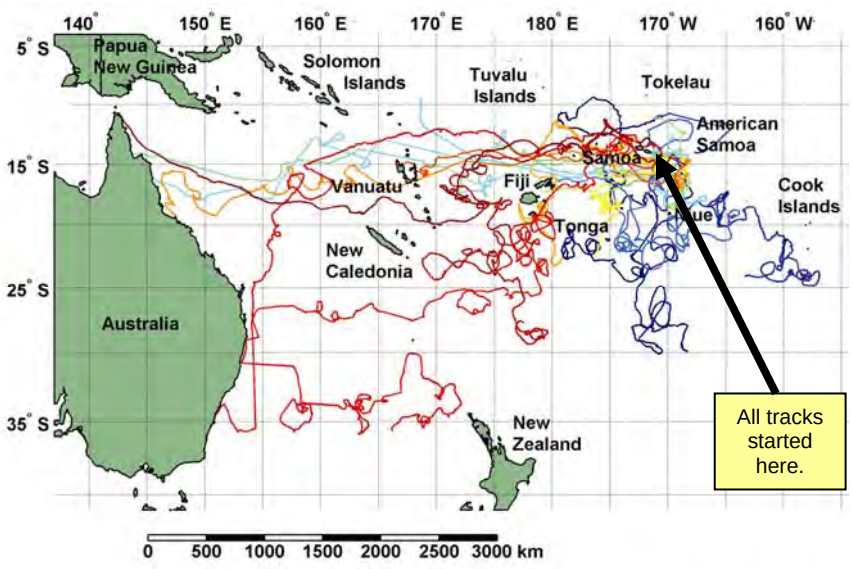
P.Craig, NPS

11. Ocean currents in the South Pacific

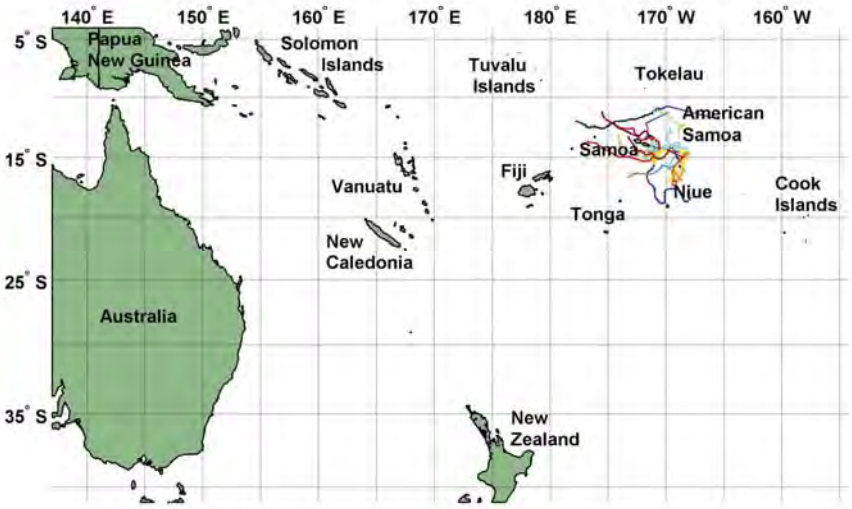


The major pattern of ocean currents in our region is the counter-clockwise flow of the South Pacific Gyre. But there is considerable variation to this pattern at finer scales of resolution. The complexity of surface currents near American Samoa is demonstrated by the tracks of 25 drifter buoys released by NOAA ships at different times and places within the territory. Each buoy floated at the sea surface but it was tethered to a "sea anchor" so the buoy moved with the surface layer of seawater (less than 50-feet deep) rather than where the wind was blowing. Most buoy tracks shown below varied from 1-3 years drifting at sea.

The high variability of the tracks reveals a strong connectivity among the islands in our region. For example, over a multi-year period, a piece of driftwood from American Samoa could eventually run aground almost anywhere. This helps to explain why our coral reefs have similar species to those found across thousands of miles of the South Pacific Ocean. That's because the pelagic eggs and larvae of many corals and fish can be transported among the islands by ocean currents. Unique species (endemics) would generally not develop at any one island due to the occasional input of marine organisms from other islands.



However, most coral and reef fish larvae do not live long enough to be spread across the South Pacific as easily as suggested by the drifter tracks above. On average, fish larvae live only about 45 days before needing to settle down on a new coral reef, so the same drifter tracks are shown below for only their first 45-day period after deployment. In this case, most drifters traveled only about 350 miles, basically remaining within our isolated archipelago. This indicates that the main supply of coral and reef fish larvae needed to replenish our reefs originates primarily within our own archipelago. In some years, American Samoa probably receives fish and coral larvae from western Samoa, and vice versa in other years. From this perspective, it makes sense to coordinate our approach to marine issues with neighboring western Samoa.



P.Craig, NPS,
R. Brainard & Ellen Smith, NOAA
Coral Reef Ecosystem Division

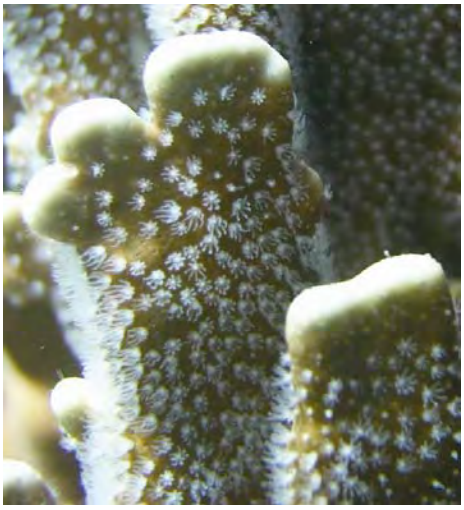
12. What is coral?

The islands of American Samoa are blessed with an abundance of coral (over 250 species), so this article presents an introduction to these unusual organisms.

Corals are animals like ourselves, although that may not be readily apparent because many look like rocks, especially those washed up on the beach. In a sense, corals are indeed partly rock, because only the outer thin layer of the coral is inhabited by the coral animal itself. In that way, corals are like large trees – the inner part is hard and provides structural support, the outer part is the living, growing organism. And, like trees, most coral animals are permanently attached to one spot on the reef.

The coral rubble that Samoans traditionally spread outside their houses, and the coral rocks along our beaches, are old, dead pieces that broke off the reef during a storm, got tumbled around and tossed up on the beach.

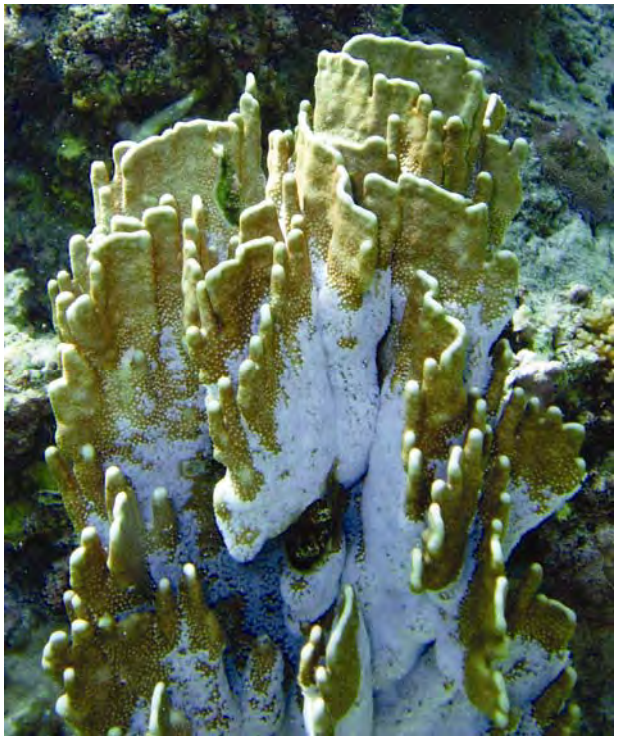
Living corals grow primarily on the outer reef flat and in deeper water. Although they take varied shapes, the coral animals inhabiting their surfaces are similar. They look somewhat like miniature sea anemones (*matamalu*, *ulumane*) or upside-down jellyfish (*alualu*) with short tentacles that give the coral a slightly fuzzy appearance when the tentacles are extended. Each single coral animal is called a polyp, but the coral branch or block we see on the reef is actually not a single animal but a colony of hundreds or thousands of tiny polyps living side by side, giving the appearance of being a single “coral”. The coral's short tentacles can be pulled back into the hard part of the coral when the animal is disturbed or when the coral is exposed at low tide, so even a live coral can look like a rock at such times.



In the coral shown at left, a single polyp lives in each hole, but all the polyps have withdrawn into their skeleton (the polyps of many coral species emerge only at night). In the coral at right, many fuzzy-looking polyps have emerged to feed.

More examples of coral polyps:

Above: two corals of the same species (*Turbinaria peltata*), one with their polyps retracted (top) and one with the polyps extended (top right).



Blue coral (*Heliopora coerulea*) with numerous fuzzy white polyps except in the yellow areas where the polyps are still retracted within the coral skeleton.

This is a soft coral (*Sarcophyton* sp.) with the polyps extended in the front half and retracted in the back half .

A coral polyp with tentacles extended.

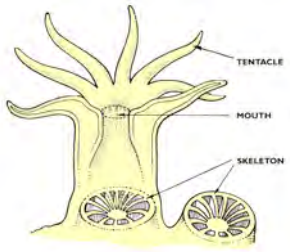
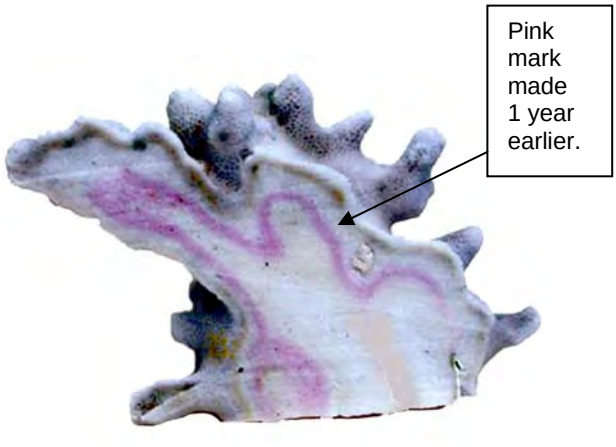


Diagram of a coral polyp.

It seems inconceivable that these tiny coral polyps can build the hard coral 'rocks' that we see on the reef. They do this by secreting layers of a hard substance (calcium carbonate) beneath their living cells. It's as if each tiny polyp built a rock-solid house for itself but then, as it grows bigger, it decides to close-off the bottom rooms in its house. Then it grows some more and closes-off another layer of bottom rooms, and so on. In this way, the coral polyp always lives in the outer, top layer which has been built upon layers and layers of rooms below. Each polyp also cements its house to those of its adjacent neighbors which strengthens the whole structure, resembling a solidly built high-rise apartment complex.



Adding on these new rooms is a slow process. Growth varies from about 0.5-3 inches per year depending on the species. The photo on the right shows this nicely (it was part of a science project). When this particular coral was living on the reef, it was stained with a harmless red color that was absorbed by the outside layer of living tissue. Then, as it grew larger, the living tissue added the red stain to the new skeleton it was making, and in doing so, it mark the size of the coral at the time it was stained. After the stain was used up, the newly laid skeleton was again white. After a one-year period, the coral was sawed in half and we can clearly see the pink band inside the coral. The distance from the pink band to the new outer edge of the coral is the amount that this coral grew in one year (about 0.3 inches in this case, as measured on the actual sample).

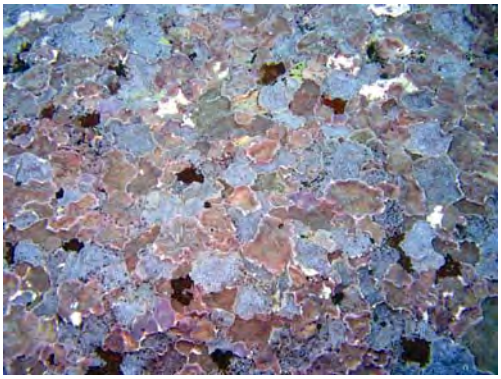
Over very long time periods, these corals grow into massively strong reef structures that can bear the brunt of powerful waves that crash upon them day after day. The very largest corals on our reefs may be hundreds of years old. Corals are one of the few organisms on earth that continually build on top of their old 'houses', forming such large solid structures. This is not like a bird that might build its nest on top of another nest, because both of these nests decay and disappear in a short time. In fact, most organisms on earth leave little trace after they die as their bones or shells disintegrate (dust to dust). Not corals. They build structures much larger and longer-lasting than the Egyptian pyramids. What other organism can do this (except modern man with his steel and cement)?

Consider Swains Island or Rose Atoll. Both are the remnants of old volcanoes that, after millions of years, finally sank back down beneath the ocean's surface and disappeared altogether as volcanic islands usually do (see Chapter 4). But as they slowly sank, the coral continued to grow on top of the submerged mountain tops, layer by layer, keeping pace with the sinking rate of the mountain. The thickness of the coral there now is probably hundreds or thousands of feet thick on top of the old mountain peak and it's all that's left poking above the ocean surface. Were it not for this thick coral formation on top of these old mountains, Swains Island and Rose Atoll would not exist today.

P.Craig, NPS

13. Coral reef community

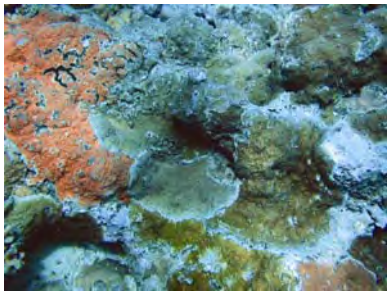
Coral reefs are complex structures built by coral organisms and algae that occur in shallow tropical waters. The reefs support thousands of species of fish, algae, octopus, shrimps, clams, starfish, and many other invertebrates. This article focuses primarily on the corals themselves. Their diversity is highest around the Philippines and Indonesia, and decreases with distance from that area, as shown in the map on page 14.



Coralline algae

American Samoa has unusual coral reefs in some ways. First, many of the reefs are dominated by a marine plant that does not even look like it is alive: coralline algae. This is a plant that usually grows as a smooth pink coating (it looks like pink paint) that slowly spreads a thin layer across reef surfaces. It can grow over pieces of dead coral rubble and eventually cement them together and stabilize a field of loose rubble that was rolling around with the waves. Young corals (larvae) that attach to rolling coral rubble get knocked off or smothered, so it is hard for coral to get established on loose rubble. Some coralline algae also release a chemical that attracts coral larvae to settle on it. Coral larvae are tiny ovals, about half the size of a grain of rice, that swim around and then settle down and grow into corals. So the pink coralline algae help corals to get re-established after hurricane damage to the reefs. American Samoa has an unusually large amount of coralline algae for unknown reasons.

A second unusual thing about our reefs is the abundance of encrusting corals. These are corals that are fairly flat and also cover the bottom like a thick layer of paint. Corals compete for space and light (so their zooxanthellae can use the sunlight to produce food), and it seems like encrusting corals have a strategy of trying to claim as much space as possible before anyone else does. Encrusting corals can be found on coral reefs anywhere, but they are more common here than on most reefs.



Encrusting corals
(*Montipora* sp.)

Finger coral
(*Porites cylindrica*)

Staghorn coral
(*Acropora muricata*)

Coral communities are made up of different species in different places. We have several distinctive coral communities in American Samoa. One occurs on the nearshore reef flats in small backreef pools, as well as in some larger pools at Utulei, Fagaalu, Alofau, Nuuuli, and the airport that were dredged to build more land for airport runways or village roads. There are two main types of corals in the pools, "finger coral" and "staghorns". Finger corals have branches that look like fingers with round tips, and staghorns look like deer antlers with many branches and sharp tips.

A second coral community lives on the "reef crest" where the waves crash. Here, corals tend to be sturdy, yet even on the reef crest one common species has many small branches about the thickness of a pencil. These corals get hit the hardest by waves, yet they have some of the thinnest and most delicate branches which seems puzzling. Perhaps the branches being close together reduces the waves' force.

A third set of coral communities live on the reef slopes, where the reef drops away into deeper water.

Here encrusting corals and coralline algae are common, but there are some places where other communities of corals can be found. In some places along the southeast coast of Tutuila, reef slopes at medium depths are dominated by a “flower coral” (*Lobophyllia hemprichii*) where the coral polyps are relatively large, up to 2-3 inches in diameter. Deeper on some slopes on the south side of Tutuila, the most common corals (*Mycedium* sp.) form overlapping plates almost like shingles on the slope.

Flower coral
(*Lobophyllia hemprichii*)

Table coral
(*Acropora hyacinthus*)

Mushroom corals
(*Fungia* sp.)

Some corals grow in a shape rather like a table -- they have a single stalk, often in the center of the coral, and their top is a big flat disk or table-top. Some may even have multiple layers of table-tops. These "table corals" are actually related to the staghorns (in the genus *Acropora*; a common species of table coral is *Acropora hyacinthus*). There is an area on the western side of Fagatele Bay where the reef slope is just covered with table corals. In another area, outer Vatia Bay, there are lots of table corals and staghorns mixed together on the slope.

A few corals live to become giants. Some of these are called boulder corals, often yellow or brown in color. These slow-growing corals can be found in all sizes on our reefs. One of the world’s largest is at Ta’u Island and is over 15 feet tall -- it may be hundreds of years old. Boulder corals are in the genus *Porites*, along with the finger corals.

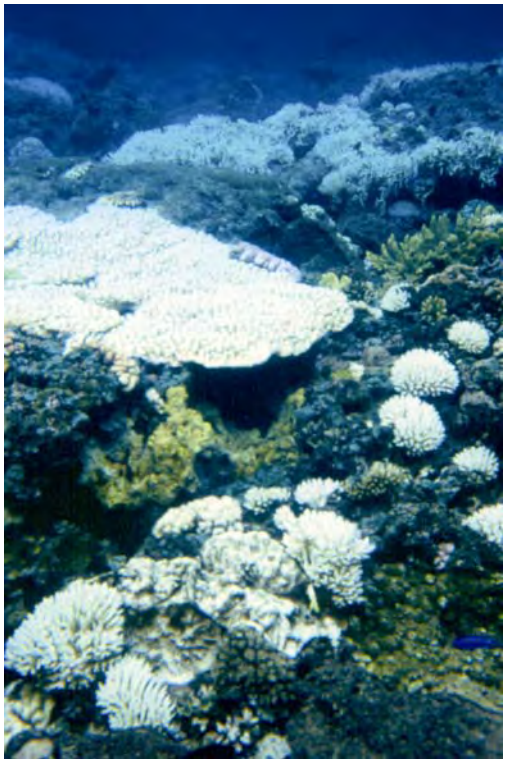
Most corals are firmly attached to the reef, but a few are not. One common type that isn’t attached is the “mushroom coral”. These corals, in the genus *Fungia*, look like a mushroom cap that has been turned over, with radiating ridges that look like the “gills” on a mushroom (see photo above). Their larvae settle anywhere on the slope, but wave action can move the adults around when it is rough. On a slope, they tend to slide downwards when the waves move them, and end up at the bottom of the slope where they accumulate. Some tiny young mushroom corals have even been observed to "walk" on their tentacles.

Coral reefs look like they are the same day after day, but over a longer time span of decades to centuries or longer, they can change considerably. They are often impacted by disturbances like hurricanes that break the coral, mass bleaching events that kill coral (see next chapter), and crown-of-thorns starfish which eat the coral. These events can kill much of the coral present at any one time, but then over the years and decades, the coral grows back. Hurricanes are natural disturbances and coral reefs are well adapted to deal with them. Individual corals are always growing and competing for space and light. Some corals grow over others and take the light. Other corals can attack their neighbors with stingers -- they are constantly competing with each other for space and light. Change is constantly occurring on our reefs.

Doug Fenner, DMWR

14. When corals turn white and die

Coral reefs in American Samoa have turned pure white on several occasions in recent years. They look freshly bleached, quite pretty, but that's a clear sign that they are in trouble.



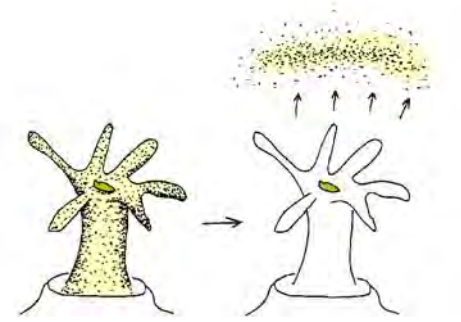
Underwater photo showing several kinds of corals that turned white, or “bleached”, due to heat stress in 1994.

Two very different kinds of stress cause corals to turn white: (1) clorox bleach, and (2) warm water temperatures. Clorox bleaching happens from time to time when a foolish fisherman dumps clorox onto the reef to kill fish. This is very short-sighted because it also kills everything else in the vicinity -- young fish, crabs, snails and corals -- and that harms the reef itself and reduces everyone's catch.

Unusually warm water temperatures, due either to weather events or global warming, can also cause the coral to bleach. It only takes a slight increase above normal water temperature to bleach the coral. Bleaching can be caused by a short-term exposure (1-2 days) at temperature elevations of 3-4 degrees, or by long-term exposure (weeks) at elevations of only 1-2 degrees. To a diver, this may look like a pretty snowfall on the reef, but it indicates that the reef is seriously stressed.

Because most corals live only in warm tropical waters, it seems odd that corals will die when the water gets slightly warmer. The reason is that corals live close to the hottest temperature that they can tolerate, so it doesn't take much to push them over the limit. To explain what is happening, recall that corals are animals with colorful plant-like cells (zooxanthellae) living in their tissues. These cells use the sun's light to produce food which is also used by the coral animal. Many coral animals receive much of their food this way, so this relationship is quite important to the coral animal. The coral, in turn, provides the zooxanthellae with nutrients and a secure place to live. Both the coral and the zooxanthellae benefit from this arrangement.

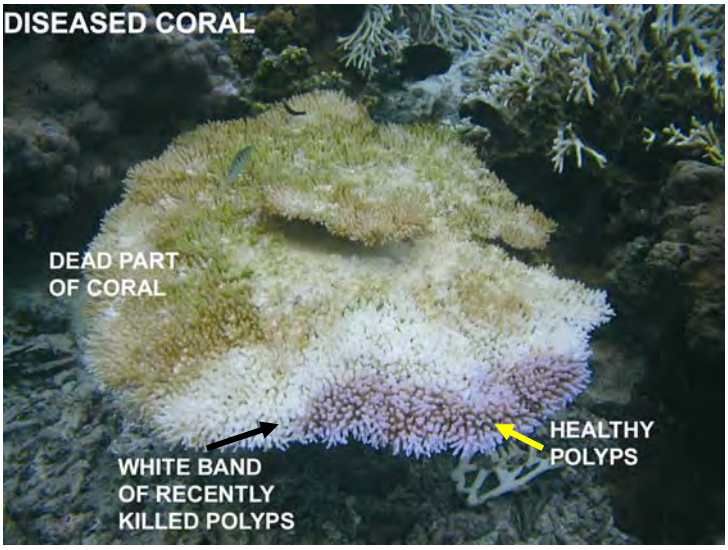
When the coral is stressed by warmer than usual temperatures, the zooxanthellae are released from the coral, for reasons known only to them. What's left is a rather colorless coral animal overlying a bright white coral skeleton (see drawing). The animal portion of the coral may eventually recover its zooxanthellae and continue living, or it may die, depending on how stressed it gets. It's easy to tell when portions of the coral die because they become covered with fuzzy green algae.



Normal coral polyp with plant-like cells inside the coral's tissues.

Heat-stress causes the coral polyp to release its plant-like cells and turn white like the photo at top.

A little bleaching now occurs here during most summers, but it was particularly bad in 1994, 2002 and 2003. Not all coral species were affected then, but those in shallow waters were hardest hit, although some bleaching down to the 130-foot depth was observed. Bleaching also occurred in 1998 when we experienced very low tides due to a strong El Nino event. The exposed corals turned white and died.



As if that weren't enough, we are also seeing more coral diseases on our reefs (who would have thought that corals can catch diseases?). Presumably the heat-stressed condition of the corals makes them more vulnerable to diseases that had formerly been rare. In the photo at right, a white band of death is sweeping across the coral, from left to right. Behind the white band (to the left), the coral polyps were killed about a week or two ago, giving time for greenish algae to start growing on the dead coral skeleton. The white band itself is a zone of freshly killed polyps and exposed white coral skeleton. In front of the white band (to the right) is the last remaining bit of live coral (purplish in color). The cause of this disease is not known yet. Although coral diseases have probably always been around, they spread rapidly on our reefs beginning in 2002.

To round-out this rather negative view of the problems coral face in our modern world, an even greater threat to them is a projected change in water chemistry in the ocean due to global warming. Just as carbon dioxide (the main greenhouse gas causing global warming) is increasing in the air, it also increases in seawater in its dissolved form. That makes seawater more acidic which, in turn, may slow the rate at which corals build their calcium carbonate skeletons. The result is that coral growth would be slowed and there might even be an increased erosion of the reef itself.

Scientists predict that episodes of warm water temperatures will become more frequent due to a general warming of the earth. That's bad news for our coral reefs. While it's unlikely that all of our corals will die off as the environment gets warmer over the next few decades, the number and/or abundance of corals may well decline here. That might impact American Samoa in two general ways. First, coral growth might not keep up with rising sea levels or the reef itself may begin to erode, thereby allowing more storm waves to reach our shorelines and cause damage to roads and houses. Second, a reduction in coral growth and number of species could reduce the diversity of habitats required by fish, so a downturn in reef catches could eventually occur. Both of these changes would probably occur at a slow but steady pace over the next 30 years.

Turbid water from stream discharge after rainfall.

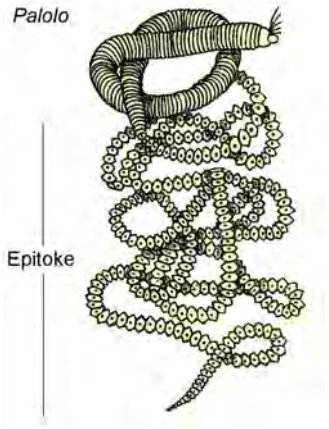
What to do? Well, it's true that American Samoa has little impact on the world's changing climate, but it makes sense not to worsen the situation by further stressing our coral reefs with rubbish, sewage from piggeries, or dirt (sediment) from land-use activities that flows into streams and out onto the reefs. The brown water we see entering the ocean from streams after a heavy rainfall is harmful to the corals. Additionally, we should locate and protect any areas where corals appear to be naturally resilient to bleaching events. These hardy survivors could then help re-seed other areas where the corals had died.

P.Craig, NPS

15. Palolo swarming

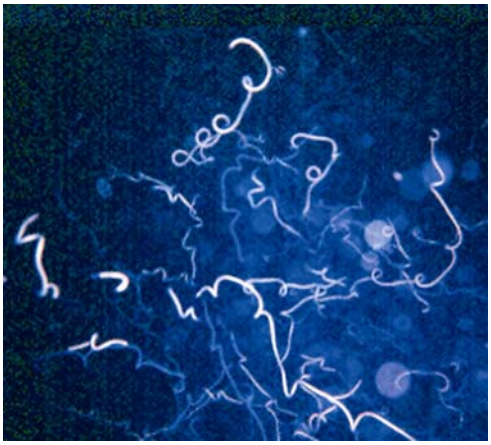
Once or twice a year, *palolo* swarm to the surface of the sea in great numbers. Samoans eagerly await this night and scoop up large amounts of this delicacy along the shoreline with hand nets. This gift from the sea was traditionally greeted with necklaces made from the fragrant *moso'oi* flower and the night of the *palolo* was and still remains a happy time of celebration. The rich taste of *palolo* is enjoyed raw or fried with butter, onions or eggs, or spread on toast.

Palolo is the edible portion of a polychaete worm (*Palola viridis*) that lives in shallow coral reefs throughout the south central Pacific, although they do not swarm at all of these locations. This phenomenon is well known in Samoa, Rarotonga, Tonga, Fiji, the Solomon Islands, and Vanuatu.



Palolo are about 12 inches long and live in burrows dug into the coral pavement on the outer reef flat. They are composed of two distinct sections (see drawing). The front section is the basic segmented polychaete with eyes, mouth, etc., followed by a string of segments called the "epitoke" that contain reproductive gametes colored blue-green (females) or tan (males). Each epitoke segments bear a tiny eyespot that can sense light (that may be why islanders use a lantern to attract the *palolo* to their nets).

When it comes time to spawn, *palolo* will back out of their burrows and release the epitoke section from their body. The epitokes then twirl around in the water in vast numbers and look like dancing spaghetti. Around daybreak, the segments dissolve and release the eggs and sperm that they contain. The fertilized eggs hatch into small larvae that drift with the plankton until settling on a coral reef to begin life anew.



Palolo underwater.

The swarming of *palolo* is a classic example of the coordinated mass spawning of a simple marine organism. The worms emerge from their burrows during a specific phase of the moon, but the actual date is a bit complicated. The swarms occur on the evenings of the last quarter moon of spring or early summer. In Samoa, this is seven days after the full moon in October or November. Swarming occurs for two or three consecutive nights with the second night usually having the strongest showing.

Palolo usually appear here in October, but sometimes in November or sometimes during both months. This difference is due to the fact that there are about 13 lunar months in one calendar year and the *palolo* use primarily the moon to time their spawning activity. If instead they always spawned every twelve lunar months, their time of spawning would occur earlier every year. After a few years, they would be spawning in August or July. In order to make up for this difference, the *palolo* will delay spawning in some years to the 13th lunar month.

The fact that *palolo* adjust their spawning time means that there are other factors beside the moon that determine the time of year they begin to mature and are ready to release their epitokes. Several studies on

this matter have suggested that rising seawater temperatures, tides, weather, moonlight or other biological signals may play a role in starting the maturation and release of the epitokes. Once the swarming begins, the presence of the *palolo* spawn in the water probably stimulates other *palolo* to release their mature epitokes.

Rules For Predicting Emergence. Everyone seems to have their own methods for predicting when the best *palolo* rising will occur. Several natural clues that preceded the *palolo* rising enabled islanders to predict the correct timing for *palolo* swarming. These included the flowering of the *moso'oi* tree, the closing of the *pālulu* flower (a morning glory), a strong smell from the reef, brown foamy scum (from coral spawn) on the ocean, toxins occurring in reef fish, and abrupt weather changes or bad weather such as thunderstorms or lightning.

So, will *palolo* swarm seven days after the full moon in October or November? One set of rules used to predict the main night of emergence depends on the calendar date of October's third quarter moon (seven days after October's full moon). If it occurs:

1. From October 1 to 8, *palolo* will not appear until November.

2. From October 8 to 18, *palolo* will not appear in October or the swarming will be weak followed by a stronger appearance in November.

3. From October 19 to November 7, there will be a single, strong swarming centered on this date.

4. From November 8 to 17, there will be a strong appearance on this date, possibly following a weaker swarming during the previous month (see number 2 above).

A good catch of *palolo*.

To further complicate matters, the actual time of emergence of *palolo* in Samoa differs between islands. They usually appear around 2 am in the Manu'a Islands and Tutuila, and 4-5 am in western Samoa. This difference is somewhat consistent from year to year and cannot be accounted for by difference in tides or moonrise. The difference in tides between islands is far less than one hour and the time of moonrise is only minutes apart.

David Itano, DMWR

16. Giant clams (*faisua*)

It's always a pleasure to see one of these beauties on the reef. Giant clams (*faisua*) are large, colorful and, surprisingly, they are part animal and part "plant". That's because giant clams, like corals, have plant-like cells (zooxanthellae) that live in their tissues and produce free food for the clams. When a clam opens its shell and spreads out its pretty mantle, it exposes these "solar panels" of zooxanthellae to the sun to make food, like a plant unfolding its leaves.

At the same time, the clam also gets some food by drawing water through its siphon and filtering out any tiny food particles (zooplankton). Perhaps that's why giant clams grow so large – they have two very different ways to get food.

We have two native species of giant clams in our local waters, *Tridacna maxima* and *T. squamosa,* which look fairly similar. They grow to about 12-15 inches in shell length, although most found today are smaller because the larger ones have been harvested. The largest and most famous species of giant clam (*T. gigas*), which grows as big as a large suitcase, is not native here but has been recently imported. In the 1990s, mariculture efforts by Department of Marine & Wildlife Resources (DMWR) introduced *T. gigas* and *T. derasa,* and re-introduced *Hippopus hippopus,* a shallow-water species that was formerly present.

Because giant clams need sunlight, they inhabit shallow, clear waters down to about 60 feet deep. They grow slowly; one local clam was 18 years old. They spawn repeatedly over their life span and release millions of eggs each time they spawn, but most young clams do not survive, so the adults have to live a long time and spawn many times to insure that the population survives. Larval clams swim in the water for about a week, then settle permanently onto the reef to grow.

The clams are a favorite food item throughout the South Pacific and their accessibility in shallow waters and slow growth make them susceptible to overfishing. That is very much the case in American Samoa, where few remain on reefs near populated areas. The bright blue clams are the easiest to spot, so many of those remaining on the reef are the more cryptically colored brown, tan and green clams.

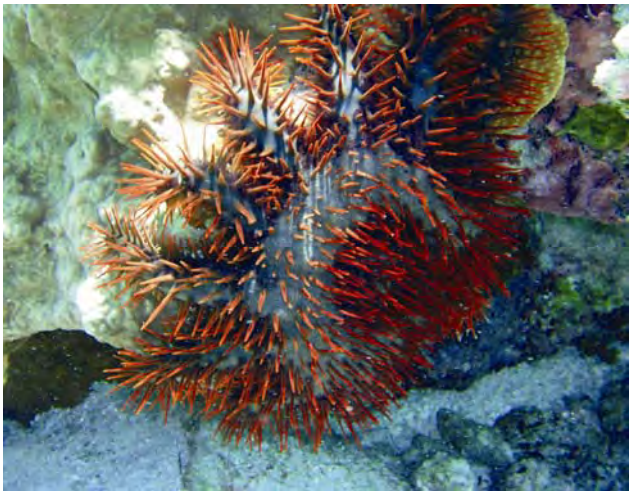
Due to their popularity, there has been an interest in growing these clams in hatcheries to supply markets for food and the aquarium trade. DMWR operated a hatchery here for many years (about 1988-2005) and tried to encourage local production by supplying small clams for local "farmers" to grow them on their reefs. That effort met with limited success for several reasons. Considerable dedication is needed because it takes several years to grow the clams to a commercial size, and the clams have to be protected from poachers and predators. And there are always *fa'alavelave* events that call for contributions of giant clams if anyone has some. In general, giant clam mariculture here usually supplemented family needs rather than create a commercial business. Periodically, the idea of raising the clams to a small size for the aquarium trade is talked about as a possible market.

Harvest regulations in American Samoa (in 2009) are: giant clams taken for personal consumption must be at least 6 inches in shell length, or if sold, a license is required and giant clams must be at least 7 inches in shell length and sold with the clam still in its shell.

P.Craig, NPS

17. Crown-of-thorns starfish (*alamea*)

Our reefs have several kinds of starfish (*aveau, fetu*). Most have five "arms," like the brilliant blue starfish (*Lynkia laevegata*), but the crown-of-thorns starfish (*alamea, Acanthaster planci*) has about 15 arms. They're a big starfish, with adults commonly over a foot in diameter. They can be a beautiful dark red, or a dark green, often with some red markings. This starfish is one to look at, but not touch. The upper surface is covered with nasty spines. Anything but the very lightest touch, and the spines will stick into you, and you will be very sorry. There are toxic chemicals in the spines, and once you are stuck, it will hurt, and continue to hurt for hours if not days. If you get stuck by several spines, the area may go numb and stay that way for a week or more, and if you get stuck by a lot of spines you could become weak or paralyzed in that part of your body or even have more trouble.



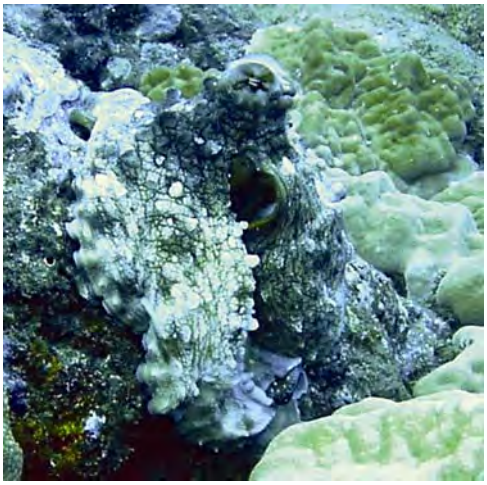
The underside of a starfish has little suckers at the ends of their tube feet. They "walk" on them and hold on to the substrate with these suckers. It is said that if you have been stung by a crown-of-thorns, have the tube feet touch or walk on the area where you have been stung, and it will reduce the pain. A much better idea is not to get stung in the first place.

Crown-of-thorns, like most starfish, have an unusual way of eating. They push their stomach out their mouth to cover what they want to eat, then their stomach digests their food outside their mouth, and then they pull their stomach back inside them. If you think about trying that on your dinner, you'll realize just how amazing that is. Crown-of-thorns are a bit unusual in what they eat: coral. They eat the outer living part of the coral, leaving the dead white skeleton. Sometimes little patches of live coral tissue are left and the coral survives and can slowly re-grow, other times the coral is completely killed.

Most of the time, crown-of-thorns are pretty rare on coral reefs. But back in the 1950's huge numbers of them appeared on coral reefs in Japan and ate the corals killing most of the reefs there. Then in the 1960's the same thing happened in Australia's Great Barrier Reef. In 1978-1979, huge numbers of them appeared in American Samoa and killed most of the corals here. When such outbreaks happen, people may try to save the reef by killing as many crown-of-thorns as they can, but cutting them up doesn't kill them, they just grow the missing parts back. It's best to spear them and take them out of the water, where they die quickly. One idea about why such huge outbreaks of millions of these starfish occur is that humans have killed the predators that feed on them, like trumpet triton mollusks and humphead wrasse. So it is best to leave those predators on the reef. Another idea that has more evidence to support it is that unusually heavy rainstorms wash nutrients from the land into the water, which feed the tiny plants and animals that are the food of the young starfish, so more juveniles survive and they grow up into the invading hordes of coral-killers. From this viewpoint, it makes sense to reduce the amount of soil, piggery sewage, and high phosphate laundry detergents that flush down our streams into the ocean. These nutrients might help more crown-of-thorn juveniles survive and grow up to eat our corals.

Douglas Fenner, DMWR

18. Master of disguise: the octopus (*fe'e*)



Same octopus, different shape and color.

There's no other reef animal quite like the octopus (*fe'e*). Although it looks like a large, unprotected meal for some big fish, it is hardly defenseless. The octopus is the "master of disguise" for its superb ability to become invisible by changing the color and texture of its skin to match its surroundings. With its good eyesight and well-developed brain, it is probably the most intelligent of all invertebrates. And if camouflage and quick wits don't suffice, it can either squeeze down very small holes or escape by jet propulsion, leaving its calling card, an inky cloud that acts as a decoy or smoke screen to momentarily confuse a predator while the octopus vanishes.

The octopus commonly seen locally is the reef octopus, *Octopus cyanea*, which is mottled red-brown in color with a large spot beneath each eye. It typically weighs 2-3 lbs. It is a mollusk, related to squid, snails, and clams, but the octopus lacks a shell and has eight strong arms covered with suckers. It breathes by sucking water into its mantle cavity and over its gills; it then expels the water through its funnel. If threatened by a predator, it can expel this water forcefully, causing it to jet away.

Fe'e feed on crustaceans (crabs, shrimps, lobsters) and mollusks (cowry snails) by creeping up on them. After pouncing on an unsuspecting prey, the octopus holds it tightly with its suckers until it can bite the animal with its parrot-like beak and inject a toxin to paralyze the prey. It may take its meal back to the safety of its den (the reef hole it calls home), and that's why there are often telltale bits of shells around an octopus den. Mating occurs year-round. The female lays her eggs inside her den and cares for them until they hatch. She then dies. When the eggs hatch, out pop miniature octopuses that are dispersed by water currents until they settle back onto the reef.

The octopus is a favorite food of local fishermen who often check particular holes on the reef known to be good den sites for *fe'e*. Octopus are taken by hand or spear and they account for about 5-10% of all the fish and invertebrates harvested on our reefs. The drooping, pale gray octopus we see hung out for sale along the roadside is a ghoulish remnant of this crafty animal.

The octopus is also caught by a traditional lure (see photo at left) made of a large cowry shell that resembles a rat *(isumu*). That came about due to an event that happened long ago, as related in the Samoan legend about the octopus and the rat. It all started with a sightseeing canoe trip on the ocean by an owl, a snail, and a rat. Their canoe started to sink, so the owl escaped by flying away, the snail sank with the canoe to the bottom of the ocean (*goto uga*), and the rat tried to swim to shore but it had a long way to go. It saw an octopus and called for help. The octopus agreed and swam to shore with the rat on his head. When they got to shore, the rat jumped off and thanked the octopus for saving his life and said that he left a little present on the octopus's head. When the octopus realized that there was a rat dropping on his head, he became extremely angry and told the rat, if I ever see you again, I'll kill you. To this day, the octopus is mad about this and is still looking for the rat.

P.Craig, NPS

19. Nearshore sharks (*malie*)

From a safety perspective, American Samoa is fortunate not to have much of a "shark problem". Based on conversations with long-time residents, it appears that there have been very few shark attacks and probably no fatalities here in the past 40 years. The few injuries that have occurred were usually related to fishing activities, and records from the hospital concur with this.

The sharks (*malie*) living in our nearshore waters are generally not dangerous to swimmers or divers but they may swim close by to see who's in their area. The most common species are the blacktip reef shark (*Carcharhinus melanopterus*) and the whitetip reef shark (*Triaenodon obesus*). These are not large sharks, usually about 4-5 feet in length, although everyone swears that the one they saw was bigger. They grow slowly and give live birth to a few pups who swim away and are on their own. Both species feed on fish and shellfish. They are attracted to wounded and bleeding fish, which accounts for several shark encounters with divers who had tied speared fish around their waists. Need it be suggested that this is not a smart thing to do?

The blacktip will quickly swim away, but on rare occasions small blacktips will sometimes startle a person by swimming directly at them. They look like a little torpedo coming straight at you, but other than your brief panic attack, no harm is done. The whitetip has an unusual habit of resting occasionally on the seafloor or in caves during the daytime.

From an ecological perspective, we do have a shark problem. There are not many of them, indeed it is uncommon to even see a shark while snorkeling or diving in American Samoa. Reasons for this are not clear. The local harvest of sharks is not large -- they are not targeted by local fishermen (although sharks will be kept if caught) and shark "finning" (taking only fins to make shark fin soup) is illegal. Perhaps fishing pressure was greater in the past or sharks may simply be unable to withstand much fishing at all. It is now well known that sharks in general are quite vulnerable to fishing pressure and are slow to recover because of their low growth and birth rates. The plight of many shark species worldwide has become an issue not just because of their decreasing numbers but because sharks play a key role in maintaining healthy coral reefs. As top predators, their removal disrupts the ecological balance of the reef ecosystem.

Sightings of more dangerous sharks in our nearshore waters are rare, but over the years, a few tiger sharks have been seen or caught around Tutuila. Hammerhead sharks are known to swim into Pago Pago Harbor, where some give birth to young and others are perhaps attracted there by the cannery wastes. Also, the large but harmless whale shark has been seen near Taema Bank and a juvenile whale shark (4.1 m total length) washed up on Aunu'u Island in 1989.

So, yes we have some sharks in our shoreline waters, but most are not of serious concern. It is actually very exciting to see one swim by. Someplace deep in our brain yells Danger! and our heart rate jumps, but the shark is quickly gone, and our only thought is wow, did you see that?

P.Craig, NPS

20. The *alogo* surgeonfish -- ruler of the reeftop

American Samoa's coral reefs are truly a wonder of nature. Our sea is home to a diverse and colorful assemblage of plants and animals. Some 930 species of fish occur here, which is about twice the number of marine fish species found in Hawaii.

At first glance, the reef seems to be an exotic panorama of mass confusion, complete with bizarre shapes of fish painted in psychedelic colors. It's like looking into an overstocked aquarium. But as you frequent the reef more often, you begin to notice some structure to the confusion. Each species is generally found only in certain habitats such as shallow reef flats, sandy bottom areas, or deeper waters.

Many individual fish even take up permanent residence at a particular site rather than roam around. One particular fish I watched stayed near the same coral block for 3 years (the fish had a unique markings on its body, so I could easily identify it). That coral block was home. Such stay-at-home behavior is actually quite common among coral reef fishes. One abundant species on our reefs that does this is the *alogo* (*Acanthurus lineatus*), also known as the blue-lined surgeonfish because of its knife-like blade located near its tail. The blade is usually not visible because it is folded away into a groove in the fish's skin. It is a bit poisonous, and careless handling of the fish may cause a puncture and painful swelling in your hand.

The *alogo* grows about 8 inches long and weighs half a pound. It is a very attractive fish, with bold yellow, blue, and black horizontal lines on its sides, although its basic color pattern can be swiftly altered depending on the *alogo's* mood. For example, when the *alogo* becomes aggressive and chases another fish, its face and fins darken and it looks angry (to me at least).

The *alogo* lives in the foamy surge zone where the waves crash against the reef. This is not an easy place to live, but the *alogo* is quite skilled at it. When a really rough wave hits, the *alogo* darts down into a hole or over the reef edge into the safety of deeper water.

Like a lot of other reef fish, the *alogo* is a territorial animal, which means that it dwells at a particular patch of reef and protects that site from all other fish. The territory of each *alogo* measures about 5 x 5 feet. There it feeds on the thin film of plant material (algae) that covers the reeftop and appears as a greenish grassy turf. Because of their territorial nature, the *alogo* space themselves evenly across the reeftop, and as they munch away on the algae-covered rocks, they remind me of a herd of miniature cows feeding in a distant pasture.

Many other species of coral reef fish are also algae eaters, and two general patterns of feeding have evolved among these species. One is for a species to become territorial and fiercely guard its own algal patch, the other is to be non-territorial and roam around the reef looking for an unguarded patch of algae to eat. To an underwater observer, this dual approach to feeding is readily visible -- most of the reef is picked clean of all edible algae and looks like bare rock, except where a territorial fish guards its lush algal plot.

The feisty *alogo* defends its plot from all competitors, so the turf algae grows well there and provides all the food the *alogo* needs. Protection of this garden doesn't come cheaply, however. The *alogo* must defend its territory every minute of the day from other fish that lurk nearby, waiting for a chance to sneak in and chow down.

Alogo feeding on turf algae growing on reef top.

Iced *alogo* at a grocery store.

That's where the *alogo's* sharp blade comes in handy. The *alogo* will threaten to viciously sideswipe an intruder with this weapon. Most other fish heed the *alogo's* warning and back-off quickly. It's mostly a bluffing game played repeatedly through the day, and rarely does anyone get hurt.

Other aspects of the *alogo's* behavior are fascinating. Every evening at dusk, all the *alogo* migrate off the reeftop to deeper waters where they will spend the night sleeping in crevices to escape being eaten by predators like sharks (*malie*) and jacks (*malauli*, *ulua*). At dawn, they return to their exact same reeftop territories by the same route. Their migrations to and from the reeftop look like rush-hour traffic on an underwater highway.

The *alogo* is a popular Samoan food fish and it is one the most important species of reef fish caught, accounting in some years for up to 30% (by weight) of all reef fish caught in the nearshore subsistence fishery. Most are caught by spear fishermen, particularly at night when the fish are sleeping in reef crevices. Daytime spear fishermen have a much harder time catching them, because the *alogo* tend to stay just out of spearing range.

P.Craig, NPS

Alogo swimming on outer reef flat at high tide.

21. *Manini* and *pone* -- two favorite reef fish

Manini and *pone* are two food fishes found just about everywhere in shallow waters around the islands of American Samoa. Like *alogo*, they belong to the family of fishes called surgeonfish because of their sharp knife blades that fit into grooves near their tail. *Manini* and *pone* are rather non-aggressive fishes, however, and they do not seem to wield their weapons much.

The *manini* (*Acanthurus triostegus*) is a small fish about 5 inches long. Its coloration is yellow with vertical black bars, which looks a bit like a prisoner's uniform and that's why this fish is also called the convict tang.

Manini often swim in large schools containing hundreds to thousands of individuals. There are two good reasons for this schooling behavior -- it helps them escape predators and it also helps them get access to food. First, when a large fish attacks a school of *manini*, the *manini* scatter in all directions like a shotgun blast. This commotion momentarily confuses the predator and the *manini* get away. Each *manini* thus has a better chance of not getting eaten if it stays in a group.

The *manini* also cleverly use their schooling behavior to get food. They like to feed on the thin green algae turf that grows on reef rocks, but these algae patches are usually guarded fiercely by *alogo* surgeonfish and damselfishes (*tu'u'u*) who are nasty to intruders. Just the sight of a *manini* gets them livid with rage. A single *manini* would not stand a chance to get by these guards, but a large group of *manini* can succeed. The *alogo* and damselfishes are simply overwhelmed when hundreds of *manini* descend into their territory to feed. While the *alogo* futilely chases one *manini* away, a hundred others are gobbling up its garden.

Manini mob feeding.

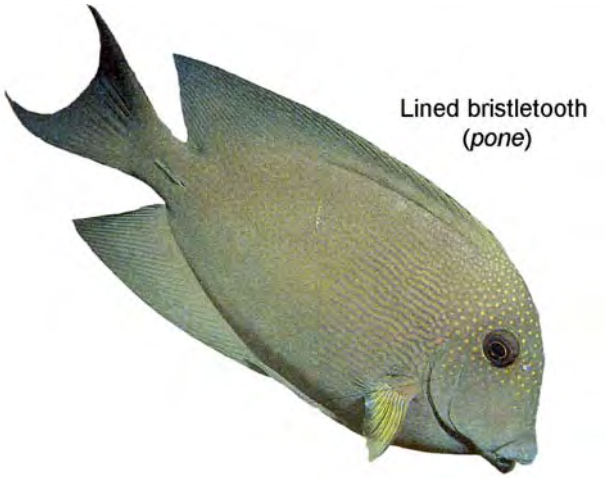
Spawning coloration at dusk (*manini* in foreground).

Manini spawning is a spectacular event. When conditions are right, thousands will assemble to spawn at a particular time and place. They often spawn in or near the reef channel (*ava*) at dusk when the tide is high. Their behavior and coloration are noticeably different at this time, as they swim around in an agitated fashion and change color to white with wider black bars. This seething mass of fish mills about until they can't take the excitement any longer. A group of them will suddenly burst upwards in the water column, spawn, and return to the seafloor again, all in a split second. Although this happens fast, you can tell that the fish actually spawned because the milt expelled by the male fish looks like a puff of smoke from a gun. When the spawning action really gets going, it looks like an underwater version of popcorn

popping. After spawning, the fertilized eggs drift away with the currents. About one month later, the small *manini* that survived this larval stage are ready to settle back onto the reef.

Pone (*Ctenochaetus striatus*, or the lined bristletooth surgeonfish) are a different type of surgeonfish in two respects. They are a dull brown color and they have funny teeth. Their lack of spectacular coloration is somewhat of an embarrassment in tropical waters which are renown for brightly colored fish. *Pone* are, however, one of the most abundant fishes on the reefs, so they must be doing something right.

Their teeth have evolved very differently from other surgeonfishes because what they feed upon is quite different. Instead of having actual teeth to bite off algae the way that *alogo* and *manini* do, *pone* have a mouthful of bristles which they use as a comb or brush to collect the detritus that lies on reef surfaces. The detritus they eat includes all the small bits and pieces of formerly living plants and animals. The detritus in your backyard, for example, might include grass clippings, old '*ulu* leaves, decaying coconut husks, rotting papayas, and numerous unseen dead insects. Not a pretty meal, to be sure.



Detritus is found everywhere, but few large animals can make a meal out of it. *Pone* can, and that may account for their abundance and widespread distribution on coral reefs.

Every several years or so, *pone* have a very successful spawning event, and uncountable numbers of their young (*pala'ia*) settle onto the reef. *Pala'ia* are very pretty and look like small dark *alogo*. But their beauty fades as they grow, and in just a few weeks they turn brown in color like the adults.

P.Craig, NPS

22. Traditional fishing methods and the *enu* basket

Modern fishing gear has replaced most traditional fishing practices in American Samoa. Fish are now caught by rod & reel, metal spears propelled by elastic bands, and monofilament gillnets and thrownets. But a few traditional practices persist. Two of these are described elsewhere in this booklet (fishing for *atule* and *palolo*). A third method called 'gleaning' involves the age-old practice of hand-picking the reefs at low tide for edible invertebrates like octopus (*fe'e*), giant clams (*faisua*), and turban snails (*alili*).

Another traditional fishing method still practiced in Manu'a is catching *i'asina* (small goatfish) in a hand-woven funnel trap called *enu*. *I'asina* are small fish (about 3.5 inches) that have just completed their pelagic existence as eggs and larvae in offshore waters and are now returning to the reefs to live for the remainder of their lives. Thousands of *i'asina* (*Mulloidichthys flavolineatus*) may appear along sandy shorelines during the months of October-April. There is little biological concern in harvesting them for human consumption, because their numbers are massive and most will be consumed by predatory fish.

Ofu

i'asina

Olosega

The *enu* basket is constructed with *'ie'ie* vines that are first buried in a beach pit to soak in seawater for a week, after which the vines are cleaned and hung to dry. The coconut sennit (*afa*) used to tie the *'ie'ie* vines together is obtained from the husks of the *niusami* coconut. The husks are soaked in the sand pit for two weeks and then pounded to separate the fibers. Over 100 feet of braided fibers are needed to build the basket. The local custom is that the *enu* must be completed before the fish start running or it cannot be used that year. To catch the fish, the trap is buried half way in shallow water along a sandy shoreline. The traps are baited with hermit crabs (*uga*) that have been pounded and mixed with sand. *I'asina* are eaten fresh or deep fried, or they are frozen.

I'asina are also caught on Tutuila, but by different methods. In Leone, *lau* (coconut fronds) are used to herd the fish over a net laid on the bottom of a shallow pool. Other villages catch the small fish with fine-meshed thrownets or wire traps. Note also that Fagasa's *enu* basket is constructed differently and is used to harvest *atule* fish.

Taito Fale Tuilagi, James Gurr, P.Craig, NPS

23. Traditional *atule* fishing

In some years, *atule* (*akule*) are the most abundant fish species caught in local subsistence and recreational catches. Information about the life cycle of this species (also known as the bigeye scad, *Selar crumenophthalmus*) is sparse. We know only that *atule* appear in some years and usually at specific coastal locations. They may reside temporarily on a reef-flat for a few months and migrate offshore each night to feed on plankton and small fish. *Atule* are thought to be a fast-growing, short-lived species that reaches 12 inches in length. Local catches of fish 6-10 inches in length consist of both juveniles and larger fish that appear to be potential spawners.

On Tutuila Island, there's a legend about the *atule* that appear in Fagasa Bay. Years ago, the Polynesian navigator Liava'a sailed to Tutuila in search of the pure waters of Fagasa. The boat accidently departed while his daughter, Sina, was still ashore collecting fresh water. When Liava'a realized this later, he became enraged and threw his entire crew into the sea with orders for them to return to Fagasa, find Sina and protect her forever. To expedite their return to Fagasa, the men were transformed into dolphins that then herded a school of *atule* to shore to make certain all who cared for Sina would be well fed. Sina was adopted by the family of High Chief Lilio in Fagasa Village. Liava'a, however, never gave up his search for Sina and years later they were briefly reunited. Tradition holds that, upon the death of Liava'a and Sina, their memories were forever preserved in special stones that are protected to this day by HC Lilio

Fagasa chiefs with the stones of Liava'a and Sina.

Enu and *ola* baskets

who is responsible for all events related to the *atule* harvest, thereby preserving the village's continuing appreciation for the generous gift of these fish. The tradition continues. When *atule* arrive in Fagasa, an ava ceremony is held in appreciation for this bounty. The stones are cleaned and when the time is right, the villagers carry coconut fronds into the water to herd the fish into the shallows where they are collected in *enu* baskets which are emptied into the *ola* basket.

Atule harvest in Fagasa, 2008 (with *malauli* jacks in foreground, right photo).

In Manu'a, *atule* school-up in shallow waters in front of Ofu and Olosega villages in some years but not others. Their harvest is a major event that involves the efforts of 50-100 villagers coordinated by the *tautai* (master fisherman). The villagers wade onto the reef flat and use the *lau* (coconut fronds woven together) to herd the fish through a V-shaped weir (made of piled stones) and into a large hand-woven mat-basket. Now that refrigeration is available, single catches (occasionally over 10,000 fish) can be much larger than in the past. The catch is divided up for each family and bountiful harvests are shared with other villages.

Atule harvest in Ofu, 2002.

In a survey of 35 coastal villages in the Territory in 2007, runs of *atule* occur at 23 of the villages and formerly occurred at 2 others.

P. Craig, NPS
Evelyn Lilio, South Pacific Academy
Taito Fale Tuilagi, NPS

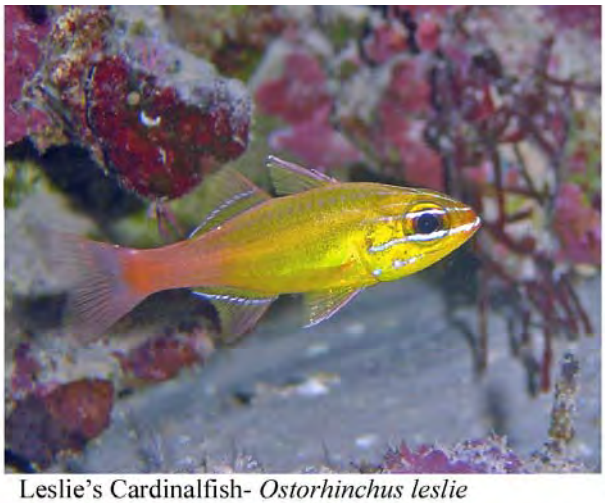
24. Small reef fish

People tend to think about fish large enough to eat when they think about our reef fish -- the jacks, groupers, and parrotfish come to mind, but what about all the other species? A lot of fish on our reefs are quite small, some being fully grown at less than one inch long. It's not surprising that these fish are hardly noticed, but much of the high biodiversity in fish life on our reefs comes from these smaller fish species. For example, nearly 10% of all fish found on our reefs are gobies, most of which measure less than 3 inches. Though individually small, these fish collectively create a portion of the fish biomass on our reefs, forming one of the crucial first links in the foodweb for the larger fish we bring to our tables. Not only are these small fish important to maintaining a healthy reef, many are quite pretty as well. Take time to admire these little fish and you can see some extraordinary things.

P. Brown, NPS

Portenoy's blenny, *Ecsenius portenoyi*, is a small fish that is currently only known from Tutuila, American Samoa.

Indian toby- *Canthigaster solandri*



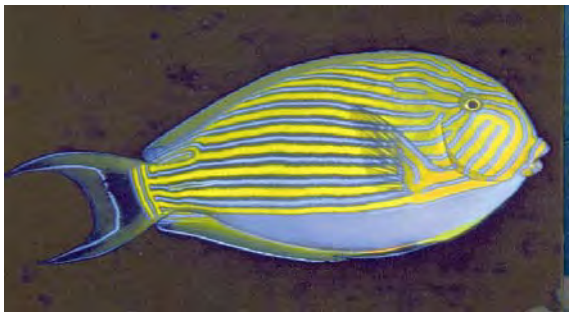
Leslie's Cardinalfish- *Ostorhinchus leslie*

Multibarred angelfish- *Centropyge multifasciata*

Gorgeous shrimpgoby- *Amblyeleotris fasciata*

25. Old fish caught locally

This is hard to believe -- an 18 year old *alogo* was caught in American Samoa. That's old enough to get a drivers license. We're talking about the *alogo*, also known as the blue-lined surgeonfish *Acanthurus lineatus*. Nothing unusual about its size -- it was the typical 8-inch *alogo* you see in the stores. And I ate it. All that remained were the little bones that scientists use to determine the age of the fish. These bones, when looked at under a microscope, have concentric circles, one for each year, just like tree rings. You just count the rings and that's how old the fish is.



What's even more astonishing is that an *alogo* caught in Australia's Great Barrier Reef was 44 years old. I am not kidding. There were also other *alogo* in the Australian sample that were 20-40 years old, so the record age of 44 is believable. These old fish were not unusually large, just the standard size *alogo*.

Similarly, a *pone* (lined bristletooth surgeonfish, *Ctenochaetus striatus*) from American Samoa was 36 years old. It turns out that this is not unusual for coral reef fish. Recent studies show that several other species of surgeonfish, unicornfish (*ume*), groupers (*gatala*) and snappers (*mu*) can also live up to 20-40 years. These findings are beginning to reshape our understanding about the ecology of coral reef fishes and their vulnerability to overfishing. The occurrence of many long-lived fish in a population indicates that the coral reef fish community is quite stable, with a low replacement of individual fish. Once a young fish gets to the reef, it may be there for decades.

Why would these fish live so long? The answer provides some key information about the environment that the fish live in. Fish typically exhibit this type of life cycle (long life span and repeat spawning) when few of their young survive. That's certainly the case for coral reef fish – their thousands of eggs and larvae drift around with the ocean currents for weeks or months (see Chapter 11). Very few of them make it back to any reef. So, if all their young usually die, the adult fish need to live a long time and spawn repeatedly to make sure that at least some young survive. If the adults lived only a short time, the population might disappear altogether.

I'asina in a basket trap (*enu*).

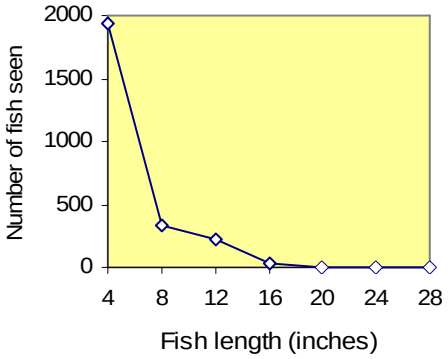
Every so often however, during years when the ocean currents and conditions are just right, massive numbers of young fish survive and appear on our reefs, like *pala'ia* (young *pone* surgeonfish) or *i'asina* (*'aloama*, young goatfish).

While this is all very interesting of course, there is an important take-home message. It is easy to overfish populations with these life history characteristics. Having a long life span and spawning repeatedly may be a successful strategy under natural conditions, but it also makes these fish extra vulnerable to overfishing. That's because fishermen tend to harvest the larger (older) fish in the population. Under heavy fishing pressure, most old fish may be taken, leaving only the smaller, younger fish. That would put the population in a precarious situation, because the younger fish left may not yet be old enough to spawn.

That appears to be what has happened in American Samoa because there are relatively few, or small sizes, of the species commonly taken for food left on our reefs. The graph (next page) shows the combined lengths of all surgeonfish, unicornfish, parrotfish, snappers, emperors, groupers, jacks and

sharks sighted during extensive scientific surveys on the reef slope at the 30-ft depth. Very few fish were larger than 12 inches. This depressing picture is not a sudden event – surveys in 1996 and 2008 show similar results.

Even though current levels of fishing do not seem excessive, the area of our reefs is rather small and consequently it is easily fished out. Fish stocks may well have been depleted years ago – knowledgeable locals and elder Samoans recall seeing far more fish on our reefs 25 years ago.



A meaningful recovery will require a reduction in the harvest of coral reef fishes, with specific protection for the larger fish. Additionally, setting aside some areas as marine protected areas is an essential component for the recovery of fish stocks. To be effective, such areas must provide long-term protection by being permanently closed to all fishing. Marine protected areas that are periodically opened up to fishing may satisfy short-term goals, but they do not allow the fish to grow big and old, and it is these old-timers that produce the most fish eggs. For example, one large snapper (*mu*) 24 inches long releases as many eggs as 212 snappers that are 17 inches long.

So that 18 year old *alogo* was not just an unusual trophy – it was also a vital member of the fish community that spawned year after year, thereby insuring that some young fish survived to maintain a healthy population of *alogo* on our reefs. That's what the long life span of the fish is telling us.

Roadside fish seller

Two fisheries in American Samoa currently target coral reef fish: the subsistence fishery and the artisanal (small-scale commercial) fishery. Subsistence fishing includes the multiple ways that Samoans have always caught nearshore fish for food. In modern times, this includes rod and reel, bamboo pole and line, free-diving, throw nets, gillnets, and gleaning (hand-picking clams and octopus). Stone weirs for *atule* and *enu* baskets for juvenile goatfish (*i'asina*) are still used in Manu'a. On Tutuila, subsistence catches appear to be modest in size and fishing effort has been steadily declining steadily over the past 20 years due to lifestyle changes (more people have regular jobs).

P.Craig, NPS

The artisanal fishery that sells reef fish to local stores is a more recent development. It is conducted by teams of night divers who use underwater flashlights and spears to catch sleeping fish. In the mid 1990s, many of these divers switched from free-diving to scuba diving, which greatly increased the number of fish they caught. This type of heavy fishing had a significant overfishing impact on our reef fish populations, so the use of scuba gear while spear fishing at night was banned in the Territory in 2001.

26. Tuna & the canneries

The ocean around us supports a variety of offshore fish, such as *masimasi* (mahimahi), swordfish, wahoo and marlin, but by far the most commercially important of these pelagic fishes are the tunas. The most common in our local waters are albacore (*apakoa*), yellowfin (*asiasi*), skipjack (*atu*) and dogtooth tuna (*tagī*) .

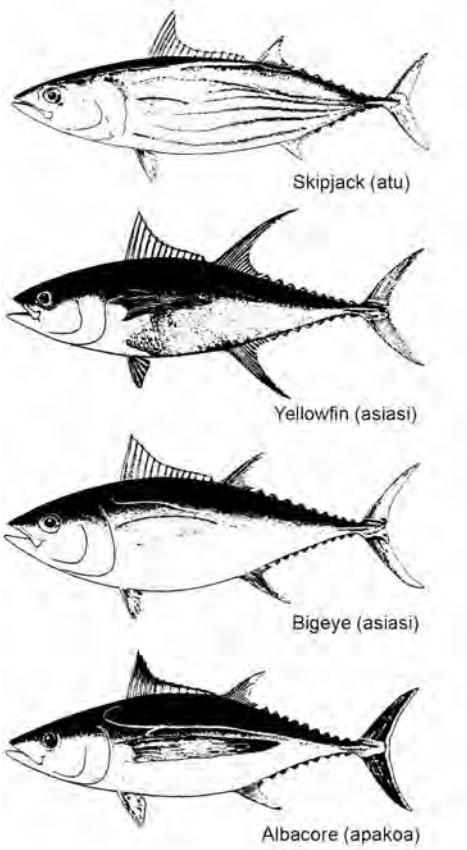
Dogtooth tuna are occasionally seen near the reef, but tuna prefer the open ocean and are wide-ranging species. These ultra-streamlined fish undertake impressive oceanic travels -- one skipjack caught here had been tagged near Australia over 2000 miles away. But the general movements of tuna in our area are not well known.

Local fishermen catch tuna in our area by trolling at FADs (fish aggregation devices), offshore seamounts, or wherever seabird flocks are feeding (the flocks indicate the presence of baitfish that the tuna are probably also feeding upon from below). In recent years, commercial catches of locally-caught tuna have increased in the longline fishery that targets albacore (see page 49).

Given that American Samoa has two major tuna canneries and is the No. 1 port in the United States in terms of value of fish landed (about $200,000,000 per year), it is somewhat surprising to realize that relatively few of the fish canned here are actually caught within American Samoa's waters. That's because tuna are not particularly abundant in our area, so deliveries by local fishermen are a small fraction of the 200,000 tons of tuna processed at the canneries each year. Commercial quantities of tuna are generally located 1000s of miles away from American Samoa, so the big purse seiners and foreign longliners that you see docked in Pago Pago Harbor generally do not fish locally. They may travel for about 1 week just to reach their distant fishing grounds. The reason why these boats deliver their catch to the canneries here is because the tuna canned in American Samoa can enter US markets tariff-free, and the US is one of the largest consumers of canned tuna. Most tuna processed at the canneries are skipjack, yellowfin and albacore. In 2006, the export of canned tuna was valued at $431 million, accounting for essentially 100% of all exports from the territory.

A rather enjoyable feature about tuna is that their meat generally lacks parasites, so people eat raw tuna in a variety of forms (*oka*, sashimi).

P.Craig, NPS




Tuna purse seiner


Foreign longliners


Deep frozen tuna "logs" for the cannery

27. Longlining for pelagic fish (*i'a lapoa*)

Pelagic fish are ocean-ranging species that usually do not venture close to shore. They are handsome, streamlined swimmers, but few of us get to see them in their prime. Shortly after being caught, their colors fade and the fish are deep-chilled or frozen for delivery to the canneries, at which point the fish look rather like grey blocks of ice. Many of us know these fish only from their pictures stamped on little cans purchased at the store.

In American Samoa's deep, offshore waters, most commercially caught pelagic fish are taken by longline fishing. The longline is a strong monofilament line that extends 30-60 miles in length and contains 3000-4000 baited hooks. The line is usually set about 350-550 feet deep but some may be set much shallower or deeper. It takes about 6 hours to set the line and 10 hours to retrieve it. In 2007, the longline catch in our waters was 7,000 tons (mostly albacore), worth $14 million. This amounted to 98% of the value of fish in all local commercial fisheries, including those taken by trolling, bottomfishing, and reef fishing.

The canneries in American Samoa process far greater quantities of fish than this, but most of their fish are caught beyond local waters (see previous page).


wahoo, paala (Acanthocybium solandri)


albacore, apakoa (Thunnus alaluga)


yellowfin, asiasi (Thunnus albacares)


mahimahi, masimasi (Coryphaena hippurus)

Steve Kostelnik and Evan Casey, NOAA Fisheries Observer Program
P.Craig, NPS

28. Turtles In trouble

In Samoan folklore, sea turtles were believed to have the power to save fishermen who were lost at sea by bringing them safely to shore. The Samoan word for sea turtle, "*I'a sa*," translates literally to "sacred fish", presumably because of this ability.

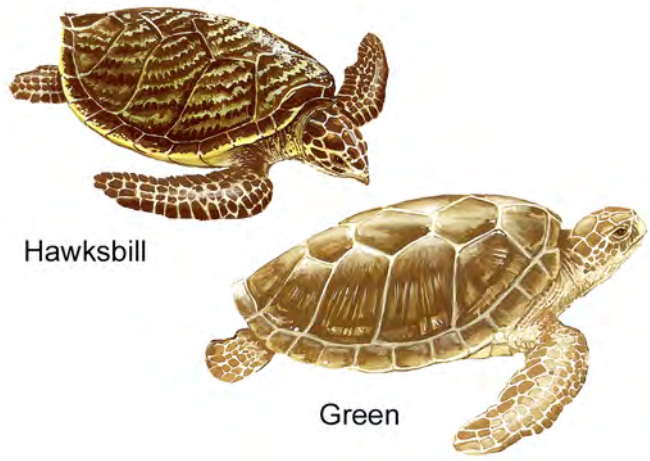

TURTLE PETROGLYPH

In times past, Samoans traditionally harvested sea turtles for food, and the shell was often made into bracelets, combs, fishing hooks. It also was used in the headpiece worn by a princess during important dance ceremonies. Turtles were incorporated into Samoan songs and art, and there are even turtle petroglyphs (rock carvings) in Faga'itua and Leone. And, there's the legend about the Turtle and Shark that appear in the sea at Vaitogi when villagers sing a special song.

It therefore seems extra unfortunate that turtle numbers in Samoa have declined so much that they are now considered endangered species. Although it is difficult to determine how many are left, it is clear that few females lay eggs each year in the Territory. This drop parallels the worldwide decline of sea turtles due to overharvest, loss of nesting beaches, and incidental kills in fishing gear. Pacific populations of one of our species (hawksbills) are "rapidly approaching extinction" according to a scientific review in 1998.

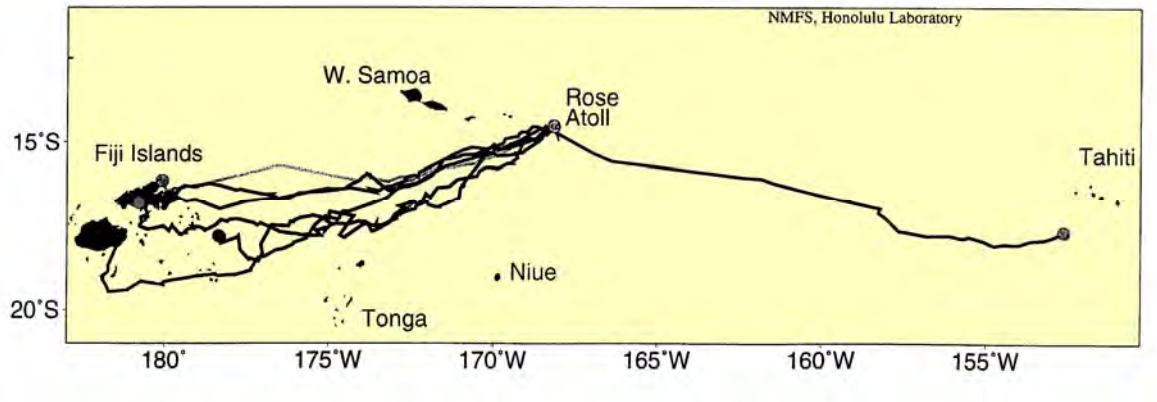
Two turtle species, the green and hawksbill, are the most frequently found turtles in our local waters. The hawksbill or "*laumei uga*" (*Eretmochelys imbricata*) is usually the species that nests on Tutuila beaches. This is a solitary nester, and perhaps only 1 or 2 hawksbill females now use a suitable beach. The hawksbill is occasionally poisonous -- in the late 1950s, people in Aunu'u got very sick after eating one.

Our other species is the green sea turtle (*Chelonia mydas*), named after the color of its fat. It is also found around our islands, but it nests primarily at Rose Atoll. These long-lived turtles have rather complicated life cycles that involve repeated long-distance migrations to and from American Samoa. They start life as eggs buried in beach sand. Once a female has laid her first group of about 100 eggs, she will return at 2-week intervals to lay more. In about 60 days, the eggs hatch and the little turtles dart into the ocean. Where they go is not known, but eventually they take up residence at some feeding area that may be far away from American Samoa.



There they remain for some 20-25 years until they become sexually mature, at which time they return to the very same beach where they came from. After laying eggs there, the adult females then turn around and go back to their distant feeding grounds. That's the basic pattern for most sea turtle species throughout the world. Swim far away to some nesting beach, then swim back to their feeding area, back and forth every few years thereafter.

We have some interesting migration data for green sea turtles at Rose Atoll (see map on next page), where a tagging study was conducted in the mid-1990s. In all, 8 tagged turtles were recovered after nesting at the atoll. Seven swam 800 miles directly to Fiji (unfortunately two of them were eaten when they got there). The last one went in the completely opposite direction to French Polynesia near Tahiti.



It's understandable why the adult green turtles do not stay at Rose Atoll after nesting, because their favorite food (seagrass) does not grow there. But I wonder why don't they just stay in Fiji where they have both seagrass and nesting beaches.

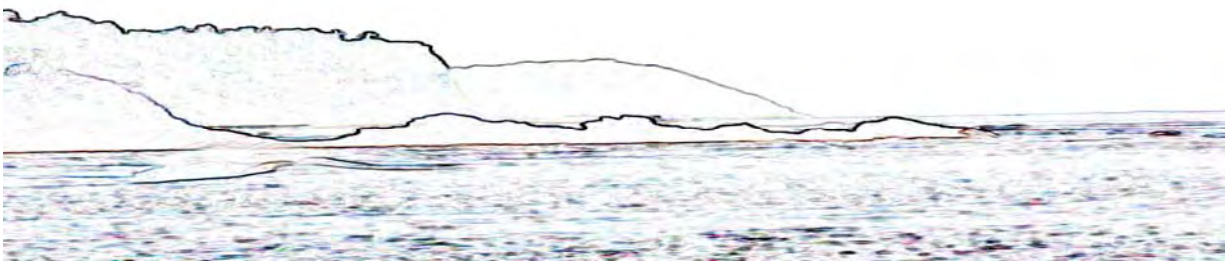
Anyway, this pattern of large-scale movements between a turtle's nesting area and feeding area means that turtle stocks in the South Pacific Ocean are all mixed together. While some of "our" turtles were caught in Fiji, the reciprocal is also true -- turtles that feed in our waters probably originated from islands elsewhere in the South Pacific. This mixing greatly complicates conservation efforts. It means that region-wide cooperation among the island countries of the South Pacific is essential; otherwise, while we try to protect turtles in American Samoa, our turtles may be killed later when they migrate to other islands.

Tough federal and territorial laws exist in American Samoa to protect turtles and their eggs, because they are an endangered species. Depending on the circumstances, there is a $500 to $250,000 penalty and up to one year in jail, for killing a turtle or importing any turtle product into the Territory (shells, stuffed turtles, turtle combs, etc.), although citations have been few, if any. And, some turtles drown when they are caught by fishing gear in the commercial longline fishery that occurs in offshore waters.

Fortunately fewer turtles seem to be taken from shoreline waters or beaches in American Samoa, probably due to their scarcity but also due to outreach programs that inform children and villagers about the endangered status of the turtles. In addition to education efforts, we must protect both the turtles and their habitat. Sandy beaches are essential for turtle nesting areas, so hauling sand away from our beaches results in the loss of critical habitat for these species. No beaches, no nesting turtles.

Although some villagers may still like to eat turtle meat and eggs, the point to remember is that turtles are a disappearing resource in American Samoa. They are a part of Samoa's heritage and need to be vigorously protected, or they may be lost altogether. It is a sad commentary that many young Samoans have never even seen a live sea turtle.

P.Craig, NPS



29. Baby turtles: look but don't touch!

Baby sea turtles. They're so neat -- perfectly formed miniatures, all racing down the beach together to get into the water. Kids think they're cute and they want to keep them as pets, and plenty of parents think baby turtles make great pets. After all, they don't bark or fight, and they're so tiny so they don't take up much space. They don't eat much, either.

Also, some people in American Samoa believe that when a nest of turtles hatches and all the babies run to the sea, their mothers are waiting out on the reef to eat them! Because of this misguided belief, some people collect baby turtles and keep them at home or release them on a different beach. But the very best thing we can do for baby turtles is: LEAVE THEM ALONE!

Many years of scientific research on sea turtles have taught us that mother turtles do not eat their babies. Adult turtles eat mostly seagrass, algae (seaweed), and sea sponges (the living kind, NOT the kitchen kind). In fact, after the female turtle has laid eggs (sometimes two or three times in the space of a few weeks), she goes back out to the sea and leaves the area. For example, after nesting at Rose Atoll, some of American Samoa's green sea turtles swam to Fiji – over 800 miles away! So, those of you with good intentions out there, rest assured that mom will not be eating her babies, and you do not need to collect the baby turtles from the beach to save them from her.

It is true that baby turtles do have predators, such as large fishes and sharks. Nature provides the turtles with some protection however: (1) most turtles hatch at night when predators might have difficulty seeing them, (2) baby turtles are dark-colored, and this "cryptic coloration" enables them to be camouflaged as they swim over the reef, (3) female turtles can lay over 100 eggs in a single nest — when this many turtles hatch at the same time, a big jack (*ulua*) or shark (*malie*) can't possibly catch and eat all of them, so some have a chance to hide in the reef. This is called "predator swamping" and is common among reptiles (lizards, snakes, turtles, etc.). For this reason it is a bad idea to take "just a few" baby turtles away, and release them later. The "predator swamping" effect is lost and those baby turtles will probably end up as some fish's lunch.

A critical reason to leave baby turtles on the beach is that THAT EXACT BEACH is very important to them. Baby turtles remember or "imprint on" the beach where they hatched. Like many animals, turtles have little natural magnets in their brains that allow them to home-in on their native beach. Years later when it's time for them to reproduce, adult turtles, with their internal "homing devices", will seek that same beach. If hatchling turtles are removed from their home beaches and kept in someone's bathtub or

bucket, chances are they will become confused and have little chances of surviving, let alone finding their home beach later (that is, if they don't just die in the bucket).

Sea turtles have been around for millions of years and survived just fine before humans started taking their babies off the beach, whether to "protect" them or otherwise. Newly-hatched turtles, just like their gigantic moms and dads, are wild animals and are not meant to be kept as pets. The ocean provides better food and a cleaner, healthier environment for turtles than humans can.

Turtles are far-ranging animals that swim thousands and thousands of miles in the sea during their lifetimes. When they go to their nesting islands, they meet with other turtles, mate, lay eggs, and so keep their species alive. Every time a female sea turtle finds her way back to the beach where she was born and nests there, she completes the ancient, natural cycle that keeps sea turtles alive on Earth. Imagine a turtle imprisoned in a bucket, tub, or garbage can, swimming endlessly in tiny circles, never to see the open ocean, never to meet another turtle, never to help its species survive.

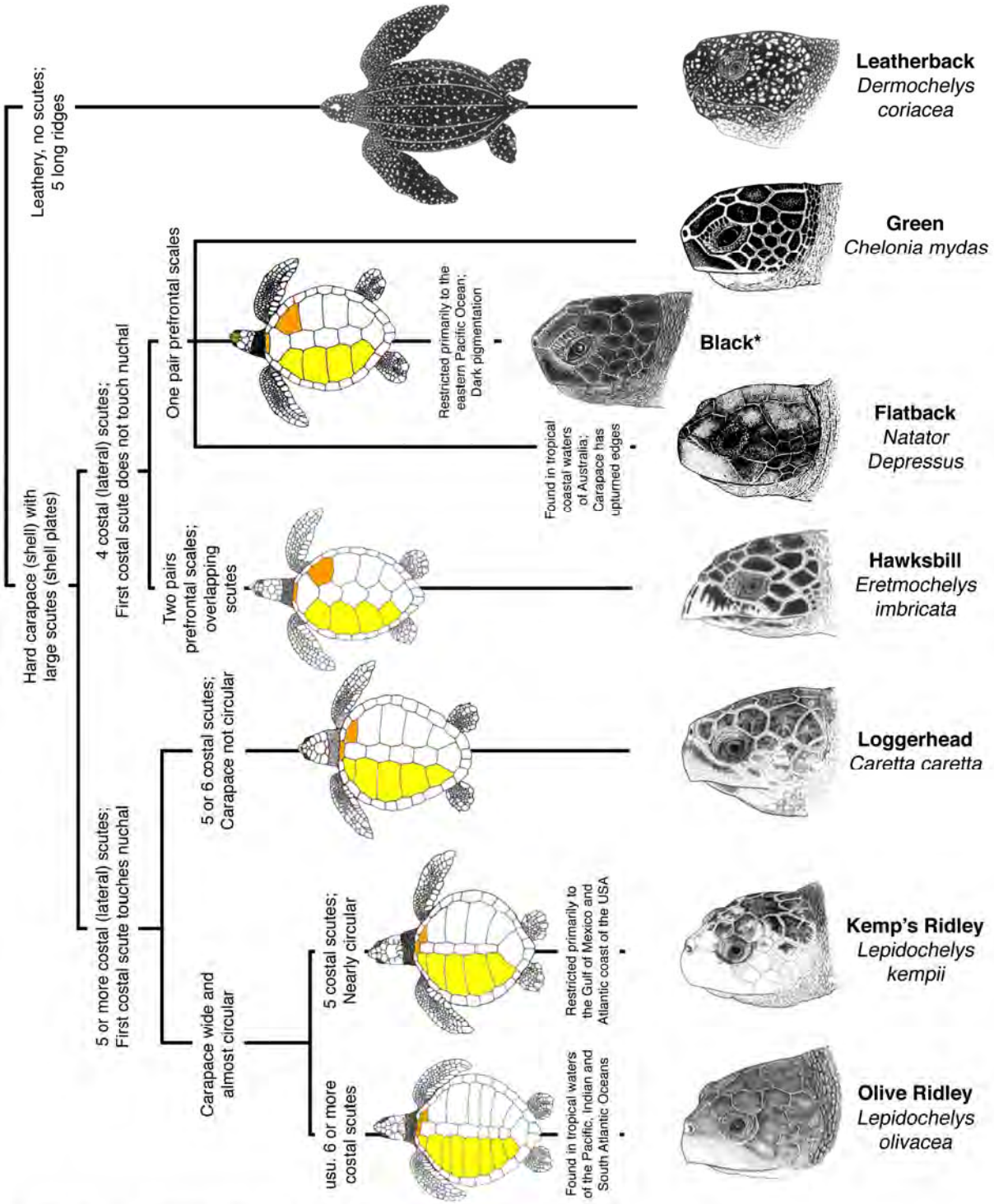
Sea turtles all over the world are dwindling in number. All species are listed as threatened or endangered under the U.S. Endangered Species Act, including our own green and hawksbill sea turtles. If we want our children and grandchildren to be able to see these huge, magnificent sea turtles swimming alive and free in the ocean, where they belong, we have to do our best to protect them now. The very best way we can to do that is by protecting the beaches where they nest, letting the baby turtles find their own way into the sea, and not hunting the big turtles. Future generations of turtles (and people) will thank us.

Holly Freifeld, DMWR

Adult turtle tracks on beach.

Ofu Island

30. Sea turtle identification key



Sea turtle figures used by permission of the Marine Turtle Specialist Group (iucn-mtsg.org)
Source: Pritchard, P. C. H. and Mortimer, J. A. (1999) Taxonomy, External Morphology, and Species Identification. pp. 21-38. In: Eckert, K.L., K.A. Bjorndal, F.A. Abreu-Grobois, and M. Donnelly (Editors). 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4. (for further details see http://www.iucn-mtsg.org/publications/) Illustrations by Tom McFarland

SEATURTLE.ORG

31. Whales Ho !

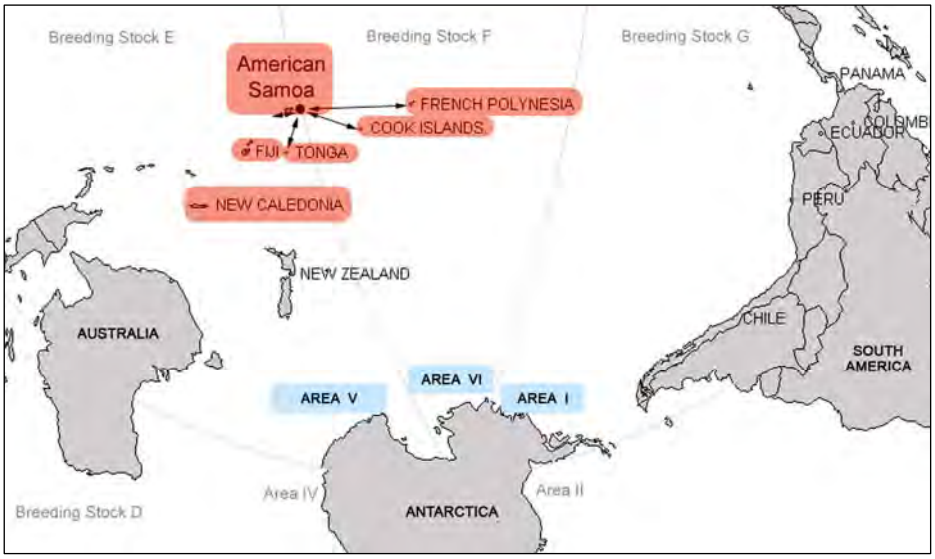
September and October are the peak months when humpback whales (*tafolā*) visit our balmy waters. It's almost impossible not to get excited when one is spotted. Most of us feel inexplicably privileged for a glimpse into their mysterious world, and there's an uncontrollable urge to shout 'thar she blows'.

Part of our fascination with whales is their huge size, of course. Adult humpbacks *(Megaptera novaeangliae*) grow up to 50 feet long and weigh about 45 tons (which equals the combined weight of about 250 sumo wrestlers). We rarely get a chance to see the whole whale, except when they make a spectacular leap out of the water. We usually see only their air spout or their humped back as they prepare to dive.

Humpbacks are air-breathing mammals (like ourselves) that live their complete lives in the ocean. They reproduce like all land mammals, but they do it underwater. Whales obviously have to make sure that their babies don't drown while being born. Mother whales nurse their young for about a year.

These whales eat small schooling fishes and krill (small shrimp). They feed by gulping in tons of water in a single mouthful, and then strain the food out as they expel the water. The out-going water is filtered through specialized structures called “baleen”, which looks (with a little imagination) like a mouthful of coconut fronds. Humpbacks lack real teeth because they have no need to bite or chew their tiny food items. It seems odd that the whale, which is one of the world's largest animals ever, feeds on such small things.

The appearance of humpbacks in Samoa is an important segment of their grand migration up and down the South Pacific Ocean between their rich feeding areas around Antarctica (blue areas on map) and their breeding areas (red areas on map). The movements of "marked" whales indicate that their migrations can include extensive east-west movements as well. Individual humpback whales can be recognized based on the unique color pattern and shape of their tail fluke. By matching photographs of flukes from different regions, general movements of individual whales can be determined. Our humpbacks have been re-sighted in Tonga, the Cook Islands, and in French Polynesia. Another one was seen in Antarctic Area I, one of the feeding areas of South Pacific humpback whales.



When the bitter winter in Antarctica sets in, humpback migrate north to warmer waters. In the South Pacific, some head towards Australia, others migrate to destinations in Oceania. American Samoa lies between two Oceania populations described by biologists as Breeding Stocks E and F. Our whales are

more closely tied to breeding areas east of American Samoa (Breeding Stock F) that include areas such as French Polynesia.

A few humpbacks might arrive in Samoa as early as July or leave here as late as December, but they are most common here in September and October. They occur in small groups of adults or in mother-calf pairs. Humpbacks have been sighted around all 7 of the islands in the Territory, but we don't know how many are actually here. They migrate here to mate and give birth to their young. And, interestingly, they stop feeding while here -- only when they return to the Antarctic do they resume feeding.

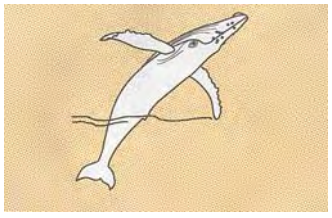
While an occasional spout of whale-breath can be seen in our local waters, you can also hear the whales if you stick your head in the water. Humpbacks are famous for their unique “songs”. Yes, whales sing! During mating season, male humpbacks sing to either attract females or to defend their territory from other male whales, much like birds do with their own songs.

The whale's song is haunting and complex. It sounds like a eerie series of chirps, squeaks, whistles, and grunts. I know that “grunts” don't seem like they could make much of a song, but you just have to take my word for it. It is unlike anything you have ever heard. Scuba divers can hear the singing if they hold their breath and pay attention. Snorkelers can also hear the songs, but they might have to dive about 10 feet deep to get below the noisy surface layer of water. The song lasts about 10-20 minutes, it has a beginning, middle and end, and all males of the same stock sing the same song. Biologists can therefore identify where a whale comes from by listening to its song. Hawaiian humpbacks sing a different song, because they belong to a different stock of whales that migrates between Hawaii and Alaska. The whales' song is one of the world's wonders of nature and it's at our doorstep.

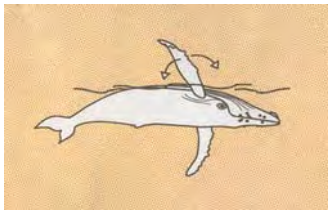
While humpback whale populations appear to be increasing in some areas of the world, those in Oceania are still considered to be endangered since being decimated by whalers in the 1800's and 1900's. By the time commercial whaling was stopped in 1966, 95% of the whales in Oceania had likely been killed. Their recovery has been unexpectedly slow, probably due to continued whaling by Soviet factory ships as late as 1972 and a subsistence harvest of these whales occurred in Tonga up to 1978. In any event, whales in American Samoa remain few in number, and in some years hardly any are seen here.

Because humpbacks use our waters to give birth to their young, it is important to protect them when they are here. Enjoy their presence, but don't pester them. Avoid the temptation to boat right up to them or follow them at close quarters. Boaters, divers and swimmers should stay at least 100 yards away, and watch from there.

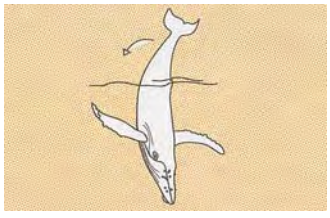
P.Craig, NPS
Jooke Robbins, Provincetown Center for Coastal Studies
David Mattila, Hawaiian Humpback Whale National Marine Sanctuary



BREACHING
Leaping partly out of the water and landing with a big splash.



PEC SLAP
Flapping its pectoral fin.



TAIL SLAP
Slapping its tail on the water.

32. Dolphins & small whales (*mumua*)

Recent surveys for marine mammals around Tutuila Island have confirmed the presence of several species of odontocetes, more commonly called toothed whales and dolphins (*mumua*). The most common species found close to shore (in waters less than 200 meters deep) are spinner and rough-toothed dolphins. Six local odontocetes are shown on the next page, and a complete listing is found on page 59.

Spinner Dolphins. Spinner dolphins (*Stenella longirostris*) are the most common dolphin seen around Tutuila throughout the year. They may come close to shore, even resting within coves and bays. They are most often found on the east and west ends of Tutuila, near Aunu'u and Sliding Rock respectively. Fagasa Bay is also well-known for its *mumua*.

Recent photo-identification of individuals suggests that the groups found around the island are largely resident here. However, their genetic diversity is high, indicating that there may be some interchange with spinner dolphins from surrounding islands. This pattern of strong residency to an island but with high genetic diversity has been documented in French Polynesia as well. It suggests that, while most of the local spinner dolphin communities are faithful to their islands, some individuals probably visit and breed with other island communities.

Rough-toothed Dolphins. The next most common dolphin seen around Tutuila is the rough-toothed dolphin (*Steno bredanensis*). This is unusual because at other locations this species is commonly found farther offshore, but here they are often seen in relatively shallow water (less than 200 meters deep) at least in September & October. Of course they may well use the deeper waters to feed, while perhaps "resting" in the shallower water. Curiously, they are often found in association with humpback whales when the whales visit American Samoa. Neither species is feeding nor does the encounter look aggressive. Most often the dolphins just seem to enjoy riding the pressure wave created around the head of the whale as it swims through the water, much like riding the "bow wave" of a boat. As with the spinner dolphins, recent photo-identification of individuals suggest that at least some individuals are residents around the island, with several individuals seen from one year to the next.

Spinner dolphin (*Stenella logirostris*)

Rough-tooth dolphin (*Steno bredanensis*)

Bottlenose dolphin (*Tursiops truncatus*)

Pantropical spotted dolphin (*Stenella attenuata*)

False killer whale (*Pseudorca crassidens*)

Short-finned pilot whale
(*Globicephala macrorhynchus*)

David Mattila, Hawaiian Humpback Whale National Marine Sanctuary
Jooke Robbins, Provincetown Center for Coastal Studies

33. Marine mammal & reptile checklist for American Samoa

Common and Samoan names	Scientific name
MARINE MAMMALS	
Whales	
Humpback whale (*tafolā, ia maanu*)[1,2]	*Megaptera novaeangliae*
Sperm whale[2]	*Physeter macrocephalus*
Short-finned pilot whale[2]	*Globicephala macrorhynchus*
False killer whale[2]	*Pseudorca crassidens*
Dwarf sperm whale[2]	*Kogia simus*
Minke whale[3]	*Balaenoptera acutorostrata*
Killer whale[3]	*Orcinus orca*
Cuvier's beaked whale[4]	*Ziphius cavirostris*
Dolphins (*mumua*)	
Spinner dolphin[2,5]	*Stenella longirostris*
Rough-toothed dolphin[2,5]	*Steno bredanensis*
Bottlenose dolphin[2]	*Tursiops truncatus*
Pantropical spotted dolphin[2]	*Stenella attenuata*
Striped dolphin[6]	*Stenella coeruleoalba*
Potentially present	
Bryde's whale[7]	*Balaenoptera edeni*
Pygmy sperm whale[7]	*Kogia breviceps*
Melon-headed whale[7]	*Peponocephala electra*
Risso's dolphin[7]	*Grampus griseus*
Fraser's dolphin[7]	*Lagenodelphis hosei*
MARINE REPTILES	
Sea turtles	
Hawksbill sea turtle (*laumei uga*)	*Eretmochelys imbricata*
Green sea turtle (*laumei ena'ena, fonu*)	*Chelonia mydas*
Olive ridley sea turtle[8]	*Lepidochelys olivacea*
Leatherback sea turtle[9]	*Dermochelys coriacea*
Sea snakes	
Banded sea snake[10]	*Laticauda* sp.

[1]Seasonally present (primarily Aug-Oct).

[2]Identifications by D. Mattila, D. Johnston, J. Naughton (NOAA), and/or J. Robbins (Provincetown Center for Coastal Studies) and/or Johnston et al. 2008. J.Cetacan Res. Manage. 10:59-66. Also identified from several skulls of pilot whales that washed ashore (Sita Bay, 1993) and one sperm whale skull (Maloata, 1994).

[3]Reeves et al. 1999. Marine mammals in the area served by South Pacific Regional Environment Programme. SPREP (Samoa).

[4]Stranded on Auto reef in 2008 (DMWR); also a visitor to Pago Pago Harbor in 2002 (identified from photograph by J. Mead (Smithsonian Museum Natural History) and W. Perrin (NOAA).

[5]Present year-round.

[6]Stranding (DMWR).

[7]Probably present in region but not yet confirmed in American Samoa (Reeves et al. 1999 – see reference above).

[8]Rare: only three recorded occurrences (DMWR).

[9]Rare: a single juvenile was caught on longline gear near Swains in 1993 (DMWR).

[10]Rare: one verified occurrence in 2000 approx. 12 inches long (NPS).

Dolphins (mumua)

P.Craig, NPS

34. Land mammal, reptile & amphibian checklist for A. Samoa

Common and Samoan names	Scientific name	Origin[1]
LAND MAMMALS		
Bats		
Samoan fruit bat[2] (*pe'a vao*)	*Pteropus samoensis*	N
White-naped fruit bat[2,3] (*pe'a fanua*)	*Pteropus tonganus*	N
Sheath-tailed bat[4] (*pe'ape'avai*)	*Emballonura semicaudata*	N
Rodents (*isumu*)		
Polynesian rat	*Rattus exulans*	PI
Roof rat	*Rattus rattus*	MI
Norway rat	*Rattus norvegicus*	MI
House mouse	*Mus musculus*	MI
Others		
Pig (*pua'a*)	*Sus scrofa*	PI
Dogs *(maile*)	*Canis familiaris*	PI
Cats (*pusi)*	*Felis domesticus*	MI
LAND REPTILES		
Geckos (*pilimo'o*)		
Pacific slender-toed gecko	*Nactus pelagicus*	PI
Oceanic gecko	*Gehyra oceanica*	N
Mourning gecko	*Lepidodactylus lugubris*	PI
Stump-toed gecko	*Gehyra mutilatus*	MI
House gecko	*Hemidactylus frenatus*	MI
Skinks (*pili*)		
Pacific snake-eyed skink	*Cryptoblepharus poecilopleurus*	N
Micronesian skink	*Emoia adspersa*	N
White-bellied or brown-tailed striped skink	*Emoia cyanura*	PI
Dark-bellied or blue-tailed striped skink	*Emoia impar*	PI
Lawes skink (*pilioua*)	*Emoia lawesii*	N
Pacific black skink (*piliuli*)	*Emoia nigra*	PI
Samoan skink (*pililape*)	*Emoia samoensis*	PI
Moth skink	*Lipinia noctua*	PI
Snakes		
Pacific boa[5] (*gata*)	*Candoia bibroni*	PI
Australoasian blindsnake[6]	*Ramphotyphlops braminus*	MI
AMPHIBIANS		
Cane or marine toad[6] (*lage*)	*Rhinella marinus*	MI

[1] N = native, PI = Polynesian introduction, MI = modern introduction.
[2]Also known as flying foxes.
[3]Also known as white-necked, Tongan or insular fruit bat.
[4]Few found after cyclones in 1990 and 1991; perhaps locally extinct.
[5]Ta'u Island; formerly present on Ofu Is. (Tito Malae, pers. com.) and Tutuila Is. (Steadman & Pregill. 2004. Prehistoric vertebrates from Tutuila Island. Pacific Science 58:615-624).
[6]Tutuila Island.

Sources: Dr. George Zug, Smithsonian Institute, Wash. DC (pers. com., 2008) for reptiles; Amerson et al. 1982. Wildlife and wildlife habitat of A.Samoa. Vol.1. Environment and ecology. US Fish & Wildlife Service (Wash. DC). 119p.

35. Flying Foxes (fruit bats)

Large flying foxes, also know as fruit bats, are one of the more unusual animals in American Samoa, especially for visitors from areas where bats are small and rarely seen. Three species inhabit our islands – two large fruit bats (*Pteropus samoensis, P. tonganus*) and a small insect-eating bat (*Emballonura semicaudata*). These three are the only native mammals in the Samoan islands.

The two flying foxes are especially distinctive: they are renowned for being large (with a wing span up to 3 feet wide) and active both day and night. *Pteropus samoensis* (*pe'a vao*) is commonly called the Samoan flying fox. It is presently found only in the Samoan Archipelago and Fiji. It once occurred in Tonga but is now extinct there. The other flying fox, *Pteropus tonganus* (*pe'a fanua*), has several common names such as the Insular, White-naped, White-necked or Tongan fruit bat. It has a wider distribution in the Pacific, ranging from islands near Papua New Guinea to the Cook Islands.

In American Samoa, flying foxes can be seen flying, soaring, feeding, or just hanging in trees. Although individuals of the two species overlap in size (adults weigh 300-600 grams), there are ways to differentiate them from a distance. When silhouetted against the sky, the *pe'a vao* has a more triangular shape, with wings that are slightly scalloped and relatively dark and opaque. Their flight appears more relaxed, usually with slower wing beats and deeper wing strokes. It is not unusual to observe them soaring in the air in the day, taking advantage of rising currents of warm air (thermals) to seemingly float up and about without flapping their wings.

In contrast, *pe'a fanua* has a more cross-like appearance: the neck and head appear more pronounced, the wings are narrower and more scalloped, and the hind legs stretch out like a tail. In flight, *pe'a fanua* tend to have faster wing beats and shallower wing strokes. They are less likely to soar in thermals and generally take a directional route to and from roosting sites at dawn or dusk.

White-naped flying fox (*pe'a fanua*)

Samoan flying fox (*pe'a vao*)

Despite these differences, it takes a keen eye to distinguish the two species from a distance. Close up, the *pe'a vao* may sport a white to yellowish triangular patch that starts from the forehead and extends to the back of its head, or it may simply exhibit a generally grayish head with or without flecks of white hair (much like a graying man). Its neck and shoulder areas are a beautiful russet brown, while the rest of the body has a dusty black appearance. The *pe'a fanua*, on the other hand, has a basically black head and body. These black areas serve to set off a distinctive band of creamy yellow on the back of the neck and

which extends slightly below its shoulders as if in a cape. This explains why they are called white-naped fruit bats although the color is not really white.

The two species have quite different social behaviors. During the daytime, *pe'a fanua* form large roosting groups or colonies of hundreds to thousands of bats. These colonies are generally organized according to their reproductive status and may be composed of bachelor males, clusters of females defended by an adult male (suggesting a harem mating system), or groups of females and their young. In any case, individuals appear to be relatively "faithful" to their roosts, usually returning to their respective colonies following foraging flights.

But the *pe'a vao* does not do this. Instead, these bats usually roost singly on branches, or as pairs of males and females (suggesting a monogamous mating system), or as a female with its young. When roosting, *pe'a vao* males tend to hang from exposed or dead branches of trees on ridge tops while females roost in more covered positions on forest slopes.

There is little information on how long flying foxes live, although some held in captivity have lived 20 years. We assume that they live shorter lives in the wild, because natural catastrophes like tropical cyclones may periodically reduce their numbers, as occurred in the early 1990s. With proper management and protection from hunting, the populations will generally bounce back, but this requires a number of years, because females of both species probably have only one young per year and we do not know how many of their young survive to adulthood.

The care and energy that both bat species put into their young is remarkable. Pregnancy lasts approximately 5 months in both species, and once the young are born, it takes at least another 3 months before they are weaned. Even after they are capable of flight, the young continue to receive parental care, perhaps until they reach adult size or become reproductively active themselves. We know this from observations of pairs of individuals seen to alight independently on the same tree and subsequently come together with one individual (presumably the juvenile) being wrapped up in the other's wings as they settle down to roost. Sightings of pregnant females and individuals carrying young in flight indicate that *pe'a vao* give birth mostly between April and June. *Pe'a fanua* births appear to occur year-round but are more common in January and June to August.

Although their name indicates that they are fruit-eaters, both species also eat nectar, pollen, leaves, and sap. They tend to consume only the "juice" of fruits and leaves. To do this, a bat will carefully chew on

food (usually eating around large seeds), press the pulp against the roof of its mouth with its tongue, squeeze and suck in the juice, then spit out most of the pulp in pellets called “ejecta.” These ejecta are especially abundant under breadfruit trees (*'ulu*) where the bats have been feeding overnight. Among the splatter of mushy bits of the fruit, you can find these pellets of drier material that sometimes show tooth and palatal (roof of the mouth) impressions, much like a dental cast produced at a dentist’s clinic. Ejecta pellets help us to identify food items that bats eat even when we do not directly observe them feeding. In addition to direct observations and analysis of ejecta, their diets are also determined through pollen present in facial hair and in feces. These data help scientists determine which plants are important because they are preferred, nutritious and/or available year-round.

Dime-size ejecta under breadfruit tree.

At least 42 plant species provide food for the *pe'a vao* and *pe'a fanua* in American Samoa. These consist mostly of forest tree species, such as *āoa* (*Ficus prolixa* and *Ficus obliqua*), *asi* (*Syzigium inophylloides*), *'a'amati'e* (*Elaeocarpus ulianus*), *ifi* (*Inocarpus fagifer*), *fetau* (*Callophyllum inophyllum*), *māmālava* (*Planchonella samoensis*), and *tava* (*Pometia pinnata*). The bats also eat cultivated fruits such as mango (*Mangifera indica*) and *'ulu* (*Artocarpus altilis*), but damage to crops is limited if fruits are harvested before they ripen on the tree. Also, when you hear the bats squealing in banana patches at night, it’s usually because they are fighting over the banana flowers, not the fruits. Despite the broad similarity in their diets, *pe'a fanua* exploit flower resources and feed on trees (especially domestic ones) closer to human habitations more often than do *pe'a vao*.

The rewards of the interaction between flying foxes and plants are certainly not one-sided, because the plants and forest also benefit from being visited by bats. When the *pe'a fanua* visit patches of *vavae* flowers (*Ceiba pentandra*), for example, they help transfer pollen from one tree to another and that, in turn, enhances fruit formation and production. Flying foxes are also important for seed dispersal. When they consume fruits with small seeds (such as *āoa*), some seeds that get swallowed do not get digested but are carried and deposited away from the tree source. In American Samoa, flying foxes are the only animals that can carry fruits with large seeds, such as *ifi*, over distances and uphill. Studies of bat movements on Tutuila reveal that bats may commute between feeding areas up to 40 km apart during a single night. Seeds that are transported can colonize naturally bare or cleared areas and aid in the revegetation of gaps in forests where trees may have fallen from disease, age, or bad weather.

Bats flying above their daytime roost.

It may bother us that flying foxes eat some of the fruit that we grow for ourselves, but these bats are tireless workers that help maintain the health of our rainforest, and they are fun to watch.

Ruth C. B. Utzurrum, DMWR

36. The vegetation of American Samoa

The Samoan islands are volcanic and oceanic in origin, formed from basaltic lavas rising from the ocean floor of the Pacific basin. The archipelago was born in isolation and has never had a connection to any other land area. Its tropical climate, fiery origin, isolation from its neighbors, and subsequent erosion and sedimentation have created the unique surface of its islands. The combination of factors, simmered in a caldron of time, and with the addition of plants arriving by means of long-distance dispersal, has created a tropical rainforest that forms a green mantle over the archipelago. Most of the natural vegetation of American Samoa (present before the arrival of Polynesians about 3000 years ago) fits into this category of tropical rainforest. Tropical rainforests are found throughout the world in areas of warm climates and sufficient to plentiful year-round rainfall. The Samoan tropical rainforest originally extended from just inland of the shore up to the summits of the highest mountains, except on those peaks where soil factors (in montane scrub) or weather factors (in summit scrub) have created scrubby vegetation in which life forms other than tall trees are predominant.

One of the significant characteristics of tropical rainforests is high species diversity. Tropical rainforests are home to the majority of the world's plant species. The flora of Samoa (the sum of the plants occurring in the archipelago) comprises about 550 native flowering plants, 215 fern species, and 13 fern ally species. About two thirds of these species are found in American Samoa. They can be divided into two types: endemic species (restricted to Samoa) and indigenous species (not restricted to Samoa). The level of endemism of the native flowering plants in Samoa is estimated to be about 30% at the species level. Areas to the west such as Indonesia and Malaysia have much larger floras, a characteristic that can be attributed to their much larger areas, older age, and to what is called a "filter effect" in which chance and distance limit the number of species successfully reaching (and becoming established in) the faraway islands of Polynesia.

Another characteristic of tropical rainforests is the presence of unusual life forms. One of the most unique is that of epiphytes, plants that grow on trees, usually in order to get closer to the sunny canopy, but which do no harm to the "host" plant. When the conditions in the forest are extremely wet, as they are in the montane forest and cloud forest, epiphytes may even cover the trees. The most prevalent group of epiphytes is the orchid family, which comprises 65 species in American Samoa (many of which are not epiphytes but grow on the forest floor). Epiphytic ferns comprise the second most abundant group of epiphytes in the Territory.

Another unusual life form common in the tropical rainforest is that of lianas, or woody vines; these are almost entirely absent from temperate forests. Lianas ascend into the canopy usually attached to growing trees, to which they cling by means of tendrils or coiling stems. From there they eventually spread to cover much of the canopy. A third unusual life form is that of the banyan (*āoa*) or "strangler." These are plants whose seeds germinate on trees and initially live as epiphytes until their roots grow down to reach the soil. Eventually the roots envelope the tree and "strangle" it to death, sometimes leaving a hollow center where the host tree died and decayed.

The vegetation of Samoa is not homogenous, because zones of plant combinations can be discerned. It is difficult, however, to make sense of the differences we can see in the pattern of plants, and even more difficult to determine where the boundaries are between the different types of vegetation. The vegetation can generally be divided into a number of categories called "plant communities." A plant community is a unit of similar vegetation distinguished from other plant communities by its structure and habitat. Eight natural plant communities can be recognized in American Samoa: (1) Littoral Strand, (2) Marsh, (3) Freshwater Forest, (4) Mangrove Forest, (5) Lowland Forest, (6) Montane Forest,

(7) Montane Scrub, and (8) Summit Scrub. Several other disturbed types of vegetation can also be recognized.

Littoral strand forest on north coast of Tutuila.

Coastal marsh in Aunu'u Crater.

Littoral Strand comprises the forest, scrub, and herbaceous zones growing directly on the seashore. Its component species are seawater dispersed and widespread on Pacific shores. Marsh, Freshwater Forest, and Mangrove Forest are classified as "wetlands," but they comprise only a small percentage of the overall land area of American Samoa. Lowland and Montane Forest together comprise the "tropical rainforest" that once covered over 90% of Samoa.

Montane Scrub and Summit Scrub are unique. Montane scrub comprises the vegetation on the summits and upper slopes and ridges of Tutuila on geologic areas called "trachyte plugs," which have a characteristic chalky soil that appears to cause stunted vegetation. The most obvious example of this is Mt. Pioa ("Rainmaker Mountain") and Mt. Matafao, the highest peaks on the island. Montane Scrub looks superficially like Summit Scrub, but is noted only from the summit of Ta'u and is quite different floristically. Its scattered, stunted trees are embedded in a dense matrix comprising shrubs, ferns, and lianas. Epiphytes also abound in this community, sometimes covering the stunted trees.

A plant community that is in equilibrium with its environment, when its form and flora change little with time (barring major disturbance), is called a "climax plant community." For example, a coastal marsh dominated by *Eleocharis dulcis* (*utu utu*) can be expected to remain somewhat constant over short periods of time (e.g., decades). "Climax forest" is often confused with "primary forest," which is the natural and undisturbed forest in an area. However, nearly all of the mature forests in Samoa are better described as climax rather than primary forest, since in ancient times much of the interior of the islands was inhabited and cleared for cultivation before being abandoned early in the European Era (after 1830).

W. Arthur Whistler

Native tropical forests serve several important functions in American Samoa and throughout the tropics. First, they provide protection from soil erosion, which leads to a higher quality of drinking water. Second, they are home to a majority of the world's plant and animal species. Third, they serve as home to animals, such as pigeons and flying foxes, and plants, such as Tahitian chestnut (*ifi*), that have traditionally been a major part of the local diet.

Unfortunately, the forests of American Samoa are seriously threatened. The most dangerous threats, direct or indirect, are the actions of our people. Due to rapid population growth, the existence of communities such as mangroves, wetlands, and some kinds of lowland forest have been nearly eliminated. Alien plant and animal species also threaten to out-compete and reduce the abundance of some native species.

37. Banyan trees (*āoa*) -- lifeline for Samoa's wildlife

In the complex world of the Samoan rainforest, each of our native plants and wildlife contributes a unique and essential part. Just as the beauty of a hymn would be less without the harmonies of different voices, so the beauty of the Samoan forests would be less if any of our plants or animals were lost. And yet, as in a choir, there are a few natural "voices" that sing out above the rest. These are the plants and animals most important for the harmony of Samoa's natural world.
Foremost among these are the *āoa*, or banyan trees.

Banyans are fascinating plants. Now, a lot of people don't think of plants as "fascinating". After all, they just sit there, right? Well, not banyans. Although banyans give life to countless animals by feeding them with their fruit, all banyans start out as killers -- stranglers, to be exact. Another name for the banyan is "strangler fig".

The *āoa* is a member of the fig family. They earn the other part of their name by their strange way of growing. Most plants sprout from seeds that have fallen to the ground, and grow up toward the sun. Banyans usually do the opposite: they sprout from seeds that have been left by birds high in a tree, and grow down toward the ground. The seedling first anchors itself by sending roots into the little pocket of decaying leaves or moss where it has sprouted, then it wraps more and more roots around the tree that supports it, called the "host" tree. Soon the banyan's roots are spreading down the trunk, and finally they reach all the way to the ground (see photos below). By then the fate of the host tree is sealed. It is literally buried beneath the growing banyan -- strangled to death. Eventually the body of the host tree decays away, leaving no trace behind, except sometimes a long hollow extending up inside the middle of the full-grown banyan. Because banyans will start life on almost any type of host tree, they kill very few of any particular kind, and so are no threat to other plant species. Still, they're rather...fascinating, don't you think?

Young banyan tree roots grow down the host tree towards the ground (left). The roots grow and tighten around the host tree (center) and eventually engulf it completely (right).

In Samoa, we have two different kinds of native banyan trees, both called *āoa*. One kind (*Ficus prolixa*) becomes a huge tree, with an enormous spreading trunk that seems to be a twisted net of many smaller trunks. This kind of banyan has green fruit. The stronghold of this kind of banyan in American Samoa was the Tafuna Plain, where hundreds of the huge trees used to grow. Today, only a small fraction remain. Most have been cut down to make room for the uncontrolled development in this part of Tutuila. Fortunately, a few magnificent trees still survive. The other kind of *āoa* (*Ficus obliqua*) is usually much

smaller and does not have such a spreading form. Its trunk usually looks more “normal”, though it may have a hollow inside. This type of banyan seems to favor cliffs and steep slopes, although it can also be found on flat land. It doesn't always start life as a strangler, but sometimes grows up by itself. The easiest way to recognize this kind of *āoa* is its fruit, which is orange or red when ripe.

There is also an introduced kind of banyan tree in Samoa, the *pulu*. This tree, originally from Asia, is usually planted along the coast in villages; a large one grows next to the public market in Fagatogo. *Pulu* trees differ from *āoa* trees by their much larger leaves and larger, fuzzy red fruit. Although *pulu* are handsome trees that are useful for stabilizing our coasts, their fruits are not favored by wildlife, and so they do not play an important role in Samoa's natural symphony.

In contrast, both kinds of native *āoa* are very important for wildlife. In fact, a good case can be made that they are the most important tree species for the fruit-eating birds and bats of Samoa. There are two reasons why they are so important. First, they produce enormous amounts of fruit. When one of the huge banyans has crop of fruit, its spreading crown has room for a whole army of hungry fruit-eaters. In a single tree, I have seen three *lupe* (Pacific Pigeons), eight *manutagi* (Purple-capped Fruit-Doves), four *manuma* (Many-colored Fruit-Doves), a dozen *fuia* (Samoan Starling), scattered *iao* (Wattled Honeyeaters), and *miti vao* (Polynesian Starlings) -- all at the same time. No other Samoan trees provide such a feast. The second reason why banyans are so important is that they fruit at all times of year. Most kinds of large forest trees have a definite fruiting season: for example, *asi* tends to fruit from April to July, but some banyans have ripe fruit every month of the year. Between 10-30% of banyan trees have ripe fruit in any given month. This means that a fruit-eater can always find banyan fruit, even if all other fruits were out of season.


Many-colored Fruit dove (manuma)

One Samoan bird has come to depend on the reliable banyan. This is the *manuma*, or Many-colored Fruit-Dove, one of the rarest birds on Tutuila. In two years of observation, I have recorded *manuma* eating fruit on 99 occasions. In 98 of these 99 times, the *manuma* were eating banyan fruit (the one exception was berries of the *sogā* bush). One probable reason why the *manuma* is so rare today is the loss of many banyan trees, particularly in the Tafuna Plain. If this bird is to survive here, it is essential that banyan trees be protected, and, if possible, increased in number. In addition to their important role in feeding wildlife, *āoa* trees also provide homes for many animals. *Lulu* (Barn Owls) frequently sleep and nest in the hollow trunks. *Tava'e* (tropicbirds) find large nesting shelters, and *fuia* (Samoan Starlings) and *ti'otala* (White-collared Kingfisher) find protected nest holes. From its open, sheltered base to its spreading, fruit-laden crown, a banyan tree is a haven for wildlife.

Sadly, banyans today are under threat in American Samoa. Many were severely damaged by cyclones in 1990-91. Many others have been cut down, and more are threatened by continued development, particularly in the Tafuna Plain. Some of the most magnificent banyans that still stand have been made into gigantic trash barrels, their hollow trunks filled with mounds of used diapers and rusting cans. This garbage is sometimes burned, which can kill the banyan even if that is not intended.

What can you do? Give banyans the respect and protection they deserve. If your family is lucky enough to have an *āoa* on your land, please take care of it. Don't cut it, burn it , or use it as a garbage dump. If you notice a young banyan getting started, help it along by clearing away vines. If you know someone who has a banyan on their land, talk to them about its importance for wildlife. The banyan is a living testimony to the bounty and riches of Samoan nature, and is a lifeline for our wildlife.

Pepper Trail, DMWR

38. Natural foods for wildlife


Samoan bat eating mamalava

An animal's place in its environment is determined, more than anything else, by what it eats. By studying what the birds and bats of American Samoa eat, and when those different foods are available, we are better able to develop plans to manage and conserve our wildlife and to help these animals in a crisis, such as after a tropical cyclone.

Most animals can be grouped by what and how many kinds of foods they eat. Animals that eat many different things are called generalists, while those that eat only one or a few foods are called specialists. True specialization is often a two-way dependency: an animal depends on a plant for food, and the plant depends on that animal to help it disperse its seeds. On remote islands like American Samoa, there is often not that much of any one kind of food, and cyclones can cause serious shortages of the foods that are available, so it is usually not a good idea for either a plant or an animal to rely on only one other creature. We have few bird or bat species that are specialists in American Samoa.

The technical word for the generalist, “omnivore”, literally means “eats everything”. Humans probably have the broadest diet of any animal -- we happily eat meat, leaves, seeds, fruit, and fungus -- not to mention Bongos. Animals that are most likely to survive in new environments, like when they first arrived on Tutuila, are often omnivores. A good example is the rat (*isumu*), which can eat fruit, eggs, crabs, fungi, and probably many other things.

“Carnivores” are those species that eat almost exclusively other animals. We usually think of carnivores as fierce hunters, like wolves or lions, but actually any animal that eats other animals is a carnivore. The Barn Owl, or *lulu*, is the only Samoan animal that hunts other birds and mammals, but we have lots of other carnivores, including all our fish-eating birds and even our many animals that eat insects.

“Herbivore” is a description of those animals that eat only plants. This is a very general term, so it is better to specify what part of a plant is eaten, whether leaves, fruits, or nectar. Each kind of animal usually is good at eating only one, or at most two, of these parts of a plant, because they are so different. For example, to rely on leaves, you need strong teeth to grind up the tough fibers, and a big stomach to process all that material. Cows and horses are well equipped for the job. At the other extreme, to rely on nectar (the sweet liquid inside of flowers), you need to be able to zip between lots of flowers and reach inside to suck up the small amount of juice in each one. Nectar-feeders tend to be small and energetic, with long beaks or tongues to reach inside flowers. Finally, to eat fruit, you need to be able to travel long distances, since trees with fruit are often hard to find.

There are no native Samoan animals that are specialized for eating leaves (except insects and snails). However, leaves are regular parts of the diet of fruit bats (*pe'a*) and Pacific Pigeon (*lupe*). Perhaps the leaves contain a nutrient that can't be found in fruit, or maybe they help to fill up a hungry animal when there is little other food available.

Nectar is a very important food for many of our local animals. The beautiful red and black Cardinal Honeyeater (*segasegamau'u*) is our most specialized nectar-eater. Its long bill and tongue enable it to reach deep into flowers, and its small size allows it to perch on even the tiniest twigs to reach

the blossoms. Other birds that eat lots of nectar are the Wattled Honeyeater (*iao*), and the pretty little parrot (*segavao, sega'ula*) found in Manu'a. It may come as a surprise that fruit bats also eat a lot of nectar. Bats eat flowers from many different kinds of plants, from those with large flowers (such as *gatae* and *futu*), medium sized flowers (such as *fa'i*), to those with large numbers of smaller flowers (such as *asi*, *maota*, and *'a'amati'e*). The bats lick flowers using their long tongues, or sometimes take a shortcut and eat the entire flower.

Fruit is the most common item in the diet of the Samoan Starling (*fuia*), Pacific Pigeon (*lupe*), Purple-capped Fruit Dove (*manutagi*), and fruit bats (*pe'a*). Though all these animals share many of the same foods, each has its favorites. Differences in what each species eats are partly caused by the different ways they feed and by their different sizes. Since *lupe* and *manutagi* swallow fruits whole, this limits the size of fruit they can eat. *Manutagi* seem to eat no fruits larger than *moso'oi*, but *lupe* are not as limited because they have really big mouths and can eat all but the largest fruits. Although *fuia* are smaller than *lupe*, they have stronger bills. This allows them to pry open tough husks, and to poke into very large fruits like *esi*. *Pe'a* can eat the largest and hardest fruits because of their strong jaws and sharp teeth. They have a very unique way of feeding: they take a bite from a fruit, but don't really swallow it. Instead, each bite is squeezed in the mouth, the *pe'a* swallows the juice and pulp, then flicks its head and spits out a flattened mass of leftover fruit called an 'ejecta'.


Banana flowers

The white-naped fruit bats (*pe'a fanua)* seem to especially like fruits from plantations such as mangos, and those from coastal trees such as *fetau*, although maybe they really like flowers best. Samoan fruit bats (*pe'a vao)* generally prefer fruits found in the forest, both from non-native trees like *ifi* and native species such as *'a'amati'e*, *asi*, and *gasu*. Both bats like figs, especially the green-fruited kind of *āoa*, and perhaps most of all, *'ulu* (breadfruit). But if you see bats in your *ulu*, you needn't worry that they are taking food from your mouth -- they like the overripe fruit that has been left on the tree so long that people wouldn't eat it anyway.


Perfume tree (*moso'oi*)


Nutmeg (*'atone*)


Fig (*mati vao*)

Our most common Columbiformes (*lupe* and *manutagi*) all love the fruit of *moso'oi*. It's funny to watch a little *manutagi* struggling to choke down a big *moso'oi* fruit -- but they get it down every time. Another large fruit favored by *lupe* (and sometimes eaten by *manutagi*) is the nutmeg (*'atone)*. This is an interesting 'fruit', since what the birds eat is almost entirely indigestible seed -- the useful part is just a thin, brightly colored network (red or orange depending on the species of *'atone*) that covers the seed. This colored part is very fatty and is a good food for birds even if there is not much on each fruit.

Apparently this is a successful way to disperse seeds, since *'atone* is the most common tree in the mature forests of Tutuila.

Fruits preferred by *manutagi* include *āoa*, *mati*, the white berries of *sogā*, and the seeds inside *maota* and *mamala* fruits. *Lupe* eat many of the same fruits, but are able to eat a greater variety because they are a big bird. They also eat the large fruits of *māmālava*, *mamalupe*, *'a'amati'e* and *'ala'a*. *Mamalupe* literally means 'pigeon's mouthful': one *lupe* once took a full 30 seconds to swallow a single *mamalupe* fruit!

Nectar feeders and fruit eaters don't just use their food plants -- they can help them as well by fertilizing their flowers. This happens when pollen from one flower sticks to a bird's feathers or the fur of a *pe'a*, and then rubs off when the animal visits another flower. Fruit eaters also help plants. Most of the time this happens when they eat the fruit but don't completely digest the seeds; when the animal defecates, the seeds may have been moved far from the parent tree where they have a better chance to grow. Many plants actually count on animals eating their fruits, and so they coat their seeds with a substance that makes them hard to digest. In this way, immobile trees accomplish their most difficult task -- dispersing (spreading) their seeds. When a tree species has no seed dispersers, its spread to new areas will be limited, it can become restricted to only a few places, and it is vulnerable to extinction from cyclones, diseases, or cutting by people. A good example of such a tree is *ifilele*, which tends to occur in only a few areas on the north side of Tutuila.

Probably the most important disperser of fruits in American Samoa is the *fuia*, since it eats a very wide variety of fruits. It is particularly important in regenerating (converting back to forest) areas that have been cleared for plantations or by cyclones. You can see this by noting how quickly a cleared area will become covered with *lau pata*, *maota*, and *masame*, or how *nonu* or *pua lulu* begin sprouting in a clearing deep in the forest. Once an area has these initial forest tree species, the area becomes more suitable for tree species that prefer mature forests, like *māmālava* or *asi*.

You can play an important role in helping the wildlife on our islands by helping our native trees. First, avoid cutting down or burning native trees, especially slower growing species such as *'au'auli* or important coastal species such as *fetau*. Other trees are so rare or important that they simply should never be cut, including *āoa*, *tava*, and *togo*. Some plantations illustrate a good compromise between the needs of people and the needs of the forest. As the plantation is cleared, smaller, fast growing trees like *lau pata* or *'atone* are cut, but larger trees are avoided, or only their limbs are pruned (cut off). In this way crops like *talo* (taro) get the sunlight they need, but it does not kill large trees that are adapted to recovering from cyclone damage. Such trees may resprout leaves and branches, probably about the time a farmer is done harvesting the crops from the plantation.

Second, help native trees by planting them. You can request seedlings of native species from the Land Grant at the Community College. Always plant native trees instead of exotic (foreign) trees unless needed for their fruit. For example, *āoa* should be planted instead of *pulu* trees. Flame trees, *vae povi* and African tulip trees may look attractive to people, but these trees benefit fewer wildlife species than our own native trees. For areas such as lawns where large trees are not wanted, tree ferns (*oliolī)* are an attractive native option, while the various kinds of *mati* are good choices for wildlife. In places where too much shade is undesirable, *filimoto* is a good choice.

[See Appendix 2 for scientific plant names]

Joshua Seamon, Pepper Trail, DWMR

39. Island streams (*vai*)

Tutuila Island has about 141 small streams that flow year-round along at least a portion of their main channel. These streams are steep, shallow and short (most are less than a mile long). Stream flows are generally low but they can flood quickly in response to heavy downpours. But even with the high rainfall in our mountains (200-300 inches per year), the water drains quickly to sea or percolates into the porous volcanic soil to recharge our groundwater supply of drinking water.

Our streams support surprisingly few species -- there are only about 8-12 freshwater fish species, and not many more freshwater invertebrates. The principal species are freshwater eels (*tuna*), gobies (*apofu, mano'o*), mountain bass (*sesele, inato*), shrimp (*ulavai*) and snails (*sisivai*). Additional species may enter the lower ends of streams, but they are not restricted to a freshwater stream environment. Three non-native fish species were also introduced here, probably in the 1970s: mollies (*fo-vai; Poecilia mexicana*) and mosquitofish (*Gambusia affinis*) to control mosquitoes, and tilapia (*Oreochromis mossambicus*) to grow in aquaculture. The impact of these alien species on the native populations is not known. Additionally, we can only wonder about the impact of the alien cane toad (*lage*) that sometimes has thousands of its young tadpoles swimming in local creeks.

The low number of species in our streams is in stark contrast to the many marine species living in our coastal marine waters (961 fish species and countless invertebrates). Part of the explanation for this difference is simply that our streams are small and offer limited habitat for stream-dwelling organisms. But another more interesting aspect of this low diversity is: how did any freshwater species get to American Samoa in the first place? We are a small island surrounded by hundreds of miles of deep ocean. Freshwater species generally cannot survive in saltwater, so how could these freshwater fish, shrimps, and snails cross the ocean barrier to get here?

The trick is that they all have a marine stage in their life cycle. After they spawn, their newly hatched larvae wash out of the stream into the ocean where they drift about as marine plankton for a few weeks or months. Some make their way back to a coastline where they seek a stream to live out the rest of their lives. It might be expected that the few freshwater species that got to our remote islands have evolved over thousands of years into unique (endemic) species found nowhere else in the world, but the opposite is generally true. The marine stage of these species allows a wide dispersal and continual genetic mixing of populations, so most of the species inhabiting our streams are widely distributed across the South Pacific.

Because streams drain the valleys we live in, they serve as good indicators of how well we are taking care of the land. Sad to say the message is not good. Our streams once provided food and drinking water, but now they are treated as a place for people to throw rubbish and piggery waste. There have even been a few deaths in American Samoa due to leptospirosis, a bacteria from piggeries and other animals that pollutes many streams. And, after a heavy rainfall, some streams turn chocolate brown with the dirt that erodes from the landscape. Much of this soil erosion is due to poor land-use practices such as the farmer's bare-earth clearings for plantations on steep mountain slopes and the run-off from inadequately designed construction sites. In the former case, the farmer not only loses the soil needed to grow his crops, but the eroded dirt fouls our streams and ends up in coastal waters where it harms our coral reefs. It does not have to be this way. There are better ways to dispose of rubbish and to prevent erosion that can make streams a healthier place for fish as well as for the children who play in the streams.

P.Craig, NPS

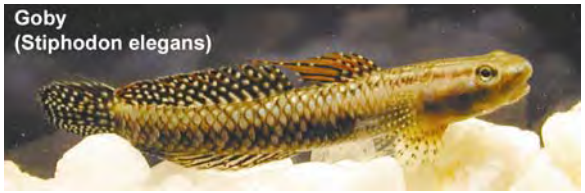
40. Life in a Samoan stream: fish, snails & shrimp

Streams are the plumbing of our islands. They rely solely on rain, which seeps from steep rainforest-clad hills and trickles through the porous volcanic soil carrying with it the products of the land. Small streams join with others to create a mosaic of channels across the landscape. Waterfalls, cascades, pools, and riffles make each stream unique and influence the kinds of animals found there.

Our freshwater stream animals play an important role in maintaining a healthy stream ecosystem. These species might be overlooked because they are shy and rather blandly colored, which might lead you to assume they are not there at all, but that of course is not true. The best way to observe them is to find a spot on a rock and quietly watch until they emerge from their hiding places. Keep in mind that from the animal's point of view there is a lot going on. Animals are constantly interacting with each other as well as with their environment. The presence of a predator, for example, will have a huge influence on the behavior of its prey. It is a constant game of cat and mouse, eat or be eaten. Habitat type, or where an animal likes to live, is also very important. Certain species prefer pools, others like shallow riffles, and for most species, waterfalls are barriers to their upstream movements although a few hardy species can climb up them.

Fish. Predatory fishes, like the freshwater eel (*Angullia* spp.), mountain bass (*Kuhlia* spp.), and dusky sleeper (*Eleotris fusca*) tend to dominate the lower reaches of a stream and feed on smaller fish and shrimp. They are only average climbers and cannot make it up the steep slopes of a waterfall. Instead they rely mainly on their powerful swimming and gliding ability to move through small rapids and over boulders and rocks. Look for eels in crevices and holes. Mountain bass are often seen in pools not far from the ocean. Their silvery sides and flag-like tails make them easy to spot. The dusky sleeper uses stealth and surprise to catch its prey. It props itself on rocks using its fins and turns darker for camouflage when ambushing prey. For this reason this species is not an easy one to spot.

Herbivorous fishes, like the small gobies (*Stiphodon* spp. and *Sicyopterus* spp.), are usually present in large numbers. They may be seen in quiet riffles and pools grazing on long green algal strands or the slippery brown algae coating the rocks. An interesting feature of the goby is that its pelvic fins form a suction cup that enables the goby to cling to rocks and climb waterfalls. One goby (*Stiphodon hydoreibatus*) is endemic to Samoa and found nowhere else in the world.



Snails. Stream snails, which all belong to the family Neritidae, are herbivores that graze on the algae growing on stream rocks. About a dozen species are known locally. Two distinct types of neritid snails are present. One is the rounded black/brown shell of the *Neritina* or *Clithon* species. The shell of these has little or no spire and an interesting device called an "operculum" that acts like a trap door. This allows the snail to retract into its shell and literally close the door -- a great mechanism to have when you do not want to be eaten.

The other type of shell is the cap-like *Septaria* species. It has no visible operculum and therefore the snail cannot retract into its shell. Instead it clamps to rocks with its muscular foot, making it very hard to detach. This is useful when you live in turbulent rapids or on steep walls. Besides these two differences, you may also notice variations in shell color, pattern, and texture. They range from light to very dark

Neritina variegata

Clithon corona

Septaria sanguisuga

brown with zigzag, wavy, or straight lines, or none at all. They may be smooth and shiny or grooved and wrinkled. Some even have horns.

A small turret shaped snail (*Melanoides* sp.) can also be found near the edge of streams in gravel and mud. This species is found throughout the Pacific.

Shrimp. Probably the most versatile freshwater species are the shrimp. American Samoa is home to two families, Atyidae and Palaemonidae, each with 4-5 species. The palaemonid *Macrobrachium* shrimp are possibly the most well known and can be seen in the lower to middle reaches of our streams. They are easy to identify by their large pincers. When wading through pools and shallow runs, watch for these shrimp as they make a quick retreat at your approach. Although shy, they will reappear if you keep still. These scavengers feed on both plant and animal material. They may also dislodge *Neritina* and *Corona* snails from rocks, open them up and devour them.

Macrobrachium lar (ulavai)

Macrobrachium lar

Atyid shrimp with leg brushes

Atyidae shrimp can be found throughout many clean streams. Some are excellent climbers and congregate in the lee of rocks and boulders of fast flowing streams. Others seek a quiet place in the vegetation and roots of plants near a stream edge where flow is slow. These shrimp exhibit distinct feeding behaviors. In fast flowing water they orient themselves in the direction of the current and spread the fine brushes on their front legs to form upturned umbrellas. They use these to filter food particles carried in the current and then push them into their mouth. In slower moving water they use their brushes to pluck food items from plants and gravel.

Stream insects. Although aquatic insects are common inhabitants in streams around the world, they are not well-represented on our small oceanic islands. Few of the terrestrial insects we see in American Samoa have an aquatic stage in their life cycle, some exceptions being a few dragonflies (see page 86), damselflies, midges, mayflies, and beetles.

K. van Houte-Howes and Don Vargo
ASCC Land Grant

41. Stream posters

Lisa Wade, Sharon Fanolua, Agnes Vargo, and Don Vargo
ASCC Land Grant


AMERICAN SAMOA STREAM ANIMALS
Macrobrachium gracilirostre
Macrobrachium latimanus
Macrobrachium australe
Macrobrachium lar
Our streams have two types of shrimps:
palaemonids and atyids.
Palaemonids have pincers. They eat both plants and small animals.
Atyids do not have pincers. Instead, they have brush-like fingers that filter small pieces of food flowing in the water.
Atyoida pilipes
Atyopsis spinipes
Caridina weberi
Caridina typus
Macrobrachium lar
Caridina weberi
Atyids are generally much smaller than palaemonids
Actual sizes shown.
Brushes closed
Brushes opened
Photos by: Sharon Fanolua, Agnes Vargo, Don Vargo and Lisa Wade
Prepared by: Lisa Wade
American Samoa Community College • Community and Natural Resources • P.O. Box 5319 Pago Pago, American Samoa • (684) 699 - 1575

Lisa Wade, Sharon Fanolua, Agnes Vargo, and Don Vargo
ASCC Land Grant

42. Snakes in Samoa !

Snakes in Samoa? You bet. Two kinds, one right here on Tutuila Island and the other on Ta'u Island. Fortunately, neither is the dreaded brown tree snake (more about that below). Also fortunately, neither is poisonous, both mind their own business, and they are no threat to anyone.

On Tutuila, we have an unusually small black snake that looks like an odd earthworm about 6 inches long. A closer inspection reveals that it has tiny scales (see close-up photo). It's called the Australoasian blindsnake (*Ramphotyphlops braminus*), because it has almost no eyes and it burrows through the soil. This secretive nocturnal snake is occasionally found by someone digging in their garden. It eats small soil creatures like termites and insect larvae.


Ramphotyphlops braminus

This harmless snake is widely distributed around the world, but it is not native to our islands. It was probably introduced here when its eggs were carried in the soil attached to some imported plants or machinery. In 1993, it was found in the Tafuna area. Others have been found in the Pago Pago and Alega.

The other snake found infrequently on Ta'u Island is the *gata* or Pacific boa (*Candoia bibroni*). It also occurs in western Samoa. At one time it inhabited Tutuila Island (its bones were found there) but it went extinct for unknown reasons. On Ofu, an older resident remembers seeing one there when he was a child.

The Pacific boa is more commonly found on islands closer to Indonesia; American Samoa appears to be the eastward limit of its distribution. Rather than being a native species here, it is thought to have been introduced by early Polynesians. It can grow to a respectable length of 3 to 6 feet and is tan or darkly colored, but its coloration can be variable. This species is usually found in forests, it is active mainly at night, and it probably eats lizards, rats, and small birds and bird eggs.

The Pacific boa looks a lot like another undesirable snake species, the brown tree snake (*Boiga irregularis*), which we don't have in Samoa and hopefully never will. You may have heard that the brown tree snake invaded Guam and caused havoc there. It wiped out Guam's native bird species and helped decimate their fruit bat populations by eating the young bats left hanging in the trees when the adults flew off to find food.


Not in American Samoa yet !
Brown tree snake

Parents in Guam were even advised to keep their infants and small children away from this snake because it is somewhat poisonous and occasionally has been caught lunching on a baby's arm. How's that for a reptilian nightmare!

Well, not to fear. We do not have the brown tree snake in Samoa. So, if you

see a large snake on Ta'u island, don't kill it. However, if you see one on Tutuila Island, it is very important that you send it to DMWR for identification. It is essential that we keep the brown tree snake out of American Samoa. Several of them have already slipped into Hawaii hidden in air cargo shipments from Guam. The snakes will crawl into the cargo or onto the plane's landing gear and then go wherever the plane goes.

A final note. On rare occasions, sea snakes have been seen in our coastal waters. One verified air-breathing banded sea snake (*Laticauda* sp.) was collected here in 2000. However, most local sightings of "sea snakes" are actually fish (eels) that are very snake-like in appearance. It would not be difficult to confuse them (see photos below). But sea snakes do occur in our region. We lie at the eastern range limit for most of the Indo-Pacific species, and resident populations occur in Niue (2 sea snake species), Tonga (2 species), and Fiji (at least 4 species). Niue is located only 330 miles south of American Samoa. Additionally, the pelagic yellow-bellied sea snake (*Pelamis platurus*) is widely distributed in the South Pacific and has been recorded both to the east and west of Samoa.

Banded sea snake

Banded snake eel (a fish)

Moray eel (a fish)

P.Craig
NPS

43. Skinks & geckos (*pili, pilimo'o*)

Because of our islands' isolation, it is not surprising that the reptile fauna here is small, both in number of species and in body size. The most prominent representatives of the land reptiles are the lizards, specifically skinks (*pili*) and geckos (*pilimo'o*). Both groups are made up of animals that are small, long, and four-legged, but that is where the similarities stop.

Geckos are probably the most familiar group of lizards on the islands because several species will happily live with people. These are the lizards that scurry across your ceiling or stalk bugs by your porch light. How they are able to run upside down across ceilings or smooth glass has to do with their amazing toes. On the bottom of each toe are thousands of microscopic hooked hairs which are able to grip even the tiniest imperfection on a surface. Scientists are now coming to realize that the hairs are also sticky due to molecular attraction. What is important to us is their seemingly insatiable appetite for small flying insects, protecting us from countless mosquito bites each night.

Geckos are also noticeable to us because of their distinct voices. You can't live here long without becoming familiar with the geckos in your house by the sounds of their loud chirps. One species actually had the same sound as my old phone, so I kept waking up at night to gecko "phone calls". Most geckos typically hide on tree-trunks during the day, so they are understandably rather cryptic and camouflaged, usually in shades of brown and often sporting a mottled or blotchy pattern which helps to break up their outline aiding their camouflage (see photo of stump-tailed gecko at right).

House gecko (non-native)
(*Hemidactylus frenatus*)

Stump-toed gecko
(*Gehrya mutilatus*)

While geckos are nocturnal and noisy, skinks are the opposite. Skinks are voiceless and active mostly during the day. These are ground-dwelling lizards although you may also see them clamoring among the bushes, but they are hardly the climbers that geckos are. Many skinks are quite content to remain concealed under a stone or rotting log, eating the many invertebrates drawn to this microhabitat. They may dart across your path while walking through the native forest. Skinks are often more boldly colored; some even have vividly colored tails in bright shades of red or brilliant blue.

There are two reasons why a small lizard would want to have such a wildly colored tail. A brightly colored animal may be more attractive to mates and may have better reproductive success which passes on their genes for bright colors. The other reason is to escape from predators. If caught by the tail, most lizards can shed their tails which often writhe and squirm, helping to keep the

predator's attention so the lizard has a better chance of escape. So, with a brightly colored tail and a drab, more camouflaged body, a predator is more likely to attack the lizard's tail, which for a lizard is a good thing.

Our island lizards are invaluable, harmless reptiles that provide a beneficial service by eating both airborne pests as well as agricultural pests that eat the crops we grow for food. See page 60 for a complete list of lizard species in American Samoa.

Paul Brown, NPS

Brown-tailed striped skink
(*Emoia cyanura*)

Samoan skink
(*Emoia samoensis*)

House gecko with
regenerating tail

Black skink
(*pili uli*)
(*Emoia nigra*)

44. Land and shore crabs

Crabs evolved in the ocean, so it is almost impossible for them to come ashore because their delicate gills would dry out and the crab would die. A few hardy species have overcome this hurdle, but none has truly broken free from the ocean. Shore crabs require occasional dips in the ocean to wet their gills, and all crabs, including the land crabs, must still return to the ocean to lay their eggs. The ocean is where their larvae develop before the young crabs crawl back onto land. The life cycle of these crabs is a marriage between the marine and terrestrial worlds.

Local shore crabs include ghost crabs on sandy beaches, shore crabs on rocky shorelines, and hermit crabs that blunder about the beaches and forest. Hermit crabs (*uga*) use empty snail shells to protect their abdomen and to provide a moist environment for their gills. When threatened, they withdraw quickly into their snail shell with their legs forming a clever protective door (see photo). But they sure seem to pay a hefty price for this convenience by having to drag those heavy shells wherever they go.



Beach hermit crabs (*uga*)

There is also a much larger and more terrestrial hermit crab occasionally seen crawling around the forest floor. This species (*Coenobita brevimanus*) measures up to 8 inches between outstretched legs. It is too large to withdraw into its shell and on occasion you might see it wearing a plastic or glass container instead. Like other hermit crabs, this species always requires a snail shell to live in, and it does not grow up to become a coconut crab.

The *ama'ama* shore crab (*Grapsus* sp.) shown below climbs out of the water for at least three reasons: to escape hungry moray eels that like to eat crabs, to graze on the algae growing on exposed intertidal rocks, and to safely shed its own shell when the crab needs to grow larger. Because crabs have an external shell (exoskeleton), they can't grow any larger until they break out of their old shell and make a larger one, a process known as molting. All crustaceans (shrimp, lobsters, crabs, etc.) have the same kind of exoskeleton, so they must molt as well. During molting, these organisms are soft-shelled and highly vulnerable to predators, so the rock crab climbs high up the shoreline rocks where it hopes it won't be seen while it molts. You can occasionally find one of their empty crab shells strangely perched high up on a shoreline rock.

Ghost crabs (*Ocypode* sp.) are responsible for most of the holes you see on beach where they hide during the daytime. They have sharp eyesight and can run fast, although once in a while you might surprise one and it freezes still, hoping you will walk on by without noticing it. At night, take a walk on a remote beach and spot them with a flashlight. They act like they have some important business going on.



Ghost crab (*avi'ivii*) digging its beach tunnel at night (right photo).

Our best known land crab is the large and edible coconut crab (*Birgus latro*), which weighs 4-7 pounds and has a leg span up to about 30 inches. It has developed a special lung-like organ of spongy tissue that enables it to breath air. This crab leads a fully terrestrial existence except when it comes time to lay its eggs in the ocean. The eggs hatch into larvae that drift in the ocean for about a month before migrating shoreward. The youngest coconut crabs use a snail shell for protection during this early period but then abandon this practice for the remainder of their long life (up to 40 years). They are nocturnal scavengers that eat coconuts, fruit, dead animals, and other organic material. There is some uncertainty about the crab's ability to husk and eat coconuts; some observers believe that the crabs are able to do so only if a coconut was damaged when it fell from the tree.


Coconut crab (*u, ūū*), juvenile (left), adult (right).

Coconut crabs are easily caught, so few are found in areas where people live. Another liability for these crabs must be trying to cross our island roads, both when small coconut crabs migrate inland from the sea, and again when large mature female crabs crawl back to sea to release their eggs. During new moon nights in summer months, squashed crab road-kills are evidence of an untimely end to their journey.

P. Craig, NPS

45. Disappearing land snails (*sisi vao*)

Snails belong to the second largest group of animals on earth, the mollusks. Only the arthropods (insects, crustaceans and their relatives) have more known species. Snails are found just about everywhere – the ocean, streams, lakes, and on land. Over 90 native species of land snails (*sisi vao*) occur in the Samoan Archipelago. Of these, 64 occur in western Samoa and 47 in American Samoa (many species are found in both places). Many are found only on our islands – that is, they are endemic to the Samoan Archipelago. Some of them even occur only on a single island, so they are endemic to that island. Slugs, which are snail-like mollusks that have no shell, also occur locally, but none is a native species -- all are recent introductions to our islands.

SLUG

Snail shells come in all shapes and sizes – flat, tall, rounded or spiraled. Some live in trees, where they may eat dying leaves. Others live on the ground and probably feed on dead leaves. Together with fungi and other microorganisms that help to decompose the leaf debris, snails contribute to the cycling of nutrients through the ecosystem.

We do not know much about the basic biology of these land snails. Some species have separate males and females, but others are hermaphrodites, whereby each snail is both male and female. However, most hermaphroditic snails still reproduce by mating with another individual – each snail can act simultaneously as a male and as a female, or in some species the snails take turns being males and females. Most snails lay eggs, but some give birth to live young – miniature snails that simply crawl away. The snails that produce live young tend to grow and reproduce very slowly – some of the tree snails may take over a year to reach full size and may live as long as 5-10 years, producing only 10-20 young per year. This contrasts with egg-laying species that probably grow much quicker, produce many eggs, but do not live as long.

There are three possible ways that land snails might have crossed the ocean to get to our remote islands. First, they might have been carried over the ocean from a distant continent – or from another island – on rafts of driftwood or fallen logs. But salt kills land snails, so this seems unlikely. Perhaps they were carried here by birds. Sometimes snails get caught up in the feathers of birds, especially if they are really small snails. And third, they might have been blown by the wind. Scientists have found that very small snails can indeed be blown long distances by strong winds. A small snail attached to a leaf, caught up in a cyclone, could be blown hundreds, perhaps thousands of miles across the ocean. Through evolutionary time (millions of years), these seemingly unlikely events had only to happen very occasionally in order for a few land snails to eventually colonize our islands.

Once the land snails arrived and managed to survive, they began to evolve to local conditions. Some species changed and became so different from their ancestors that scientists now identify them as different species. Others evolved into more than one species. This is how the Samoan islands came to have many land snail species found nowhere else on earth – they evolved after they arrived here.

Many of the local snail species have attractively colored shells and have often been used in the making of *ula* or *lei* and for other ornamental purposes. For instance, the hanging light fixtures in the old lobby of the Rainmaker Hotel in Pago Pago contained 10,000 or more shells of tree snails that used to be abundant in the forests of Tutuila.

But now many of our local snail species are disappearing. At least 7 species have become extremely rare and one of them, *Diastole matafaoi* from Tutuila, is now extinct. Others are undoubtedly in trouble but have simply not been fully evaluated yet. The two main reasons for their decline are the same reasons that biodiversity is vanishing all over the world. First is habitat destruction or modification. As native forest is cut down for timber or cleared for agriculture or urban development, the habitat of those snail species that depend on the forest disappears and so the snails disappear too. Second is the introduction to the islands of alien species – species that have been brought to the islands by humans, either on purpose or accidentally. These aliens include pigs that degrade the forest by rooting for food and creating wallows, plants that grow and reproduce more strongly than the native species and replace them in the forest, birds that spread alien plants by carrying their seeds into native forest, rats and ants that prey on snails, and many other species that people have introduced to the islands. These alien species also include snails and slugs that come from elsewhere in the world. Most people are likely to see only these aliens unless they hike into the most pristine native forest.


Bradybaena simularis (alien)


Achatina fulica (juvenile)


Achatina fulica

Perhaps the most commonly seen are the giant African snail (*sisi aferika, Achatina fulica*) and the large black or brown slugs. But there are many other species that are not so obvious but can be found easily just by turning over some leaves on the ground almost anywhere in the islands. The giant African snail is a pest of agriculture and in gardens but some of these other less well-known species may also be causing problems for the native snail species. Two of the alien species (*Subulina octona, Paropeas achatinaceum*) are now the most abundant snails in the leaf debris of native forest throughout the islands. It is quite possible that they are impacting native snails by competing them for the resources they depend upon.


Euglandina rosea (alien)

Another alien snail, the predatory snail known as the 'cannibal snail' or 'rosy wolf snail' (*Euglandina rosea*), was introduced in an ill-conceived attempt to control the giant African snail by eating it. It was introduced even though there is no scientific evidence that it would reduce populations of the African snail. The problem is that it attacks native snail species that had evolved in the absence of such aggressive predators. Some of our local species reproduce at a very slow rate and this means that their populations are highly vulnerable to sustained predation. *Euglandina rosea* is thought to have been introduced only to Tutuila and Ta'u. In western Samoa it was introduced to Upolu in the 1990s.

An even more voracious predator of snails, the flatworm *Platydemus manokwari*, was unfortunately introduced to Upolu in 2003 to control the African snail. This free-living flatworm was also found on Tutuila and Ta'u islands in about 2004. It is black or dark brown, with a single line down its back, and it can grow to almost 3 inches long and 1/4 inch wide. This flatworm is believed to have decimated snail populations on other Pacific islands.

Robert Cowie
University of Hawaii

46. Four large insects: *afato, se, alisi, lelefue*

Insects are an impressive group. They are immensely abundant and diverse (over 800,000 species worldwide), they inhabit almost every terrestrial and aquatic habitat imaginable, and they were on earth long before the dinosaurs ever roamed. Over 2,500 species have been recorded in the Samoan Archipelago, with many more yet to be documented. Four large but somewhat secretive insects are featured here. All are harmless.


Afato

Giant longhorn beetle. These beetles are unusual for two reasons: they grow very large and people eat them. The adult beetle pictured here was almost 3 inches long from head to tail. What does it eat with those large powerful jaws? It lays its eggs in standing dead trees (particularly *māmālava, tufaso, tavai*) and after hatching, the larvae feed on the surrounding wood. These larvae (*afato*) grow very large and are collected and eaten in Samoa, Fiji and probably throughout the South Pacific. Two villages in Savai'i are particularly well known for harvesting many *afato*: Gataivai and Aopo. *Afato* are fed coconut shavings, and then they are often eaten with coconut cream, and they taste like …. coconut. But times are changing in American Samoa -- one person said he had eaten *afato* in the past but now he prefers to eat a Big Mac.

Walking stick (*se*). These large green or brown insects can grow up to 5 inches long. They usually remain motionless and look like a branch or small twig, hoping that this camouflage will spare them from being eaten by a hungry Samoan starling (*fuia*). These slow-moving 'sticks' feed on leaves, most notably coconut fronds. Some can fly, although not very gracefully -- if one lands on a person, a local belief is that it is a messenger announcing that someone will be coming to visit you.

Katydid (*alisi*). Here's one of the insects that makes all that noise at dusk (along with the crickets and cicadas). As the sun sets, katydids start the evening with a loud screechy chorus that lasts about 20 minutes. After a little warm-up noise, they synchronize with their neighbors so that all of them are screeching in unison. These are male katydids trying to attract females. The sound is produced as they rub special structures on their front wings, back and forth. Katydids are green, about 1.5 inches long, and look like a leaf. Just like the walking sticks, katydids hope their camouflage make them difficult to see. Katydids are related to crickets and grasshoppers and are sometimes called long-horned grasshoppers.

Hummingbird moth (*lelefua*). At dusk you might be surprised to see what looks like a hummingbird hovering in front of a flower, sipping its nectar. This is actually a thick-bodied moth with an extremely rapid wing beat and a long proboscis that it sticks down the flower tubes. This is a good example of convergent evolution, where two very different kinds of organisms (a bird and a moth) evolved a similar way to extract nectar out of long, delicate flowers. The moth is also known as the hawk or sphinx moth.

P.Craig, NPS

47. Dragonflies and damselflies (*seemu*)

Only a few groups of aquatic insects have managed to successfully colonize the remote islands of the Pacific. Among the most successful of these are the Odonata, or dragonflies and damselflies (*seemu*), the adults of which may be commonly seen flying above streams and ponds. American Samoa supports a diverse native biota of Odonata, including at least 13 species, all of which are native species and 3 are endemic (found only in the Samoan islands). All 13 species occur on Tutuila, but only a single small-sized, widespread damselfly species, *Ischnura aurora*, is presently known from the Manu'a Islands.

Odonata are predators in both their immature and adult stages, and they eat mosquitoes and other insects. The immature stages of the Samoan species are aquatic and utilize a variety of habitats, ranging from standing water ponds, to rocky streams, to wet bedrock seeps.

The Samoan Odonata represent an interesting component of the islands' freshwater biodiversity, and one well worth conserving. The major threat to these species, as elsewhere in the Pacific, is the introduction of invasive freshwater species such as fishes and amphibians. Other invasive species threats include insectivorous birds, and the little fire ant, *Wasmannia auropunctata*, which invades riparian zones (stream banks) and has had negative impacts on the stream invertebrate biotas of other Pacific islands, by attacking Odonata as they cling to rocks or vegetation while emerging from the aquatic immature stage to the flying adult state. This invasive ant is present in the Cook Islands and the Solomons, and has a clear potential to spread to American Samoa via ship-borne commerce.

Dan Polhemus, Div. Aquatic Resources, Hawaii

Dragonfly, *Lathrecista asiatica*

Dragonfly, *Macrodiplax cora*

Damselfly, *Amorphostigma* sp.

Damselfly, *Ischnura aurora*

48. The bugs in your house

There will always be some bugs in your house, so relax a little and get used to them. Before you know it, you will be sweeping termite droppings off your kitchen counter as if you didn't have a care in the world. Several common household insects (beetles, moths, termites, cockroaches, wasps, ants) and other arthropods (centipedes, millipedes, spiders) are described below.

Centipede (*atualoa*). The large, 6-inch brown centipede (*Scolopendra subspinipes*) is well known locally but not commonly seen. It is fast and scary looking as it searches for things to eat at night. Occasionally someone gets bitten and it can be extremely painful. The local Emergency Medical Services responds to a few calls each month, particularly after a lot of rainfall has driven the *atualoa* to higher grounds. People vary in their response to a bite, but for most, there is not much that can be done about it, and the pain will usually lessen in a few hours.

Millipedes (*anufesaina*). Millipedes are neither insects nor worms but a different kind of arthropod. They differ from centipedes in being slower, rounder and having two pairs of little legs per body segment. Our local millipedes grow up to about two inches long. They are active at night and feed primarily on rotting wood and leaves. They are generally harmless and curl up when threatened. However, *anufesaina* have defensive glands along the sides of their body that can produce a foul and sometimes poisonous secretion, and they can cause a burn-like pain on your skin if you squash one.

Cockroaches (*moga moga*). At least give cockroaches some credit for inhabiting earth millions of years before we humans ever showed up. Nonetheless, it is their fate to be despised insects associated with filth. They are extremely hardy scavengers that will eat almost anything. One species living here is the large non-native American cockroach, *Periplaneta americana*. Their egg cases look like brown beans, each containing 10-20 eggs that hatch in 5-7 weeks. Their total life span is probably 2 years or so. Cockroaches are nocturnal, so if they are also seen during daytime, your house may be heavily infested.

Ensign wasps. A wasp yes, but a good one, so don't swat it. You'll occasionally see these spider-like black insects flying around the house. They look like they were built out of parts that don't quite match up. There's a large head, and a boxy middle part (thorax), followed by a tiny posterior (abdomen) hanging off the back that bobs up and down like a flag being waved (the "ensign"). These wasps don't sting people. Instead they use their "stinger" to lay their eggs inside cockroach egg cases. Before the young cockroaches can emerge from the case, the wasp eggs hatch first and eat all the cockroach eggs. All in all, these little "black flag" wasps probably kill a lot more cockroaches than we ever could with our spray-can insecticides.

Termites. There are usually two times when we notice termites in the house. The first is when a large swarm of them suddenly appears fluttering around a light bulb in the evening. These are male and female termites in love. What identifies them as termites is their large, equal-size pair of wings, and that they shed their wings after their nuptial flight. It's sad to see them do this – purposely give up the gift of flight for a life of eating wood. But that's what they do and they do it well. Wooden structures don't last long here. The second time we notice termites is when we see the daily piles of their droppings on the kitchen counter or floor. At one point, their droppings in my

house were so numerous, I collected them in plastic bags, with the idea that maybe I could market them as "South Pacific pollen" to some health food store in California.

Ambrosia beetles. These irritating little beetles appear in the early evening, fly towards the light, and crawl on you like fleas in your hair. If you don't know what I'm talking about, you are one of the privileged people whom these beetles do not bother. These wood-boring insects (*Xyleborus* sp.) are dark brown and 2.5 mm long. They are called ambrosia beetles because they carry a fungus (the "ambrosia") that they use to inoculate the tunnels that they drill into a tree. The fungus grows in the tunnels and provides food for their larvae. After mating, the female beetles emerge and go in search of another tree to lay their eggs in.

Casebearer moth. At some point you may notice these odd little insects dragging around their flat diamond-shaped cases. These are the larvae of the small casebearer moth (*Phereoeca* sp.). The larva is visible when it extends out of the case, but it retreats into the case when threatened or it turns around and pops out the other end. They plod on, as if they really have someplace to go. The larger cases are about 1-cm in length and are made out of silk fibers encrusted with debris such as sand particles, hair, and insect parts. The larva lives and grows in the case for about 2 months, feeding on odd things like old spider webs, wool fibers, etc. After pupating, the larva develops into a tiny gray moth that measures about 5 mm from head to tip of wings. A female moth lives only a week and lays about 200 eggs.

Spiders (*apogaleveleve, fe'euta*). We have a variety of web-spinning spiders in the house, as well as hunting spiders that don't make webs but actively search for their prey. Some are quite big and may give you a fright, but none is known to cause us problems. Hunting spiders include jumping spiders (which hunt in the daytime and are common in houses), wolf spiders (not often seen in houses), and large huntsman spiders that are big enough to catch cockroaches. Remember: they are eating the other bugs in your house.

Ants (*loi*). Ants are everywhere here. You may not notice them very much until you leave some leftover sweets or other food lying around and come back later to find it crawling with ants transporting it piece by piece or drop by drop back to their nest. One common species is the crazy ant, *Paratrechina longicornis*. They are black, about three millimeters long, and have long legs and antennae. They seem to be running all the time, and it's amazing how fast they can appear by the dozens around some spilled soda or juice. When disturbed they run even faster, circling and zigzagging all over -- as if they really are crazy.

Bug eaters: geckos (*pilimo'o*). From the abundance of gecko droppings around my house, it's apparent that the geckos hanging on the walls are eating lots of bugs. Think of these droppings as little blessings in disguise.

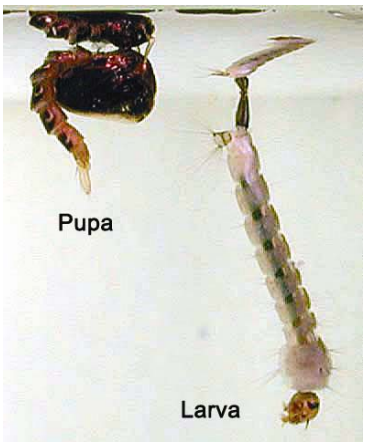
P.Craig, NPS
Mark Schmaedick,
ASCC Land Grant

Spiders hatching from egg case.

49. Mosquitoes (*namu)*, Filariasis & Dengue Fever

Mosquitoes may play a role in the grand scheme of things, but their focus on sucking my blood is not endearing. Worse still, they can infect us with two diseases in American Samoa -- more about that shortly.

At least 12 species of mosquitoes (*namu*) occur here. Most are common across the western South Pacific region, but some are endemic to the Samoan islands (*Aedes upolensis, Coquillettidia samoaensis, Ochlerotatus samoanus, Oc. tutuilae*) and a few are newly introduced.



Their life cycle involves several stages -- the adults fly, but their juveniles live in water. To reproduce, the adult female needs to obtain a blood meal (from you) to develop her eggs. She then lays her eggs in quiet puddles of water where they hatch and grow. The larvae must breath air, so they generally hang around at the water surface but will wiggle quite actively when disturbed. After a week or two, the larvae pupate (a resting stage) and then emerge as flying adults. Females may live for 2-3 weeks and lay several clutches of eggs (each requires a blood meal). Only the female mosquito searches for a blood meal; the males (the ones with fuzzy antennae) feed on plant nectar. Also, not all the mosquitoes are after you personally -- some species seek out birds as their preferred blood meal.

The female mosquito finds you by following signals given off by your body such as odors, body heat, and carbon dioxide. Light and movement also help her zero-in on you. She then sinks her long and thin mouth parts into your skin and sucks out a drop of blood, engorging so much that she can barely fly away. During the biting process, she secretes saliva into the cut to prevent the blood from coagulating. Your body's reaction to this saliva is what causes the bite to itch and swell.

Mosquitoes can carry two diseases in American Samoa: filariasis and dengue fever. Both can cause serious problems. These diseases are spread by specific mosquito species: dengue (principally *Aedes polynesiensis* and *Ae. aegypti)* and filariasis (mainly *Aedes polynesiensis,* and *Oc. samoanus*).

Filariasis, also known as elephantiasis (*tutupa, mūmū*), is caused by parasitic nematode worms called filariae. When an infected mosquito bites you, these minute worms crawl from the mosquito's mouthparts onto your body and into the cut. This is not a particularly efficient way to enter your body, so the number of them transmitted from a single mosquito bite is probably limited. Multiple mosquito bites by infected *A. polynesiensis* may be needed before a person develops the full-blown disease. The worms lodge in a person's lymphatic system where they can live for 4-6 years and produce millions of minute larvae (microfilariae). These larvae circulate in your blood and are sucked up by other mosquitoes that bite you and thus can be spread to other people. In severe cases, filariasis can cause a very large swelling of arms, legs or genitals.

The number of people infected in American Samoa has been high. In 1999, people in several villages here were examined for filariasis and 17% were found to be currently or recently infected. But not all these people have swollen limbs. In general, about half of the people who are infected show no symptoms of the disease, but they may develop them as they get older. Our local Public Health Department together with the Center for Disease Control has joined a worldwide program to reduce filariasis by giving every person on island a medication that kills the microfilariae circulating in your blood, thus preventing their further spread by mosquitoes. The cycle of infection can be broken if the

number of people carrying this disease is significantly reduced. By 2007, the local infection rate had dropped to 2%.

Dengue fever is also transmitted by mosquitoes. Dengue is a viral disease that is rapidly expanding in tropical and subtropical areas of the world. It's not native to American Samoa but is periodically brought here by travelers from other infected areas. It then gets spread around primarily by the daytime-biting *Aedes polynesiensis* and *Ae. aegypti* mosquitoes. This virus is present in the mosquito's saliva, so it is injected directly into you when an infected mosquito bites you. Symptoms range from mild fevers to severe and potentially life-threatening illness. No vaccine is available yet.

A key point to emphasize here is that filariasis and dengue cannot be spread directly from person to person. An intermediate host, the mosquito, is required to transmit the disease.

Three other mosquito-borne diseases are worth mentioning. The most serious one, malaria, does not occur in American Samoa. It is found in the western region of the South Pacific, but the particular species of mosquito that transmits malaria (the *Anopheles* mosquito) does not occur this far east. A different type of malaria does occur here, but it infects only birds (avian malaria). The birds don't seem to be greatly affected by it however, perhaps because they've adapted to it over a long period of time. There is also a mosquito-borne parasitic nematode on island that affects dogs (heartworm).

Will tourists to American Samoa pick up these diseases? Not too likely. First, dengue is usually not present here; it occurs only when an infected traveler brings the disease here. Second, filariasis probably requires multiple bites by specific mosquito species, and probably only a small percent of this species actually carries the disease at any given time.

Scientists predict that we may see an increase in such diseases due to global warming. Although exact mechanisms are not known, many pathogens are sensitive to temperature; for example, growth, reproduction, and biting rates of insects all increase with higher temperatures. Global warming appears to be triggering a number of disease epidemics worldwide, involving a diversity of pathogens (viruses, bacteria, fungi, parasites) and a wide range of hosts (humans, corals, oysters, terrestrial plants, birds).

There are several basic measures that can be taken to reduce mosquito-borne diseases to your family:

1. Find their breeding sites. Mosquitoes require water to complete their life cycle, so removing pockets of standing water around your house will help reduce their numbers. Survey your yard and eliminate areas where water can collect, such as discarded tires, buckets, coconut shells, saimin bowls, aluminum cans, cemetery urns, clogged roof gutters, etc. Drill holes in the bottom of large containers so that the water does not accumulate in them, or cover large objects like rain barrels with screening.

2. Avoid getting bitten. When the mosquitoes are out, wear long-sleeved shirts and long-pants. Use repellants and insecticides safely. Repair window screens on your house, and if needed, sleep under mosquito net tents while resting during the day and night.

3. Take filariasis medicine. Remember, you can be infected with the filariasis worm and not have symptoms. The filariasis medicine is effective, but unfortunately it was discontinued in 2007.

4. Be thankful for the swiftlets (pe'ape'a). They eat mosquitoes (and other flying insects).

P.Craig, NPS

50. Fungus: the vital decomposers (*pulouaitu*)

What do leaf spots, beer, itchy feet, rotting trees, fresh bread, mold, and pizza have in common? Fungus! Different kinds of fungi (the pleural of fungus is fungi) can cause diseases in plants and humans, make alcohol and raise bread. Certain fungi (mushrooms) are cooked and eaten.

Fungi are sometimes used by Samoans to make fermented drinks, such as *pulouaitu* (ghost hat). This drink is made from mushrooms growing out of cattle dung that are boiled, strained, and drunk to cause an alcohol-like feeling. *Alafa* is an interesting forest mushroom (*Mycena* sp.?) that glows in the dark and has actually been used to illuminate or mark trails at night. Children also create a strange effect by sticking *alafa* on their faces. Several other unrelated organisms also produce this bioluminescence, or biological light, by metabolizing a chemical in their bodies called luciferin. Different organisms produce different colors of light: green for jellyfish, greenish-yellow for fireflies, red for railroad worms, and greenish-blue for glow worms and mushrooms. Scientists continue to study this light-producing process, which is extremely efficient (almost 90%).

People used to think fungi were a kind of plant and placed them in the plant kingdom. But fungi are so different from any other organism, they were given their own kingdom. Most fungi (except yeasts and a few others) are made up of many cells arranged in long strands called hyphae. All the hyphae together make up the mycelium, or body of the fungus. As the hyphae grow through their food, a plant for example, they release enzymes. These enzymes dissolve the plant cell walls and the fungus mycelium absorbs the nutrients from the plant.

We are usually aware of fungi only when they damage something. That's because they live inside the things they are eating. Sometimes we see their white mycelium in rotted wood, but most often we don't see them until they form "fruiting bodies" like *faleaitu*. These fruiting bodies make thousands and thousands of spores that grow into new fungi wherever they land. Sometimes these spores are brightly colored, like the blue, green, or white mold on old food, or the black mold in the bathroom shower. Other times we find mushrooms, another kind of fruiting body, growing on the ground or from trees. Fruiting bodies are an indication that the insides of the trees are being eaten. These fungi may be thin and delicate, tough and rubbery, or hard as wood. The "ear fungus" (*Auricularia*) is brownish-purple, and thin like an ear, while the "tooth fungus" (*Flavodon*) is bright chartreuse with short tooth-like pores on which the spores are formed.

Most wood decay fungi are called conks, or shelf fungi. One of the most common "wood rotters" in American Samoa is the artist's conk (*Ganoderma australe*). This fungus grows out from the tree in the shaped of a fan. It has a light brown top that is sometimes dusty with spores from the conks above it, and a whitish-gray lower surface. The gray surface looks smooth but is actually made up of thousands of very small pores, inside of which the spores are formed. If this pore surface is lightly scratched, a brown line remains, and for centuries people

have left messages or drawn pictures on them, hence their name, “artist’s conk”.

Some fungi threaten our food supply. The black leaf streak disease of bananas (*lausului*, or black Sigatoka) is caused by a fungus (*Mycosphaerella fijiensis*) that you can only see through a microscope. It damages the banana leaves, making the fruit small and of poor quality. Farmers have to use special chemicals to control this disease, which cost them time and money. The taro leaf blight disease (*lega, sega*) that killed most of the Samoan taro in 1993-1994 was caused by a water mold (*Phytophthora colocasiae*). We used to call water molds ‘fungi’, but scientific tests show they are more closely related to certain red algae. They have spores that swim and their mycelium is made of very different ingredients. Water molds are no longer in the kingdom Fungi, but have been placed in one of the new kingdoms, either Protoctista or Chromista.

Banana black leaf streak disease (*lausului*).

Taro leaf blight (*lega, sega*).

Lichens on tree trunk

The colorful lichens that grow on trees and rocks are actually fungi and algae living together. This type of relationship is called mutualism, where both organisms benefit from the relationship. In severe climates, the fungus protects the algae from damaging ultraviolet light and supplies water and dissolved minerals. The algae makes food for both organisms through photosynthesis. In other instances, this symbiosis could be considered parasitism. In American Samoa, many algae living on leaves or tree bark receive enough moisture and shade to exist without the help of a fungus. In fact, the fungus may actually damage or kill the algae.

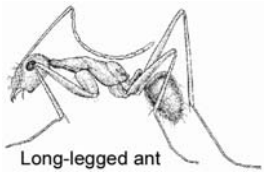
Fungi fill a very important role in nature by breaking down dead organisms into their basic elements so those elements can be used again to build new organisms. This nutrient recycling is especially important in the tropics where organisms are born and die at a very fast rate. If it weren't for fungi, bacteria, and other small organisms that eat dead plants, dead trees and bushes would soon bury us.

WARNING! Many fungi are poisonous. Eating them can cause sickness or even death. Don’t eat any mushroom unless you are certain it is safe.

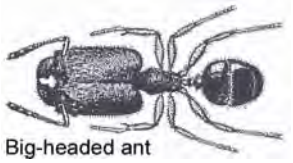
Fred Brooks, ASCC Land Grant

51. Soil Community (*ele'ele*)

A poetic definition of soil is "rock on its way to the sea." While this neatly sums up the origin and the fate of most soils, much remains to be told about what happens to the rock while it is "on its way." In short, it undergoes physical, chemical, and biological changes that convert it into the fertile matrix that sustains life. Biological changes are brought about by an extremely diverse soil community. Those members that are easily visible, such as insects, worms, mites, and snails, form a specific community of invertebrates. Microorganisms in the soil (bacteria, fungi, algae, and protozoa) comprise another complex community.


Long-legged ant

Among the insects, ants play a dominant role in our islands' soil communities. They are, according to ant expert E.O. Wilson, "the little creatures that run the world." As social insects, they act in concert to instantly and unselfishly sustain and defend their large colonies. A sophisticated caste system allows for labor efficiency, with the entire colony functioning as a social unit. There are many types of ant in the world (about 9,500 known species), 68 of which are now in American Samoa, but only 12 of these are native species.


Big-headed ant

Some of the more common members of our ant community are the non-native long-legged or yellow crazy ant (*Anoplolepis gracilipes*, from Asia or Africa), the large black trap-jaw ant (*Odontomachus simillimus*, from Ceylon), and the big-headed ant (*Pheidole* spp., from Mauritius). A new invasive ant was discovered in Fagaalu in 2002, the tropical fire ant (*Solenopsis geminata*) which has a painful sting. We suspect that a colony of this ant, native to the American tropics, arrived on a shipment of lumber to the village, and unfortunately, it has become established on the island. The big-headed ants have a specialized soldier caste with outsized heads and powerful muscles that operate sharp, triangular jaws. They are also notorious as a destroyer not only of other ants but of whole native insect faunas. Quite likely, many native species have been eliminated by these fierce competitors, leaving us with mainly non-native species that are either unaffected by ants or have a beneficial relationship with them.

Vying with ants for importance in our soils are earthworms. In 1881, Charles Darwin first drew attention to the great importance of earthworms in the breakdown of dead plant material and the release of essential nutrients for new plant growth. Darwin credited "these lowly organized creatures" as playing a major part in the history of the world. Over 3,500 earthworm species have been described worldwide. A survey of the territory in 1998 found 7 species, all of which were unintentionally brought here from Asia, Africa, and the Americas by people. They hid among the banana, taro, and other crops carried on the voyaging canoes of early Polynesians. They traveled on ships of European explorers arriving from the New World. And they come today in the containers unloaded at Pago Pago Wharf.

The most common of our earthworm species, *Pontoscolex corethrurus*, is an alien species native to Brazil but is now found in tropical regions throughout the world. It has recently come under attention for its role in accelerating – of all things – global warming. Decomposing soils of the world releases 60 billion metric tons of a major greenhouse gas, carbon dioxide, into the atmosphere each year. This is ten times the amount contributed by the burning of all fossil fuels combined. It is estimated that *P. corethrurus* can release carbon from the soil 20 to 30 % faster than other worms.

As we human beings go about our self-important business of attending school, earning a living, and making lofty decisions about this and that, we should pause to consider the large army of creatures under our feet who are really in charge of our long-term destiny. As part of the "excited skin of the earth," they are the unsung players that maintain the life-giving soil that we all ultimately depend upon for our very existence.

Don Vargo, ASCC Land Grant

52. Pest invaders are here

The history of life on islands is a story of invasions. Ever since the high islands of American Samoa rose out of the sea as barren piles of volcanic rock, living things have been making the long and dangerous journey across the Pacific to reach this new land. Until a few thousand years ago, every plant, insect, and bird that lived on our islands was the descendant of a lucky adventurer that had crossed hundreds or thousands of miles of open ocean to establish a new colony here.

The first Samoans were also such lucky adventurers, making the perilous voyage here in their journeying canoes. But their arrival marked the beginning of a new way for plants and animals to reach our islands -- being carried here, either by accident or on purpose, by people. Ever since then, the environment of American Samoa has changed tremendously.


Mile-a-minute vine (fuesaina) & White ginger

Some of these changes may have benefited some wildlife species. For example, the introduction of several important food plants such as breadfruit and bananas provide a year-round source of food for some birds and fruit bats, rather than seasonally like some native plants that are eaten by wildlife. Other changes brought by the Polynesians were harmful to the environment -- for example, the introduction of rats (*isumu*). And since the arrival of Europeans and Americans, the rate of introduction of new plants and animals to American Samoa has increased tremendously. The results have often been disastrous.

Some plants brought by the Polynesians "escaped" to spread widely through the natural forest such as *ifi* and *nonu* trees. More recently, about 250 alien plant species (many of them weeds) have also become established in American Samoa and some of these threaten our native forest. One that is familiar to everyone is the "mile-a-minute" vine, or *fuesaina* (*Mikania micrantha*). This was introduced by accident, sometime before 1924. It is now a major pest in plantations and forests, and has spread tremendously following tropical cyclones in the early 1990s. The vine needs sunlight for its very fast growth, and so doesn't do well inside the shade of the mature forest. The cyclones, however, opened up the forests to sunlight by knocking down many trees and breaking off the tops of thousands more. Vines like these can form layers several feet thick that can choke the seedlings of native trees and slow the recovery of our forests from the damage of the cyclones.

Another well-known pest to agriculture is the giant African snail (*sisi aferika, Achatina fulica*). This was reportedly introduced to the Pacific when the governor of Tahiti imported them to satisfy the hunger of his mistress for escargot, or edible snails. Bad, bad idea -- not only were the snails not edible, but they quickly spread throughout Polynesia, and became a major pest of taro and other crops. Unfortunately, the story does not end there. In the hopes to control the giant snails, a predatory snail (*Euglandina rosea*) native to Florida was deliberately introduced here in 1980. The idea was that this new snail -- the one with the long pinkish shell -- would

kill off all the giant snails. Instead, it has driven the native land snails of the Pacific islands to the edge of extinction. Most of the native snails of Tahiti are now extinct, and the Samoan snails, which used to be collected by the thousands to make *ula*, are almost gone. Meanwhile, the giant snail continues to thrive despite the new predator.

Another example is of an invasion that is still under way -- by introduced birds. The first bird introduced to American Samoa was, of course, the chicken (*moa*). Although these occasionally nest in the forests, they are not truly established as wild birds here, and are no threat to our native birdlife. However, we do have three introduced bird species on Tutuila. One of these is the *manu palagi*, or Red-vented Bulbul, the black bird with the crest that is common in nearly every village. This species became established here in the 1950's. The other two species both arrived in the 1980's and there seems to be no name for them in Samoan. These are the Common Myna and the Jungle Myna. They look almost the same -- both are blackish brown, with big white patches in the wings and tail when they fly. They are now abundant from Pago Pago to Leone and have spread to the eastern and western ends of the island. None of these three introduced birds has made it to Manu'a, which is still home to only our native Samoan birds.

What's wrong with having new kinds of birds to live in our villages and gardens? In some parts of the world, including Hawaii, both bulbuls and mynas are serious pests on fruit crops such as guava. Second, they may spread the seeds of pest plants, like mile-a-minute vine and "Koster's curse" weed (*Clidemia hirta*), that native birds do not eat as readily. Third, they may drive out native birds, like the *iao* or Wattled Honeyeater. Although we don't know for sure that this is happening, there seem to be more *iao* around villages in Manu'a than on Tutuila where the introduced birds are common. Finally, the introduced birds may spread diseases that will attack our native birds. This has happened in Hawaii. In fact, on the main islands of Hawaii, the native birds have been almost completely exterminated. Every bird you seen in the lowlands of Hawaii is an introduced species; the native birds survive only in isolated mountain forests. We don't want our Samoan birds to share this sad fate.

The lesson to learn from these examples is that we must be very, very careful when thinking about introducing a new plant or animal to Samoa. Even species that seem beneficial, like the predatory snail, can have bad and unforeseen effects. And once a new species is established, it is almost impossible to get rid of. Wisely, the Territory has established strict laws against bringing in exotic animals and any plant that may become a noxious weed. Flowering plants, like Honolulu rose (*Clerodendrum chinese*), may look pretty in a garden but turn into major pests when they run wild.

American Samoa's forests and wildlife are unique to all the world, having developed here over hundreds of thousands of years in isolation. We must take care to preserve and protect this special heritage by staying alert to keep unwelcome invaders from our shores.

Pepper Trail, DMWR

53. Introduced species: toads everywhere (*lage*)

The cane or marine toad (*Rhinella marinus*) is a relatively recent introduction to American Samoa. It was purposely brought here from Hawaii in 1954 to control mosquitoes or insect pests that attack taro. Toads (*lage*) were introduced into artificial ponds at Taputimu on Tutuila, and from there, stocks were liberated in Tafuna and Utulei. The toads then expanded their range to include all of Tutuila, from sea level to the top of Mt. Alava. Fortunately, they have not yet been transported to Manu'a or to western Samoa.

The toads breed year-round here. All they need is standing fresh or slightly brackish water in which to lay their eggs. Thousands of eggs that look like a string of black and white pearls are laid by each female. Within a week the eggs hatch into small black tadpoles that feed voraciously on aquatic plants. The tadpoles look defenseless but are thought to be toxic to birds and other animals. Within a month these tadpoles develop legs and change into adult toads.

As adults, they typically hide under boards or vegetation during the heat of the day and emerge at night to feed on insects and other invertebrates. They eat snails, millipedes, centipedes, spiders, roaches, moths, flies, caterpillars, termites, beetles, ants, earthworms, grasses, and even an occasional small toad.

How many toads inhabit Tutuila Island and how many bugs do they consume each night? In a wildlife study conducted in 1976, biologists estimated that over 2 million toads lived here with us. Some rough calculations suggest that these toads consume about 5 tons of bugs every night!

To some people it might appear that the toad is beneficial. One must keep in mind, however, that many of those insects would have been eaten by native birds and perhaps by the small insect-eating sheath-tailed bat (*pe'ape'avai*) that may now be extinct in American Samoa. No one has examined the actual impacts the toads are having on our native wildlife, but there are many examples of introduced species causing the extinction of native plants and animals by out-competing them for food or other resources.

Another concern involving the toad is its toxic skin glands. The adults have two large parotid glands on their “shoulders” that secrete a creamy white fluid when handled. These secretions are highly toxic if eaten, rubbed into the eyes, or brought into contact with mucous membranes. Dogs have died when they mouthed these toads. In addition, a high incidence of the salmonella bacteria occurs in toads, thus an abundance of toads near drinking water supplies may lead to bacterial contamination.

Gilbert S. Grant, DMWR

54. Forest invaders

Most rainforests in American Samoa are in generally good condition – a diverse set of native trees occupy much of the landscape and include many endemic species found only in the Samoan archipelago. But there are also non-native plant species here and some are beginning to out-complete the native species. Several of the worst invasive plants on Tutuila Island are shown in this article.

One invasive tree of high concern is *Falcataria moluccana*, locally called the *tamaligi palagi*. Growth of *tamaligi* is extraordinary and trees can reach heights of over 20 feet within two years. In 2001, about 35% of Tutuila was infested with *tamaligi*. It was particularly dense in Fagasa and Pago Pago where villagers began effectively killing the trees by stripping off its bark. By taking aggressive action against invasive species, control is still possible.

Villagers kill *tamaligi* trees by removing the bark.

Numerous dead *tamaligi* trees reveal how they were beginning to dominate the rainforest canopy.

Other invasive trees:

African tulip tree, *fa'apisī* (*Spathodea campanulata*)

Beautiful flowers, but this tree is very invasive, capable of displacing lowland native rainforests; seeds are highly wind-dispersed; current core area is Leone-Malaeloa.

Red seed tree, lōpā (*Adenanthera pavonina*)

Also known as the "coral bean tree" and formerly grown for food, this tree is rapidly overtaking the native rainforest.

More invasive trees and vines on Tutuila Island:

Luecaena, *fue pepe*
(*Luecaena leucocephala*)

Easily naturalized in coastal areas; crowds out native species; resprouts vigorously after cutting; seeds remain viable in soil for 10-20 years.

Merremia, *fue lautetele*
(*Merremia peltata*)

This fast-growing vine smothers plantations and forest trees with large heart-shaped leaves.

Rubber tree, *pulu māmoe*
(*Castilla elastica*)

Used to make *kirikiti* (cricket) balls, this tree spreads fast and out-competes native trees. Birds and bats eat the fruits and spread its plentiful seeds.

Strawberry guava
(*Psidium cattleianum*)

Discovered at Atauloma on Tutuila in 2002. This tree is a serious pest in Hawaii, forming dense thickets. Birds and bats eat the fruit, spreading its seeds. Nearly eradicated by 2009.

Cinnamon, tinamoni
(*Cinnamomum verum*)

Non-native species occasionally found on Tutuila. Cinnamon has invaded ridge forests in Matafao and Maloata. Could become a major problem.

Feral pig, pua'a
(*Sus scrofa*)

Feral pigs eat the farmer's taro and damage native forests by tilling the soil, which creates pockets of water where mosquitoes breed.

Tavita Togia, NPS

55. Common pests and diseases of local agricultural plants

Gazing up at the beautiful mountains on our islands, we see hillsides of lush green tropical foliage -- a picture of botanical health. That's true for the most part, but if we look closer, we notice that some plants can get sick and die, or they can be injured when insects, animals, strong winds or landslides damage their leaves, stems or roots. Sometimes insect pests or diseases spread fast, injuring or killing many plants over a large area. Then we take notice, particularly if we were growing those plants to eat. Here are five common plant pests and diseases that can cause serious damage to local agricultural plants.

Taro leaf blight disease (*lega, sega, laumu*). Many people became acutely aware of this plant disease in 1993-94 when it destroyed most of the Samoan taro crop. The disease is caused by a fungus (*Phythophthora colocasiae*) that has been in Fiji for many years, but we don't know how it came to American Samoa. Perhaps it arrived here on taro tops (*tiapula*) from another island, or its fungal spores blew in on the winds of Cyclone Val in 1991. Taro leaf blight is most severe when the weather is cool and wet. Rain splashes spores of the fungus into the air, which are then blown by wind from plant to plant. The expanding brown spots made by this fungus cause leaves to die faster than normal, so the plant must use its energy to make more leaves instead of storing the energy in the taro corm (*i'o ole talo*) that we want to eat. Farmers are now growing taro varieties from Micronesia that are more resistant to the fungus. The Palau taro, for example, still gets the disease, but less severely, so the leaves live longer and corms are of normal size.

Armyworms (*anufe-ailautalo*). These insects are more appropriately called cluster caterpillars, because they are not worms at all. They are the juvenile stage of a thick-bodied grayish-brown moth (*Spodoptera litura*) that flies about at night. It is a serious pest for many crops and may occur throughout the year. The caterpillars are often found on taro leaves in small numbers and if found soon enough, they can be picked off by hand before they eat too much of the leaves. Sometimes there are so many that they can't be removed fast enough. As with taro leaf blight, this has a major impact on the plant, because energy is taken from the corm (*i'o ole talo*) to replace damaged leaves, so the harvest is reduced. The female moth lays 200 to 300 eggs in a cluster during the night. After the eggs hatch, the young larvae feed together, eating larger and larger holes in the leaves as they grow, until only the thick ribs of the taro leaf remain. The mature larva falls to the ground, forms a pupa which is the resting stage when the caterpillar changes shape and grows wings, and afterwards emerges as an adult moth that flies off to lay more eggs. The complete life cycle, eggs to adult, takes only about 30 days. In American Samoa there are several friendly insects, mainly small wasps, that attack and kill armyworms. But if the armyworms are too numerous, the wasps cannot control them and considerable damage to the plant may result. Unfortunately, spraying the armyworms with pesticides also kills the helpful wasps.

Banana bunchy top virus (*laufeti'iti'i-vaelusi*). This is one of the most serious diseases of bananas. The virus can be so devastating that some regions of the world affected by it, like parts of Hawaii, are no longer able to produce bananas commercially. For unknown reasons, places like American Samoa are less severely affected. It may have something to do with the small insect, an aphid (*afiti*), that carries the disease from plant to plant. Perhaps these aphids are less effective virus carriers or they are not very abundant here. Banana plants infected with the virus produce small, narrow leaves with yellow, tattered edges bunched together, thus the name “bunchy top”. When one plant becomes infected, the virus spreads to the rest of the plants growing from the same “root” mat. Infected plants stop producing

bananas and become shorter and shorter until the plant finally dies. During this time, any aphid feeding on an infected plant can carry the virus to an uninfected banana plant. Another way the disease is spread is by removing suckers from an infected root mat and planting them elsewhere. There is some concern in American Samoa that the disease could begin to spread more widely, but there is a safe way to control bunchy top with a small application of a common herbicide [contact Land Grant for details].

Burrowing nematode (*nematota*). This pest attacks the roots of banana plants. Nematodes are small, worm-like residents of soil and water. Most of them feed on dead plants and other tiny organisms, but some attack the roots of living plants. The burrowing nematode (*Radopholus similis*) enters young banana roots and eats the insides. When large numbers of nematodes feed on a plant, the roots are so damaged that the plant can fall over. This is one reason why banana plants topple over during strong winds or rain, or when they bear a heavy bunch of fruit. Damaged banana plants usually produce fewer and smaller fruits than healthy plants. Banana varieties grown in American Samoa have no resistance to this pest. The best way to control the nematodes is to remove their source of food (the banana root mat) for one year or flood the land, making it unsuitable for the nematode.

Rhinoceros beetle (*manuainiu*). These giant beetles cause a distinctive diamond-shaped pattern cut out of coconut leaves (fronds). The adult beetle burrows into the tops of coconut trees, then down toward their center. As it burrows, it cuts through the new, unopened leaves, so when the leaves open later, large wedges of the leaves are missing. If the midrib is cut, the leaf may break on windy days. While this may weaken some leaves and make them look unsightly, we don't know if the damage is serious enough to reduce the number of coconuts produced by the tree.

The adult beetle (*Oryctes rhinoceros*) is amazingly large -- almost two inches long -- black and shiny, with a horn on its head, like a rhinoceros. Although it's hard to visualize, the horn apparently helps them feed by stabilizing the beetle while it moves its jaws up and down, scraping a hole in the tree. The beetles do not eat the wood but live on sap from the damaged plant cells. The female lays one egg on the ground, usually in dead coconut trees, logs, piles of compost or debris. The young larvae are white with a brown head. They grow almost four inches long before they pupate and become adult beetles.

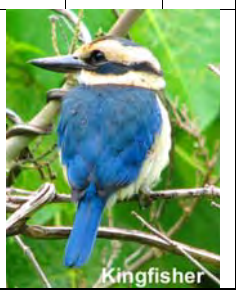
Larva

Rhinoceros beetle

Fred Brooks
ASCC Land Grant

56. Bird checklist for American Samoa

Common and Samoan name	Scientific name	Tutuila	Ofu - Olosega	Ta'u	Swains	Rose
LAND BIRDS						
Crake, spotless	*Porzana tabuensis*	E		R		
Cuckoo, long-tailed (*aleva*)	*Eudynamis taitensis*	M	M	M	M	M
Dove, friendly ground (*tu'aimeo*)	*Gallicolumba stairi*		R			
Fruit dove, many-colored (*manuma*)	*Ptilinopus perousii*	R	R	R		
Fruit dove, purple-capped (*manutagi*)	*Ptilinopus porphyraceus*	R	R	R		
Honeyeater, wattled (*iao*)	*Foulehaio carunculata*	R	R	R		
Honeyeater, cardinal (*segasegamau'u*)	*Myzomela cardinalis*	R				
Kingfisher, white-collared (*ti'otala*)	*Todiramphus chloris*	R	R	R		
Lory, blue-crowned (*segavao, sega'ula*)	*Vini australis*	V	R	R		
Mao (*ma'oma'o*)	*Gymnomyza samoensis*	E				
Owl, barn (*lulu*)	*Tyto alba*	R	R	R		
Pigeon, Pacific (*lupe*)	*Ducula pacifica*	R	R	R		
Rail, banded (*ve'a*)	*Gallirallus philippensis*	R	R	R		
Shrikebill, Fiji (*sega o le vau*)	*Clytorhynchus vitiensis*		R	R		
Starling, Polynesian (*miti vao*)	*Aplonis tabuensis*	R	R	R		
Starling, Samoan (*fuia*)	*Aplonis atrifusca*	R	R	R		
Swamphen, purple (*manu ali'i*)	*Porphyrio porphyrio*	R	R	R		
Swiftlet, white-rumped (*pe'ape'a*)	*Collocalia spodiopygia*	R	R	R		
SHORE AND WATER BIRDS						
Curlew, bristle-thighed *(tuli*)	*Numenius tahitiensis*	M	M	M	M	M
Duck, Australian gray (*toloa*)	*Anas superciliosa*	R	V			
Godwit, bar-tailed (*tuli*)	*Limosa lapponica*	M				M
Heron, reef (*matu'u*)	*Egretta sacra*	R	R	R	R	R
Heron, white-faced	*Ardea novaehollandiae*		V			
Lapwing, masked	*Vanellus miles*		V			
Plover, golden (*tuli*)	*Pluvialis dominica*	M	M	M	M	M
Sanderling (*tuli*)	*Calidris alba*	M			M	M
Tattler, wandering (*tuli*)	*Heteroscelus incanus*	M	M	M	M	M
Turnstone, ruddy (*tuli*)	*Arenaria interpres*	M	M	M	M	M
INTRODUCED SPECIES						
Bulbul, red-vented (*manu palagi*)	*Pycnonotus cafer*	I				
Dove, rock (*lupe palagi*)	*Columba livia*	V				
Junglefowl, red (*moa*)	*Gallus gallus*	I	I	I		
Myna, common (*maina fanua)*	*Acridotheres tristis*	I				
Myna, jungle (*maina vao)*	*Acridotheres fuscus*	I				
(continued on next page)						



Common and Samoan name	*Scientific name*	Tutuila	Ofu-Olosega	Ta'u	Swains	Rose
SEABIRDS						
Booby, brown (*fua'o*)	*Sula leucogaster*	R	R	S	S	R
Booby, red footed (*fua'o*)	*Sula sula*	R	R?	S	S	R
Booby, masked (*fua'o*)	*Sula dactylatra*	S	S			R
Frigatebird, great (*atafa*)	*Fregata minor*	R	S	S	S	R
Frigatebird, lesser (*atafa*)	*Fregata ariel*	R	S	S	S	R
Gull, laughing	*Larus atricilla*	S				
Noddy, blue-grey (*laia*)	*Procelsterna cerulea*	R	R	R		
Noddy, black (*gogo*)	*Anous minutus*	R	R	R	R	R
Noddy, brown (*gogo*)	*Anous stolidus*	R	R	R	R	R
Petrel, collared (*ta'i'o*)	*Pterodroma leucoptera*			R?		
Petrel, Herald (*ta'i'o*)	*Pterodroma arminjoniana*	R		R		
Petrel, Tahiti (*ta'i'o*)	*Pterodroma rostrata*	R		R	R?	
Petrel, white-necked (*ta'i'o*)	*Pterodroma externa*	S				
Shearwater, Audubon's (*ta'i'o*)	*Puffinus lherminieri*	R		R		
Shearwater, Christmas (*ta'i'o*)	*Puffinus nativitatis*			R?		
Shearwater, Newell's (*ta'i'o*)	*Puffinus newelli*	S				
Shearwater, short-tailed (*ta'i'o*)	*Puffinus tenuirostris*	*				
Shearwater, sooty (*ta'i'o*)	*Puffinus griseus*	S				
Shearwater, wedge-tailed (*ta'i'o*)	*Puffinus pacificus*	R?		R?		
Storm petrel, white-faced	*Pelagodroma marina*	S				
Storm-petrel, white-throated	*Nesofregetta albigularis*			R?		
Tern, black-naped (*gogosina*)	*Sterna sumatrana*		S		S	S
Tern, bridled	*Sterna anaethetus*	S				
Tern, crested	*Sterna bergii*	S				
Tern, gray-backed (*gogosina*)	*Sterna lunata*	R				R
Tern, sooty	*Sterna fuscata*	S			S	R
Tern, white (*manusina*)	*Gygis alba*	R	R	R	R	R
Tropicbird, red-tailed (*tava'e'ula*)	*Phaethon rubricauda*				S	R
Tropicbird, white-tailed (*tava'esina*)	*Phaethon lepturus*	R	R	R	R	R

E - extinct (formerly breeding sp.)
H - hypothetical record
I - introduced
M - migrant
R - resident native
S - seabird visitor
V - vagrant
* recorded at sea


Brown booby (fua'o)

Sources: J. Seamon (DMWR, pers. comm., 2004); Amerson et al. 1982. Wildlife and wildlife habitat of Am. Samoa, USFWS; Engbring et al. 1989. A 1986 survey of forest birds of American Samoa, USFWS; Grant et al. 1994. Notornis 41:215-217; Steadman & Pregill. 2004. Pacific Science 58:615-624.

57. The Pacific Pigeon (*lupe*), Samoa's royal bird

The *lupe*, or Pacific Pigeon, is the king of Samoa's birds and in many ways it is the most culturally important bird in our islands. It is our largest forest bird and is the only one able to feed on, and spread, the large seeds of some of our most important rainforest trees. Its cultural significance is revealed by the many Samoan proverbs that relate to the *lupe* and the art of *lupe*-hunting. The importance of *lupe* is also shown by the amazing *tia seulupe* (star-mounds) which are massive stone platforms built by the ancient Samoans, which served at least partly as pigeon-trapping sites.

The *lupe* is a member of a group of birds called the imperial pigeons because of their large size and dignified appearance. Most imperial pigeons live in the islands of the Pacific, although a few reach the mainland of Asia and one occurs in Australia. These birds are closely related to the much smaller fruit-doves, like the *manutagi* (Purple-capped Fruit Dove) but are only distantly related to the common pigeon that waddles around the cities of the world. The *lupe* is found from the islands north of New Guinea east through Fiji, Tonga, Samoa, Niue, and the Cook Islands. Interestingly, throughout most of this wide range, it is usually found on small islands and atolls, not on large 'high islands'. This is most striking in Fiji, where *lupe* are found on the small islands of the Lau group, but not on the large islands of Vanua Levu, Viti Levu or Taveuni. A closely related imperial pigeon replaces the *lupe* on those high islands.

Lupe are a common sight in forested areas of American Samoa and can be seen flying high over villages or bays. They even visit *moso'oi* and *poumuli* trees near houses, if those houses are not too far from forests. Even when not seen, they announce their presence with easy to hear calls: a low, rising and falling moo like that of a cow, or a loud, rolling prrrrrhhh. One of the benefits of American Samoa's ban on hunting *lupe* (and *pe'a*) after the cyclones in the early 1990s is that they become less scared of people, giving us better chances to see and appreciate these spectacular birds.

Their nests are hard to find. During all our time in the forests, we have seen only a few. We have also seen evidence of nest-building (for example, *lupe* flying with sticks in their bills) on several other occasions. All these observations were during the months of January through September. *Lupe* nests are open platforms of twigs, with no lining. They are usually placed in dense clumps of leaves high up in trees, making them very hard to see.

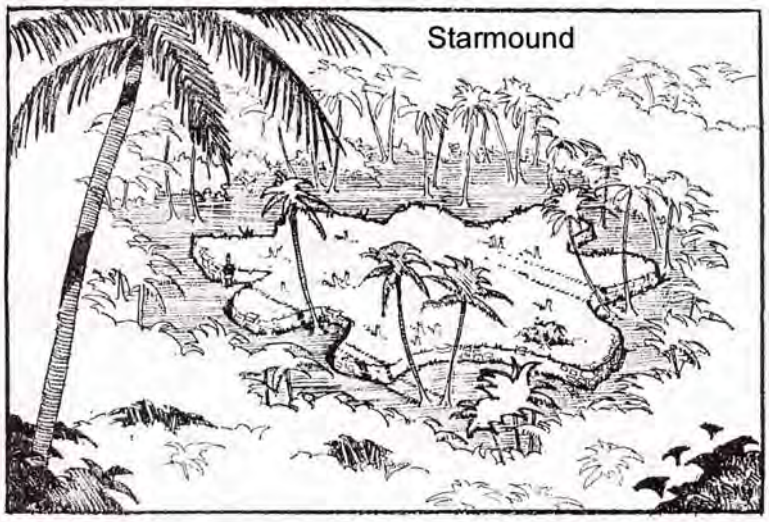
These birds lay only a single white egg. Both parents help incubate the egg and feed the chick once it hatches. All members of the pigeon family have an amazing ability: they feed their young a sort of “milk”. This is a nutritious liquid that is a combination of digested food and other substances secreted by special glands in the bird's digestive system. Both male and female pigeons make this milk, so both parents take an equal part in feeding the young. Information from related species of imperial pigeons suggests that *lupe* eggs take about 27 days to hatch, and that the young spend about 28 days in the nest after hatching. It seems like *lupe* could nest more than once a year, but most young birds are seen from July to August, so most nesting probably occurs at just one time each year.

Lupe eat many different rainforest foods, and not just fruits from favored trees like *'atone, ma'ali, mālili, mamala, māmālava, moso'oi* or *āoa*. They also eat fruits from vines such as *mamalupe* (pigeon's mouthful) and low shrubs like *to'ito'i*. *Lupe* eat leaves from many different trees, including *'au'auli,*

'a'amati'e and *ifi*, although in almost all cases they like the young leaves best. This makes sense, since young leaves are probably the most tender and easy to digest, and may have fewer poisonous chemicals than old leaves. *Lupe* also like flowers on occasion, both from trees like *'ala'a* or *ma'ali* and from shrubs such as *tī*.

Obviously, the *lupe* is not a picky eater. This may explain why it is such a widespread and successful bird, since it will eat food from both coastal and mountain areas. In fact, after Cyclone Val in 1991, many *lupe* on the coast near Vaitogi survived by eating the fruits of *to'ito'i*. Thus, in times of limited food, it can find food where other birds might not. At other times, *lupe* may eat unusual foods (like leaves and flowers) to get certain nutrients, just the way people sometimes take vitamin pills to supplement their regular diets. *Lupe* are also able to eat some fruits that smaller birds cannot, and so may be important for spreading these trees to new areas or even among different islands.

Since the *lupe* is such an adaptable bird, and has been able to recover both from human activities like hunting and from natural disturbances like the tropical cyclones in the early 1990s, it may seem surprising that there are many fewer now than in earlier times. The most dramatic evidence for this are the many *tia seulupe*, or star mounds, that were built by ancient Samoans. A survey discovered the remains of over 60 *tia* in the eastern part of Tutuila alone. Each *tia* is a massive stone platform with one or more arms extending from it. Pigeon-catching huts were built on top of the platform, and village chiefs competed to catch the most birds, using a tame *lupe* as a decoy, and a long-handled net to sweep up the flocks of pigeons that were attracted. Early missionary accounts tell how whole villages would spend weeks camping out in the forest around the *tia*, and that pigeon-catching season was a time of feasting and partying. *Lupe* must have been very abundant to support this elaborate cultural activity. While the *tia* certainly had ritual and religious importance in addition to their use as pigeon-catching sites, the latest studies suggest that pigeon-catching was central to their role in ancient Samoan society. A well-preserved star mound, with explanatory signs, can be visited in Ottoville, next to the Fatuoaiga Catholic Church compound.



Now, though, the rainforest that once covered the Tafuna Plain have been cut down. This type of lowland forest, with its abundant *māmālava, tava, maota, mamala*, and *āoa* trees, was almost certainly the best habitat for *lupe* in American Samoa. Today, only scattered *āoa* remain, and *lupe* are seldom seen in Tafuna. Even though *āoa* is a valuable food for *lupe*, we can see that it was the whole forest, and not just one kind of tree, that made the Tafuna rainforest so valuable to *lupe*. However, this large area of habitat is gone, and it seems we will never see as many *lupe* as did the first Samoans. Perhaps more than any other animal, the *lupe* is of irreplaceable importance to Samoa, both because of its natural role in spreading rainforest seeds, and its cultural role in the stories, proverbs, and heritage of the Samoan people.

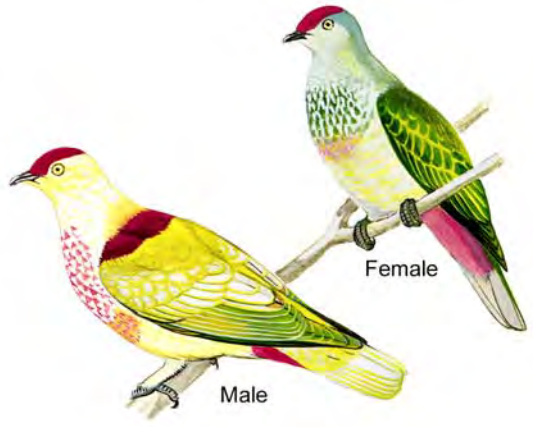
Pepper Trail, Joshua Seamon, DMWR

58. The rare Many-colored Fruit Dove (*manuma*)

One of the rarest birds that nest on Tutuila is also one of the most beautiful: the *manuma*, or Many-colored Fruit-Dove. The *manuma* here is considered a different subspecies than those from Fiji and Tonga because they have a slightly different color pattern. The male *manuma* is creamy white below and pale yellow above, with a dark crimson band across the back, a crimson patch on the forehead, and a purplish-red blotch on the breast. The female is very different and looks like the much more common *manutagi*, or Purple-capped Fruit-Dove. She is mostly green above and gray below, with a crimson forehead patch. Unlike the *manutagi*, the female *manuma* doesn't have a yellow band on its tail.

The *manuma* was not rare on Tutuila in the 19th and early 20th centuries, according to the journals of the early scientific expeditions. It was usually found in flocks; in 1923 a collector killed 10 birds with a single shot into a feeding tree on Ta'u. However, when the first modern studies of American Samoa's birds were done in mid-1970, only a small number of *manuma* could be found. Follow-up in the mid-1980's confirmed the *manuma*'s rarity. They estimated that the population size on Tutuila was only about 80 birds.

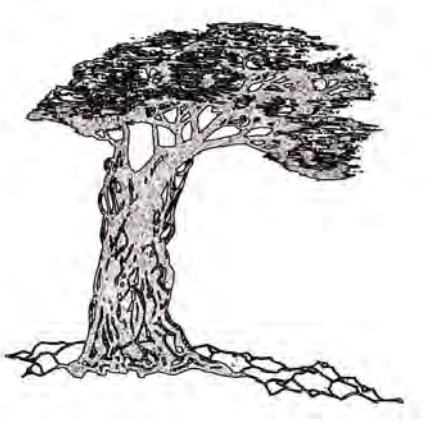
After the cyclones in the early 1990s, even fewer *manuma* were seen, and perhaps less than 50 remained on all of Tutuila. Today, however, *manuma* are regularly seen at some locations on Tutuila, although not in very large numbers. Biologists would call their current distribution rare and local, but they are occasionally sighted at many places around American Samoa. Interestingly, *manuma* are much more common in Fiji, Samoa, and Tonga, sometimes being found well away from mature forests.



We know very little about the biology of *manuma* in American Samoa, or why it is less common here than elsewhere. These are social birds, often being seen in small flocks, but they are also very protective of feeding areas, driving other *manuma* away from their spot in the canopy of a fruiting tree. One odd thing is that you rarely see the same numbers of each sex -- almost always there are several more males than females in any flocks. We do know that they seem to have a very strong preference for the fruits of banyan (*āoa*) trees, and in American Samoa it is almost always seen near or in these trees. They are also known (from Fiji and Tonga) to eat *moso'oi*, *'o'a* and *māgele* fruits, all of which occur in America Samoa. Perhaps there are still so few *manuma* here that they are seldom forced to eat anything but their favorite food, but would eat other fruits if necessary.

It is dangerous for animals to specialize too much on any one food, especially on remote islands like American Samoa. This can be shown with an example from business. While a store that sells only antique cuckoo-clocks might do fine in New York, Los Angeles, or another big market, it would certainly fail very quickly in American Samoa. There isn't enough business here for such a specialized service. Similarly, an island animal that concentrates on only one kind of food may find itself in trouble when that food supply fails. An animal that lives on a continent can move in search of the food it needs, but island

animals have nowhere else to go. On larger islands like Upolu, Savai'i or Viti Levu, *manuma* may be able to travel long distances to get the food they like the best. This may be difficult on small islands like those of American Samoa, and means that animals can only specialize on very reliable food trees such as banyan trees (*āoa)*.



These giant banyan trees, which are so important to *manuma*, face many problems of their own. The Tafuna Plain used to have many huge banyans, but most of these have been cut down to make way for the exploding human populations in that area. Moreover, banyans, with their large size and spreading crowns, are very vulnerable to storm damage. Many were killed or severely damaged by Cyclones Ofa and Val in the early 1990s. Even those that survived the cyclones had their leaves and fruit stripped off, leading to a prolonged period of famine for *manuma*.


Banyan (aoa)

There are two things that must happen if the *manuma* is to survive and remain a special part of Samoa's wildlife. First, the birds must be protected from hunting. Although the *manuma* is too rare to be sought by hunters, a few may have been killed every year by hunters out for *lupe* and *manutagi*. When a population is as small as the *manuma's*, even a few preventable deaths per year are a significant problem.

The second thing that must be done if the *manuma* is to survive is to protect banyan trees on which they depend. Without enough banyans to assure a year-round supply of its favorite food, the *manuma* may well become extinct on Tutuila. People need to protect these magnificent trees, which are important food sources for many other Samoan wildlife species, including the fruit bats (flying foxes).

Pepper Trail, Joshua Seamon, DMWR

59. The honey-birds


Wattled Honeyeater (iao)

The most familiar birds of Tutuila's villages and gardens are the *iao* (Wattled Honeyeater) and the *segasegamau'u* (Cardinal Honeyeater). Although they look different, these birds are members of the same *aiga*, the family of birds called the honeyeaters. Honeyeaters are found throughout the Pacific islands, New Guinea, and Australia. As their name implies, most of them include the sweet nectar of flowers in their diet (though none of them eat real honey).

The *iao* or Wattled Honeyeater (*Foulehaio carunculata*) is the commonest forest bird in Samoa. It is also found in Tonga and Fiji. Although not a particularly beautiful bird, with its greenish-brown feathers and yellow flaps of bare skin on the face, its boundless energy and continuous song enliven our islands. Its bold and fearless nature keeps it busy chasing other birds, and its loud alarm calls warn other animals of the *lulu* (Barn Owl) or other danger. Samoan legend tells that when the *iao* calls at night, it means that ghosts (*aitu*) are near.

The *iao* feeds at almost all the flowers of the forest, from small *'atone* (nutmeg) flowers to the large crimson blooms of *gatae* (coral tree). Christmastime is the best time of year for *iao*, because the *asi* trees are in full bloom. These white brushy flowers cover the tree crowns and are rich with nectar. At that time, the *iao* get so full of this nectar that they're like kids full of candy and cake at a party -- they rush every which way through the forest, chasing each other and yelling out songs at the top of their lungs. At other times when flowers aren't quite so abundant, they eat a lot of insects as well, and also include some soft fruits and berries in their diet.

Even though the *iao* is our commonest bird, we really don't know very much about its habits. Their nests are beautifully woven cups of grass, typically well-hidden in the dense foliage of a tree. Usually only one or two eggs are laid. Most nesting appears to take place between September and December.

The *segasegamau'u* or Cardinal Honeyeater (*Myzomela cardinalis*) is the prettiest bird of Samoa's gardens. Unlike most Samoan birds, the male and female Cardinal Honeyeater look very different: the male is bright red, with black wings and tail, while the female is a dull gray, with a little bit of red on the rump. These tiny birds (the smallest in American Samoa) always seem to be active, flitting among the *'aute* (ornamental hibiscus), *teuila* (ginger), and *nonu* (Indian mulberry) in our gardens, or sampling nectar at flowers high in the forest treetops. Like the *iao*, the *segasegamau'u* is very vocal, though not as loud as its larger cousin. Its sweet warbling songs are familiar sounds in our villages and plantations.


Cardinal honeyeater (female)


Cardinal honeyeater (male)

The *segasegamau'u* is even more of a honey-bird than the *iao*. Though it will occasionally eat small insects, it seems very dependent on flower nectar at all times of year.

You can see the difference in the beaks of the two birds: the Cardinal Honeyeater has a very delicate, sharp beak that is perfect for slipping into flowers but not so good for grabbing big bugs. The beak of the Wattled Honeyeater is sturdier, more all-purpose: good both for flowers and insects.

Perhaps because of its love of flowers, the *segasegamau'u* seems happy to live close to people, in gardens and plantations. Although much less common than the *iao* in the forest, it is the honeyeater that you're likely to see around villages. Around villages on Tutuila, that is; surprisingly, the *segasegamau'u* doesn't occur on any of the islands of Manu'a. Outside of American Samoa, the species is found in western Samoa, Vanuatu, and the Solomon Islands, and very close relatives occur in Micronesia and Fiji.

The nest of the Cardinal Honeyeater is a beautiful, delicate cup of fine grass fibers, often decorated with moss. It may be placed high in a tree or almost on the ground in thick foliage. Four to five tiny eggs are laid. The *segasegmau'u* seems to nest in all months of the year.

There used to be a third kind of honeyeater on Tutuila, the very large, blackish *ma'oma'o* or *mao* (*Gymnomyza samoensis*). This is a real mystery bird. Larger than a *fuia* (Samoan Starling), with loud wailing calls, the *ma'oma'o* is remembered by some of the elders of Tutuila, and was collected by scientists here in the 1920s. However, except for a couple of possible sightings in the 1960s and 1970s, it has never been seen since. The *ma'oma'o* is now found only in the remote mountains of 'Upolu and Savai'i, where it is rare and little known. We will probably never know if this bird was once an important part of our forests, or if it occurred here only as a rare visitor from western Samoa. According to legends, hearing the wails and screams of the *ma'oma'o* around a village meant that misfortune or a death was about to happen. Sadly, this prophecy seems to have come true for the *ma'oma'o* itself, which is now in danger of the greatest misfortune --

Pepper Trail
DMWR

60. Samoa's starlings

Starlings are a group of birds with a real image problem. Over much of the world, “starling” means just one thing -- the Common, or European Starling. This plump, short-tailed, oily black bird was originally found in Europe, but it has spread across the cool, temperate countries of the world, from the US to China, and from Australia to Argentina. Everywhere it goes, this bird becomes a pest in both cities and the countryside, often driving out native birds and destroying fruit crops.


Samoan Starling (fuia)

However, starlings are much more than this one obnoxious species. Most starlings are found in the tropics, and they are a varied, interesting and often beautiful family of birds. In the Pacific, starlings are a characteristic and important part of our native birdlife. In fact, the most unique of all our birds in American Samoa is the *fuia* or Samoan Starling.

Why is the *fuia* so special? Well, not because of its appearance. With its dull brownish-black color, the *fuia* could hardly be called beautiful. No, the *fuia* is special because it is the only American Samoan bird that is “endemic” to Samoa. This is a word used by scientists to describe something found in only one place. The *fuia* is found only in the islands of American and western Samoa. All our other birds are found in at least one other group of islands. Therefore, if the *fuia* became extinct in the Samoas, there wouldn't be a single one left in the world.

Fortunately, there is little danger that the *fuia* will become extinct. It is a survivor, a real Samoan success story. It is the most adaptable bird we have, equally at home in Pago Pago, in small villages, in plantations and in the rainforest. The secret to its adaptability is its eating habits -- a *fuia* will eat almost anything. They gobble down a wide variety of fruit, from the hard seeds of the *mamala* tree to the big stinky fruits of *nonu* bushes, from the leathery fruits of *lau pata* to the soft figs of the *mati*. They also love insects, including big stick insects, caterpillars, and other agricultural pests. Therefore, *fuia* are friends to farmers, and deserve our protection. *Fuia* even eat lizards, and indulge their taste for sweets with visits to lick up the nectar of *gatae* flowers. Because of their broad diet, *fuia* can always find food, and can live almost anywhere there are trees.

As in most Samoan birds, male and female *fuia* look almost the same. The species seems to nest in all months of the year. *Fuia* nests are usually placed in hollows in trees: snapped-off coconut trunks are favorite nest sites. They will also nest among the dense fronds in the top of a coconut, and even use man-made nest sites, like cracked telephone poles. *Fuia* eggs are pale blue.

We don't really know very much about the social life of the *fuia*: for example, do they mate for life? Do they defend territories from other *fuia*? Do they stay in one small area, or do they move all around the island? It would be interesting to know more about this most Samoan of our native birds.

The *fuia* is not our only native starling; it has a small and shy cousin, the *miti vao*, or Polynesian Starling. Although much less common than the *fuia* in Samoa, the *miti vao* has a wider range, being found in Fiji, Tonga, and Niue as well as American and western Samoa. Unlike the *fuia*, the *miti vao* is almost entirely a bird of the forest, rarely seen in plantations, much less villages. The reasons for this aren't clear. It seems to have a broad diet, though not quite as accepting as the *fuia*. It eats both insects and fruit, and is often seen feeding on hard-seeded fruit like *mamala* and *taputo'i*, though we don't know if this is because the *miti vao* prefers such food or because the more aggressive *fuia* drives it away from softer, more nutritious fruit.

Across most of Tutuila you may have some difficulty finding the *miti vao*. There are a few places where they seem to be more common: Maloata on the west end of the island, between Afono and Vatia on the north side, and along the Mt. Alava Road. Look for a small, short-tailed bird with a grayish back, a pale breast with darker streaking, and white eyes. Its quiet but musical whistles and trills are very different from the harsh screeches and piercing whistles of the *fuia*. *Miti vao* nests are placed in hollows and holes, as are *fuia* nests. They usually lay two pale blue eggs with brown specklings. So few nests have been found here that we really don't know what time of the year this species prefers to breed, or if they may nest at any time. The *miti vao* is a species that apparently declined after tropical cyclones in 1990-91. We can only hope that populations will increase over time, provided that enough good forest remains to give this species the wild habitat it needs.

One interesting thing about the *miti vao* is that there is a very different form of this bird in Manu'a. There, the *miti vao* are very dark on both upperparts and underparts, with heavy dark streaking on the breast. To become so different, the Manu'a birds must have been separated from those on Tutuila for a long time, probably thousands of years.

Unfortunately, the native *fuia* and *miti vao* aren't Samoa's only starlings. Since the 1980's, two other members of the starling family have invaded Tutuila, and are now among our commonest birds. These are the black and white mynas that are common from Pago Pago Harbor to Leone. Two species of mynas are established here, both of which were originally native to India. The Common Myna is brownish black, with a yellow bill and a yellow patch of bare skin around the eye. The Jungle Myna is similar, but is darker and slimmer, with an orange beak and no yellow skin around the eye. Both species have large white patches in the wings and tail. The Common Myna is a major pest in many parts of the Pacific, including New Zealand, Hawaii, Fiji, Cook Islands, and French Polynesia. The Jungle Myna has become established only in Fiji and in the Samoan islands. Both species eat almost anything and are very happy in cities and villages, where they eat garbage and nest under roofs even in occupied buildings. These unwelcome invaders can damage guavas and other fruit crops, can spread disease, and may compete with our native birds in villages. So far, the mynas have not yet spread to the Manu'a Islands. It is important that we prevent their spread, and reserve American Samoa, as much as possible, for our native birds, including our native starlings, the *fuia* and the *miti vao*.

Pepper Trail, DMWR

61. Swiftlets & sheath-tailed bats (*o le pe'ape'a*): a mosquito's nightmare


Namu

High above the villages, valleys, and mountains of Samoa flies a deadly predator, as terrifying as a tiger shark -- if you're a mosquito (*namu*), that is. This is the *pe'ape'a*, the only bird in Samoa that lives entirely on a diet of insects.

But wait a minute -- *pe'a* means bat: isn't the *pe'ape'a* a kind of small bat? Well, yes and no. Actually two completely different creatures share the name *pe'ape'a* in Samoa. One is a bird, the common White-rumped Swiftlet that is seen flying by day all over our islands. Like all birds, this *pe'ape'a* has feathers and lays eggs. The other *pe'ape'a*, more properly called *pe'ape'avai*, is a tiny bat, the Sheath-tailed Bat that is active only at night. This animal may now be extinct in American Samoa. Like all bats, this *pe'ape'a* is a mammal and has fur and gives birth to live young that it feeds milk. The confusion arises because both creatures are tiny, active insect-eaters that are almost always in flight, and look similar as they dart and swoop after their prey.


White-rumped swiftlet (pe'ape'a)

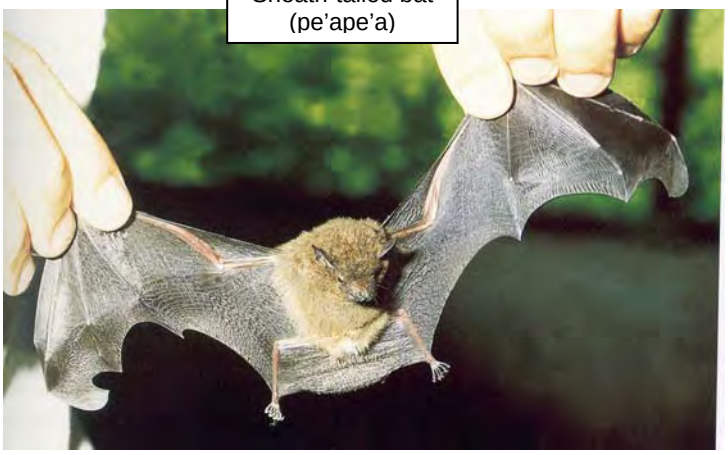
First let's talk about the common *pe'ape'a*: the bird. It belongs to a family of birds that are truly creatures of the air, the swifts. They have tiny legs and feet, and never land except at nests or in their roosting caves. Capturing and eating food, drinking, gathering nesting material, and yes, even mating, are all done in flight. In fact, it is likely that the *pe'ape'a* is like many other kinds of swifts and actually sleeps while flying. With their long, powerful wings and perfectly streamlined bodies, *pe'ape'a* are beautifully adapted for a life of flight.

As they fly, *pe'ape'a* are continually hunting for small insects, especially mosquitoes, flies, and flying ants and termites. These are scooped up in the swift's huge mouth, which is made into an even larger trap by long bristle-like feathers around the mouth. The swiftlet is a very useful bird because of all the insects it eats.

When the *pe'ape'a* finally does decide that it's time to land, it heads for a cave or a protected overhang on a cliff. There it flutters in to grasp the rock, usually hanging vertically. These caves and sheltered overhangs are also the nest site for the swifts. The nest is a small platform made of moss and fine twigs cemented together with the bird's saliva, attached to the rock. Some close relatives of the *pe'ape'a* make their nests entirely from dried saliva, which (believe it or not) are collected and cooked up to make that famous delicacy, bird's nest soup. The nests of our *pe'ape'a* are not suitable for this, so anyone with a taste for bird saliva will have to look elsewhere.

Swiftlets lay one or two white eggs, and appear to nest at any time of year in Samoa. Although most nests are placed where at least a little light penetrates the cave, some are far back, where it is completely dark. How do the swifts find their way in and out? The answer is that these birds, like many small bats, have the amazing ability to echo-locate. They give loud clicking calls, and then listen to the echoes to orient themselves and avoid the walls of the cave. This ability is fairly undeveloped in birds, and the swiftlets don't use it to locate their insect prey, which is why they hunt during the daytime. In many small bats, however, echo-location is incredibly advanced, and is used to hunt tiny insects in complete darkness. One bat with this ability is the Sheath-tailed Bat, which brings us to our second *pe'ape'a*.

The Sheath-tailed Bat (*Emballonura semicaudata*) also feeds on mosquitoes and other flying insects. But unlike the swift, this small bat does not seem to accept sheltered cliffs as roosting or breeding areas, inhabiting only deep and protected caves. There are few such caves in American Samoa, and therefore few good homes for the bat. Ever since Cyclone Ofa in 1990, the known bat caves on Tutuila have been almost deserted. Cyclones Ofa and Val swept water and debris into several caves, and the days of strong cyclone winds may have made it impossible for the bats to find food. Unless more bats survive in caves that we don't know about, the long-term survival of this useful and fascinating animal in American Samoa is doubtful. There is little we can do to help the bat except to stay away from their caves to avoid disturbing the few surviving animals. Sadly, the Sheath-tailed Bat seems to be endangered throughout most of its range, including in western Samoa and the Marianas, as well as here.



Sheath-tailed bat
(pe'ape'a)

And what about the swift? Although the population of these birds was reduced by cyclones in 1990-91, the species seems to be in no danger of extinction. It is still possible to see flocks of hundreds of swifts swirling together in areas where winds collect large numbers of insects, for example in Malaeimi Valley and in such highland areas as Aoloau and Afono Pass. There is every reason to believe that these birds will always enliven the Samoan sky -- and strike terror into the hearts of mosquitoes everywhere.

Pepper Trail
DMWR

62. Familiar and mysterious birds -- the rails

The *ve'a*, or "roadrunner", is one of Samoa's most recognizable birds. It is a familiar sight tiptoeing out of the grass or running crazily across the road, its neck stretched out and its big feet trying to keep up. And its loud, screeching voice is a familiar sound, seeming to complain at the disturbance as we walk to the taro patch. However, for all its abundance, the *ve'a* is still a little-known bird, quickly disappearing from view when disturbed and impossible to follow in the thick grass it favors. What's more, the *ve'a* has two even more mysterious cousins in American Samoa, and another in western Samoa that, as we will see, is the most mysterious Samoan bird of all.


Banded rail (ve'a)

The *ve'a* and its cousins belong to the family of birds known as the rails (named from a old English word meaning to screech -- many of these birds have loud, harsh voices). The *ve'a* is called the Banded Rail, because of the black and white bands on its sides and underparts. It is found all across the Pacific from the Philippines and Indonesia to Samoa, Tonga, Fiji, and on to Australia and New Zealand. It is usually common wherever it occurs, with the exception of Fiji. On Fiji this formerly abundant bird has been exterminated on the large islands of Vanua Levu and Viti Levu by an introduced predator, the mongoose. This shows how important it is to keep Samoa free from such destructive introduced animals.

The *ve'a* is a very useful bird, eating many insects that can harm crops. In fact, it will eat almost anything, including fruit, worms, snails, mice, and even toads squashed flat on the roads. It sometimes can be seen deep in the forest, but prefers open areas with dense grass. Therefore, taro and banana plantations are some of its favorite places. The nest of the *ve'a* is very hard to find, being built on the ground well-hidden in thick grass. The *ve'a* lays 4 to 6 eggs. Like young chickens, young *ve'a* can run around almost as soon as they hatch, and they leave the nest immediately. It is common to see one or two fuzzy, dark gray chicks being led into the grass by their watchful parents.


Purple swamphen (manu ali'i)

The other Samoan rail that most people know is the *manu ali'i*, known as the Purple Swamphen. This large and beautiful bird is a dark purple, with a bright red beak that extends up over the forehead. It is even more widely distributed than the *ve'a*, occurring from southern Europe through Africa and all the way to Australia and New Zealand. It is much less common than the *ve'a* in American Samoa, but occurs in low numbers almost everywhere, especially in more remote plantation areas. This bird is more often heard than seen; it gives a loud screech with an echoing, honking quality.

Like the *ve'a*, the *manu ali'i* prefers areas with thick undergrowth rather than true forest. It has a very wide diet, including many insects and much plant material. It sometimes gets into trouble with farmers because of its fondness for green bananas and taro tops. However, usually it does little damage, and repays it by eating soldier worms and other crop pests. In former times, the *manu ali'i* was sometimes hunted, and this may be why it is so shy, usually running or flying off with loud screams as soon as it sees you. Like the *ve'a*, it nests in thick vegetation, either on the ground or in a low bush. It lays 3 or 4 eggs, and the young leave the nest to follow their parents as soon as they hatch.

Our third kind of rail is a real mystery bird, as shown by the fact that it has no Samoan name. In English it is called the Spotless Crake. Although its wide range in the Pacific is very similar to the *ve'a*, in American Samoa it has only been sighted on the island of Ta'u. The Spotless Crake is very small, only about half the size of a *ve'a*, and is all dark gray except for red legs and eyes. It lives in dense grass, almost never flies, and is active at dawn and dusk. All this makes it a very hard bird to find. In fact, only a single bird was seen by biologists in 1986, and another was sighted in 2001.

There is one more kind of rail to mention, and this is the most mysterious Samoan bird of all. It is the *puna'e*, or Samoan Woodhen. This bird was first described by scientists in 1874, and last seen in 1908. In the whole world, only 11 preserved specimens of it exist. It apparently occurred only on Savai'i in western Samoa.

Old stories tell that the *puna'e* lived in burrows in the mountain forests, and that it was formerly so abundant that it was hunted with nets and dogs specially trained to tell which burrows were occupied. If these stories are true, the *puna'e* was a very special bird indeed, since no other rails live in burrows. In the last ten years, there has been an unconfirmed report of the *puna'e* being seen in the mountains of Savai'i. These remote forests have been rarely visited by biologists, and we can hope that this unique bird may yet survive in the depths of that misty wilderness.

Pepper Trail, DMWR

Pago Pago Harbor

63. Our strange winter visitor, the Cuckoo (*aleva*)

The *aleva* or Long-tailed Cuckoo is a very odd bird, no doubt about it. For one thing, when the weather starts to get cold in its summer home, the *aleva* migrates north for the winter. For another, it has a highly unusual home life: it doesn't build its own nest or care for its own young, but abandons its eggs in the nests of other birds, to be raised not only by strangers, but by completely different kinds of birds. The *aleva* lives and breeds in New Zealand for half of the year. But when winter approaches, around March or April, the *aleva* leaves its chilly home islands, and flies north into sunny Polynesia. In fact, it is the only land bird to migrate north to spend the winter with us (although a few *aleva* may be found here year-round). The *aleva*'s winter range extends all the way from Palau on the west to Pitcairn Island on the east, but the largest numbers winter in Fiji, Samoa, and Tonga. Here it can be found on any island, from the mountainous interiors of the largest high islands to the coastal vegetation of tiny atolls. Wherever it ends up, the *aleva* feeds mostly on large insects, including caterpillars and stick insects, but also small lizards.

The *aleva* is a hard bird to see, usually creeping without a sound through dense foliage. In fact, we most often see *aleva* because they are being chased by other birds, especially the *iao* (Wattled Honeyeater). *Iao* seem to hate *aleva*, and chase them vigorously, with loud scolding cries. It is interesting to try to figure out why they do this. There are at least three possibilities. It may be that *aleva* will eat eggs if they get the chance; however, this has never been observed. Second, in flight the *aleva* looks much like a hawk, with its pointed wings and long tail. Perhaps *iao* mistake the *aleva* for a hawk, and think they are chasing a dangerous predator away. But there are no hawks in Samoa. Therefore, this explanation would mean that *iao* still have an instinctive fear of hawk-like birds thousands of years after they last saw a hawk (which was probably when the ancestors of our *iao* came here from Fiji). The last explanation seems even more far-fetched. This is that the *iao* chases the *aleva* because it is afraid that the cuckoo will lay its eggs in the *iao*'s nest. To understand this possibility, we must discuss the strange breeding behavior of the *aleva*.

Like many other members of the cuckoo family, the *aleva* is a nest parasite. This means that it secretly lays its eggs in other birds' nests. The unlucky host birds think that the cuckoo egg is their own, and raise it alongside their own babies. Usually the baby cuckoo is much larger than the babies of its hosts, who are unable to compete and starve to death. Many New Zealand birds, including honeyeaters related to the *iao*, recognize the *aleva* and chase it away. This makes a lot of sense in New Zealand, where the *aleva* breeds. But the *aleva* never breeds on its wintering grounds in Polynesia. Therefore, the *iao* has no reason to fear that the *aleva* will lay eggs in its nest. Could there be an instinctive hatred of cuckoos in all members of the honeyeater family? Like many questions in biology, this one would be hard to answer, but it's still fun to think about.

Older Samoans say that *aleva* used to be much more common than they are today. The *aleva* is now a rare sight on Tutuila. It's hard to know just how rare the bird really is because of its secretive habits. If you see one, consider yourself lucky, and take a moment to think about the many mysteries in the life of this strange visitor to our shores.

Pepper Trail
DMWR

64. Barn owls (*lulu*) -- spirit of the night

The barn owl or *lulu* is a highly beneficial bird in American Samoa, but some people fear it because they associate it with ghosts or *aitu*. Its ghostly white appearance and its preference for flying at night enhance its reputation as a mysterious bird. It is not uncommon when driving around Tutuila at night to see one perched on a telephone pole or gliding across the road. Its eerie screech pierces the night and can be frightening if you are not expecting it.

Owls are carnivores that usually swallow their prey whole. A few hours after swallowing a rat (*isumu*) or some other prey, owls regurgitate or spit out a pellet of indigestible bones and hair about two inches long and one inch in diameter. By examining these pellets, we can determine what the *lulu* eats. In the remains of 482 meals, rats made up most (81%) of those meals, followed by mice (9%), geckos (7%), and bones of a few birds (2%), which consisted of White Terns (*manusina*), Wattled Honeyeaters (*iao*), mynas, and Samoan Starlings (*fuia*).

No chicken remains were found, but this was not unexpected because owls do not generally attack large prey. Chickens and fruit bats (*pe'a*) are too heavy for an owl to carry and too large to swallow whole. Instead, they would typically eat the meat and viscera at the site of the kill. Soft tissues such as these would be totally digested and not be found in pellets. We have other evidence that one flying fox was killed and partially eaten by an owl.

Even though *lulu* occasionally take a bird, bat or even a chicken, their value in controlling rat populations is tremendous. One pair of owls may catch 2-4 rats per day. Without owls, Tutuila and Manu'a would probably be over-run with rats. A *lulu* seen flying through a village should not be feared or hated but welcomed, because it will probably mean one less rat near your *fale*.

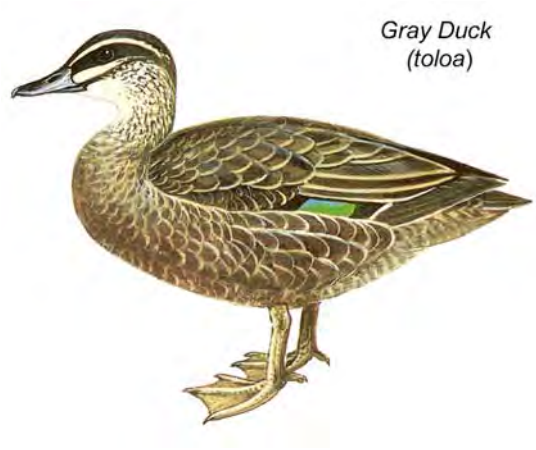
Gilbert S. Grant
DMWR

65. Birds of wetland and reef: Gray Duck and Reef Heron

Two very different birds depend on Samoa's shallow water habitats. One is the familiar *matu'u*, or Pacific Reef-Heron, a bird that is seen nearly every day by anyone visiting Samoa's shoreline. The other is Samoa's only duck, the *toloa* or Gray Duck, a bird that is so rare that most young Samoans have probably never seen one.

It comes as a surprise to some people that we don't have more kinds of ducks in Polynesia. After all, ducks like water, and we've got plenty of that, right? Well, we've got plenty of salt water, but very few lakes, marshes, or large streams of fresh water. Almost all ducks prefer fresh water, and even the few kinds of "sea ducks" eat mostly seagrass and other plants that aren't found around Samoa's coral reefs. Therefore, there aren't many suitable homes for *toloa* in American Samoa. These suitable homes are the fresh and brackish (fresh/saltwater mix) water wetlands.

"Wetlands" is a word that we hear a lot about. It refers to areas of land that are permanently or periodically flooded or submerged in shallow water. So much wetland habitat has been lost in the United States, primarily through draining and filling, that strict federal laws have been passed protecting wetlands. Locally, the Coastal Zone Management Program is responsible for protecting our remaining wetlands, which serve vital roles as nurseries for fish and crabs, natural water purification and recharge areas, sites for taro production, and homes for rare plants and wildlife. There used to be extensive mangrove (*togo*) swamps bordering Pago Pago Bay, but these were filled in long ago, before the negative environmental consequences of such activities were understood. The largest remaining wetland areas here are the *pala* lagoons in Nu'uuli and Leone and the marshes and Pala Lake on Aunu'u Island. There are also many other small but important wetlands remaining in both Tutuila and Manu'a.



These areas were once home to *toloa*. However, as wetlands were filled in and as shotguns became available, this once-popular game bird became rarer and rarer. During a major survey of Samoan birds in 1986, not a single *toloa* was seen, leading to the concern that this bird might be extinct in American Samoa. Happily, this is not the case. A few *toloa* still live in the territory, mostly on Aunu'u, where the village leaders have taken an active role in protecting their ducks. This bird, and the wetlands it depends upon, need our continued protection if it is ever to recover to healthy population levels.

The *toloa* is a "dabbling duck". This means that it doesn't dive under the water to feed, but rather tips down, with its tail in the air and its neck stretching under the water, to reach the plants and small insects and snails that it feeds on. Although it sometimes swims in the sea, it does not feed there, and, like most ducks, it does not eat fish.

One interesting thing about the *toloa* is that is doesn't always nest near the water. It may build its nest in tall dense grass, or place it in a low tree hollow. Five to ten pale green eggs are laid. The journey of the young ducks from the nest to the safety of the water is a dangerous one, and usually only one or two ducklings make it.

The *toloa* is a great wanderer. The bird is found across a huge geographic area, extending from Indonesia to French Polynesia, and south to New Zealand and Australia. The *toloa* is a strong, fast flier, and commonly flies between islands. It seems likely that the small population on Aunu'u, which was apparently absent in the

late 1980's, may have recolonized American Samoa from western Samoa, where the duck is slightly more common. This gives us reason to hope that the *toloa* may return to areas that it formerly used, if the wetlands are preserved, and the duck is protected from hunting. So ... if you see a *toloa*, consider yourself lucky, and don't disturb it. Perhaps one day Samoa's special duck will once again be a common sight.


Reef Heron (matu'u)

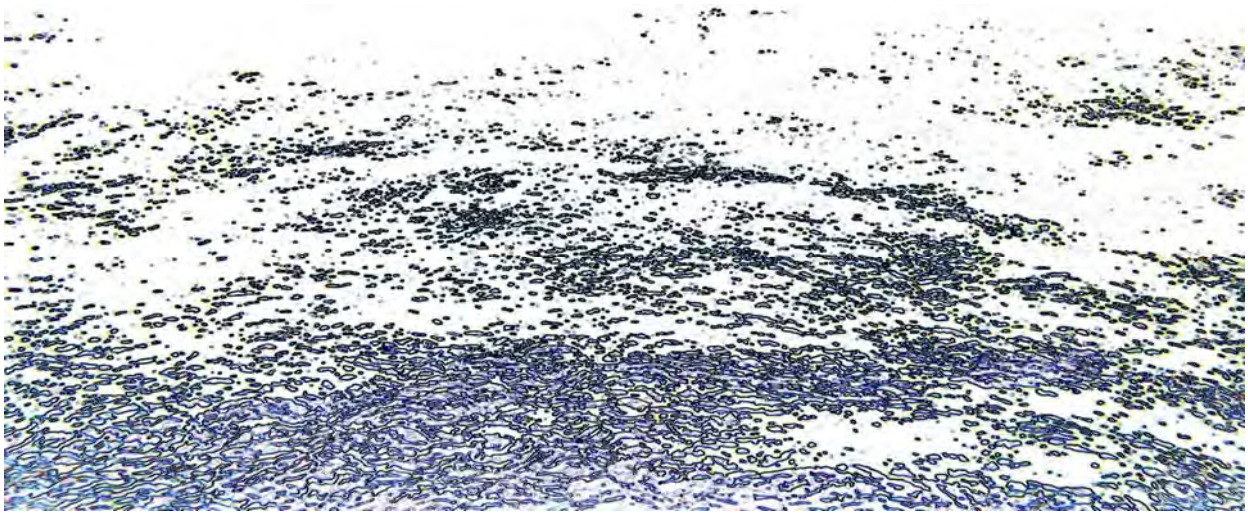
The *matu'u*, or Pacific Reef-Heron, is a common sight today. With its long legs and long neck, often curved in an S-shape, the *matu'u* is one of Samoa's most recognizable birds. One interesting fact about the *matu'u* is that it comes in two color forms, either dark gray or pure white, although almost all the *matu'u* in Samoa are dark gray. In other areas, particularly atolls like Swains Island or Rose Atoll, almost all the *matu'u* are white. It seems that in Polynesia the dark forms are found on volcanic islands, with dark lava rocks, while the white birds occur on atolls with white sandy shorelines. In many other parts of its range, however, including Fiji, both white and gray forms occur commonly in the same area. The reason for the *matu'u*'s two color forms remains unclear.

The *matu'u* is the master spear fisherman of the bird world. It stalks slowly across the reef flat, scanning for the slightest movement, and then throws its long neck forward as fast as lightning, catching its prey with its long sharp beak. It feeds on a wide variety of reef creatures, including fish, crabs, and snails.

Although the *matu'u* usually makes its living feeding on the coral reef, it also uses the freshwater wetlands of Samoa. Mangrove areas like the Nu'uuli Pala are frequent feeding sites, and the birds will also hunt for food in freshwater streams. These rainforest stream valleys are the *matu'u's* favored nesting areas, where the herons build their large nests high in the trees. Some *matu'u* also nest on offshore islets, and have even been reported to nest on ledges in caves. Usually three pale green eggs are laid.

Strict protection of Samoa's wetlands is essential if the *toloa* is to regain its place among our familiar native birds and if the *matu'u* is to continue to be a common resident of our shoreline villages. Please help spread the message that landfills kill a very important part of Samoa's natural environment -- our wetlands.

Pepper Trail, DMWR



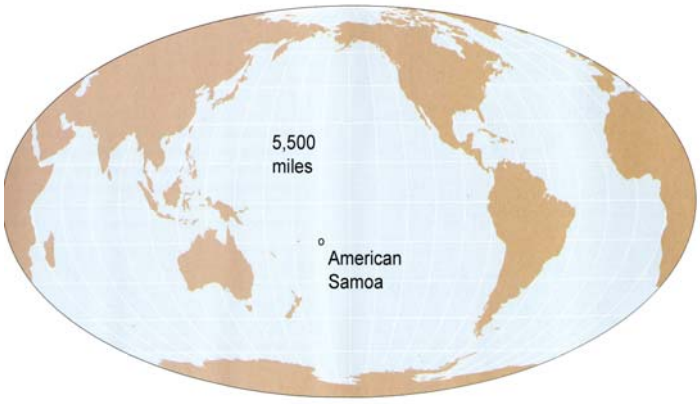
66. Shorebirds (*tuli*): incredible voyagers

April-May is the time of year when some familiar visitors leave American Samoa and begin an incredible and perilous journey home. These visitors are the shorebirds, or *tuli*. Three different kinds of *tuli* are common visitors here between the months of September and April: the Pacific Golden Plover, the Wandering Tattler, and the Ruddy Turnstone.

Golden Plover in breeding (left) and non-breeding coloration (center).

Wandering Tattler

During the northern summer, all three *tuli* nest in Alaska and northern Canada. The plover and the turnstone nest in the tundra, where their neighbors are caribou and grizzly bears. The tattlers nest by icy mountain streams, sharing their world with mountain sheep and golden eagles. But when the northern days grow shorter and colder, the birds probably begin to dream of the beaches and reefs of Polynesia, for they set out on one of the greatest of all animal journeys. From gathering places on the coasts of Alaska, the *tuli* take off to fly non-stop over 3,000 miles of open ocean to the Hawaiian Islands. These birds cannot land on the water and take a rest -- their feathers are not waterproof, so if they land in the water, they drown. Not only is this flight an amazing physical feat, but it requires tremendous navigational abilities to find tiny specks of land lost in the featureless sea. After a well-earned rest in Hawaii, the *tuli* take off again for another flight over thousands of miles of ocean to reach Samoa.



Incredible flight of shorebirds (*tuli*) from American Samoa to Alaska and Canada, with a stopover in Hawaii.

Here, each kind of *tuli* takes up a slightly different lifestyle. The Golden Plover is often seen on the beaches, but even more commonly can be found searching for food on the short grass of the village *malae*, parks, the golf course, and the airport. We can only hope it will not be harmed from competing with the many myna birds that now occupy these areas. Although this plover is plain brown during most of its stay in American Samoa, it gets a beautiful new set of feathers just before it heads north: a golden-spangled back and jet black underparts. The plover is the commonest *tuli* in Samoa, and it features in many myths and legends. *Tuli* the Messenger is one manifestation of Tagaloa, the supreme god of the ancient Samoans, and in one version of the Samoan creation story, Tagaloa created the first dry land as a resting place for *tuli*.

The Wandering Tattler is a beachcomber. It is almost always seen on beaches or the reef, using its long beak to pry small crabs, worms, and other delicacies out of the sand or coral. It is a solitary bird, soberly dressed in gray. When disturbed, the tattler's loud cries explain how it got its name.

The turnstone was named for its way of feeding. These small, energetic, sociable birds like to vigorously flip over small stones, bits of seaweed, or debris in search of food hiding beneath. They can be seen either on the beach or in grassy areas. The turnstone has a beautiful pattern of black and white patches on its back when it flies, and in breeding plumage, it is a handsome bird with orange-brown, black, and white patterning.

All these *tuli* can usually be seen in such places as Sliding Rock and Pala Lagoon from September to April. But in April-May, all but a few stragglers will have left Samoa to take their long, long trip back to Alaska. So, the next time you see some *tuli*, wish them a safe journey and try to imagine, maybe with a little envy, their great adventure.

Pepper Trail
DMWR

Other shorebirds occasionally seen here:

Bristle-thighed Curlew

Bar-tailed Godwit

Sanderling

67. Samoa's seabirds: *tava'esina*, *gogo* and *manusina*


Red-footed Booby
(fua'o)

The islands of Samoa are true oceanic islands: they are not riders on the skirts of any continent, but are the tops of huge mountains, rising up through the great ocean depths. Surrounded as they are by thousands of square miles of ocean, it is not surprising that the Samoan Islands have more kinds of seabirds than any other type of native wildlife. In all, 20 species of seabirds are known to nest in Samoa (and many more can be seen passing through our area), compared to 18 kinds of resident landbirds and only three kinds of mammals (all bat species).

Our seabirds are a diverse group. Some, such as shearwaters and petrels (*ta'i'o*), are rarely seen, but nest in burrows on the tops of mountains like Lata and Pioa. Their eerie calls can be heard at night in places such as Afono Pass. Others like frigatebirds (*atafa)* and boobies (*fua'o*) are seen flying around our coasts, but nest on the high cliffs of Pola or in trees on the remote north side of Tutuila. The tern family has many different-looking birds living here, including the solid black and brown noddies (*gogo*), the beautiful blue-grey noddy (*laia*), the white tern (*manusina*), and the grey-backed tern (*gogo sina*). Here we will discuss the three most common and conspicuous seabirds of Tutuila: the *tava'esina*, *manusina*, and *gogo*.

The *tava'esina (tava'e)*, or White-tailed Tropicbird, is one of Samoa's most beautiful creatures. The sight of a *tava'esina* soaring overhead is unforgettable, as its gleaming white feathers and graceful tail streamers blaze against the deep indigo of the Polynesian sky. Happily, it is also a familiar sight, as these birds are common all around Tutuila.


White-tailed Tropicbird (tava'esina)

The *tava'esina*, so graceful in the air, is comical and awkward on land, so much so that Samoan legends describe the bird as lazy or dim-witted. In fact, *tava'esina* are probably as industrious and intelligent as your average bird. Their awkwardness results from the fact that their legs and feet are tiny for the size of the bird, and are placed far back on the body. Thus, all *tava'esina* can do on land is to shuffle along, bumping their powerful chest muscles on the ground. Luckily for them, *tava'esina* spend little time on land.

They typically nest high in rainforest trees, preferring protected sites such as large hollows or clumps of ferns or other plant material. Here they lay a single large egg. At hatching, the young tropicbird is one of the cutest of all baby birds -- a completely round ball of silvery fluff. As they grow, they molt into their juvenile plumage, with black and white barred feathers across their back. This is their appearance when they leave the nest on their first flight toward the sea, often a mile or more away. The fledglings often seem to have problems with this flight, based on the number of young *tava'e* that are brought in to our office, unable to fly. These youngsters are usually very gentle, and with several days of feeding with sardines or other fish, they often regain their strength and are able to fly away.

Tava'esina are master fishermen, making plunging dives for squid and a variety of small fish. One of their

favorites are flying fish -- I've often wondered whether they catch the flying fish in the air or while they're swimming. The *tava'esina* is well known to Samoan fishermen, who watch its behavior at sea to help them locate schools of *masimasi* and other fish. The *tava'e* is important to human fishermen for another reason: its feathers are prized for fishing lures. The gleaming white breast feathers are tied to hooks and used to attract *malau* (squirrelfish) and other fish. It is a traditional belief that only feathers from living birds stay dry and shiny after repeated use, and it was a badge of honor for a Samoan youth to climb a *tava'e* nesting tree and pluck out the plumes. This supplied a lure while causing no harm to the birds.

The *tava'e* has a close relative, the Red-tailed Tropicbird, or *tava'e'ula*, that nests on Rose Atoll. This bird is larger and heavier than the *tava'esina*, with shining pinkish-white feathers and red tail plumes. It typically nests on the ground among rocks, roots, or logs. In former times, this bird apparently nested on Tutuila, but it no longer does so. The reason may be the abundance of introduced animals such as rats, cats, and dogs that attack ground-nesting birds on Tutuila.


White Tern (manusina)

Our next seabird, the *manusina* or *manu sina* (also called the White Tern or common fairy tern) is perhaps Samoa's most familiar bird. At almost any time of day you can lift your eyes to the mountains and see these pure white birds circling effortlessly over the green forest. I recommend contemplation of this lovely sight to anyone feeling burned out by the noise and ugliness that sometimes surround us at eye level. It's always a nice reminder of the beauty of the natural Samoan environment.

The *manusina* is found throughout the tropical oceans of the world and seems able to adapt to human-altered landscapes better than do many seabirds. Those of you familiar with Honolulu may have noticed *manusina* fluttering in the trees along Kalakaua Avenue, where they actually nest in the middle of Waikiki. The nesting behavior of *manusina* is remarkable indeed. In fact, “nesting” is being a bit generous, since *manusina* make no nest at all. Instead, they balance their large single egg in a knothole, stub, or other more or less precarious perch in a tree. They will even accept man-made structures like rooftops and ledges. It is amazing to see a *manusina* stubbornly sitting on its egg as a strong tropical storm swings its branch wildly. Risky though is seems to us, this nesting strategy certainly works, as the White Tern is a common and widespread bird.

Manusina feed on a variety of small ocean fish, which they pluck from the surface. Unlike all the other seabirds of Samoa, the *manusina* carries fish back to its chick in its beak, rather than swallowing them first. In fact, they have the incredible ability to capture several tiny fish in a row, shift them crosswise in their bill, and carry them back home, without dropping any. How do they do it?


Noddy
(gogo)

The final seabird to be discussed is the *gogo*, or Brown Noddy. Like the *manusina*, this bird is a member of the tern family, but these two cousins are different in many ways. For starters, the *gogo* is as dark as the *manusina* is light. It is dark chocolate brown all over, except for the top of the head, which is a whitish-gray cap. It is also more sociable than the *manusina*, usually nesting in loose groups, or colonies. The *gogo* is very flexible in its nesting behavior. On Tutuila, *gogo* usually nest high in trees in forested stream valleys, building bulky nests of dead leaves and other plant material. They also sometimes nest on cliffs, for example at Fagatele Bay. On Rose Island and other atolls, *gogo* are happy to lay their eggs on the ground, making only a small scrape in the coral rubble, which they often decorate with empty seashells and even bones. Like other tropical seabirds, the *gogo* typically lays only a single egg.

There is another *gogo* here, the Black Noddy, which is smaller and blacker than the Brown Noddy, and has a different way of flying. In good light they are separated from Brown Noddies that have a distinct brown and black pattern on the wings. Black Noddies are more often seen feeding in flocks with *manusina* than are Brown Noddies. The diet of the *gogo* is apparently similar to that of the *manusina*, since both birds feed on small fish and squid captured near the surface. How do different birds with such similar food habits coexist? Maybe each catches just a particular kind or size of fish, or dives to a certain depth.

Red Footed Booby
Fua'o

Brown Booby
Fua'o Manu ula

Masked Booby
Fua'o

Lesser Frigatebird
Atafa

One of the most interesting sights in American Samoa is a foraging flock of seabirds. These groups can have from five or ten to hundreds of birds. They are a great chance to see the many different ways seabirds catch fish: *laia* flutter above the waves, sometimes dangling their feet into the water, *gogo* swoop low over the water, *fua'o* dive into the water with a huge splash, and *atafa* wait until a *fua'o* catches some fish, then chase it and take the fish from it. The birds you see in such a flock are a good indication of which fish are below the water, something Samoan fishermen use to locate schools of fish. A flock of small birds like White Terns and Black Noddies usually indicates skipjack or small tuna, while large flocks of *fua'o* indicate larger fish. As fishing partners or simply as beautiful neighbors on our islands, Samoa's seabirds are a special part of our wild heritage.

Pepper Trail, DMWR

Sooty terns at Rose Atoll

68. The special birds of Manu'a

The Manu'a Islands are famous for their history, culture, and spectacular beauty, but the wildlife of Ta'u, Ofu, and Olosega is also special. Given that these islands are only 60 miles east of Tutuila, you might expect that the same kinds of birds and animals would be found in both places. But in fact there are four kinds of birds living in Manu'a that do not occur on Tutuila.


Blue-crowned Lory (segavao)


Blue-crowned Lory
(sega'ula, segavao)

The most beautiful of these is Samoa's only parrot, the *segavao* (*sega'ula*), or Blue-crowned Lory. This is a tiny jewel of a bird, only 7 inches long, but colored with emerald green back and wings, ruby red face and throat, and a sapphire blue crown. In historic times, these colorful feathers were used to decorate fine mats.

Segavao often come in to villages to feed on the nectar of coconut (*niu*) and coral tree (*gatae)* flowers, but they are not easy to see in spite of their bright colors. Your first clue to their presence is often their high-pitched whistles, given as they fly overhead or scramble in the top of a coconut tree. This pretty little parrot is also found in western Samoa, but does not live on Tutuila. We don't know why. Tutuila seems to have some of the food *segavao* like, including *āoa* fruits, but perhaps there are not enough flowers all year round. In the forests of Manu'a, *segavao* particularly like the flowers of *Astronidium pickeringii*, a species for which we know no Samoan name. This tree of the melastome family is common in the high forests of Manu'a.


Fiji Shrikebill
(*sega o le vau*)

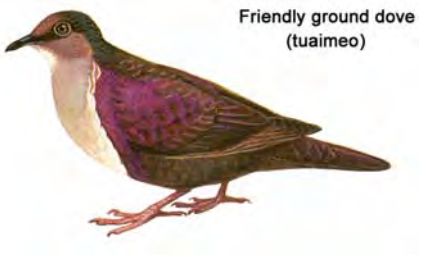
Another special bird of Manu'a is the *sega o le vau*, the Lesser (Fiji) Shrikebill. This is a charcoal-grey bird with tiny white corners on its tail, although if you get a very good look you might see a little brown along its sides, or its blue-grey legs. *Sega o le vau* are about the same size as *iao*, but are stockier and have bigger heads and wider beaks. This bird is found nowhere else in the Samoan islands. It also occurs in Fiji, but birds there look very different and are mostly brown. *Sega o le vau* can be seen on all three islands of Manu'a, but they are not closely tied to a particular habitat. They are usually heard before they are seen, as they often make a loud chatter as they poke through dead vines or *'ie'ie* leaves. They also make a clear two-toned whistle, and may answer if you imitate this call. These birds seem sociable and often move through the forest in small groups of two or three. They often ignore people, and if you sit very still they will sometimes feed within arm's reach.


Spotless crake

The Spotless Crake is a small black bird that looks like a half-grown Banded Rail (*ve'a*). It is extremely rare and has only been found in American Samoa on Ta'u Island. It lives in dense grass, is active mostly at dawn and dusk, and is very shy. All these habits makes it very hard to see, and only a few birds have been sighted in recent years.

Another rare land bird in American Samoa is the *tu'aimeo*, the Friendly Ground-Dove. This bird gets its name because it was first discovered in Tonga, once

called the Friendly Islands. A better name would probably be the Shy Ground-Dove, as this bird will sit very still on a low branch and hope you do not notice it. Your best chance of seeing one is if it happens to be walking in the path you are using, as it may run ahead of you or fly up onto a tree limb. You may also hear its call, a single, drawn-out coo that is slightly lower and much longer than the rapid, short coos of the fruit-doves *manutagi* or *manuma*. If you are very close, you can hear a slight variation in the tone of the call. *Tu'aimeo* are mostly dark brown birds, although like many doves the males can be very pretty if seen in good light. Unlike other doves or pigeons in American Samoa, this bird spends most of its time on the ground, where it feeds on fallen seeds, fruit, and buds. *Tu'aimeo* can be seen on Ofu and Olosega, as well as in Fiji, Tonga, and Samoa.



Birds are not the only unique wildlife of Manu'a. For example, Ta'u is home to American Samoa's only native snake, the *gata*, or Pacific Boa. This dark brown snake is harmless to people, apparently living mostly on a diet of lizards (*pili*), birds and bird eggs. It is rare, or at least very hard to find in the deep forests of Ta'u, and should be left undisturbed whenever it is found.

Why is the wildlife in Manu'a so different from that on Tutuila? One reason could be the wildness of Manu'a: large areas, mostly on Ta'u, are untouched by villages, plantations, and roads. Another reason may be that in Manu'a the native birds have fewer problems caused by introduced birds, animals, diseases, or plants. Or, it could be that the terrain in Manu'a, which has many areas with steep yet forested ridges that have quite different plants than similar ridges, such as Alava, on Tutuila. Each of the special birds of Manu'a may have different reasons for being there, but the absence of all of them from Tutuila suggests there might be a single explanation for this pattern, and this remains an interesting biological question about American Samoa.

Joshua Seamon, Pepper Trail
DMWR

69. American Samoan Christmas bird count

This article gives a snapshot of what birds might have been seen by a visitor to Tutuila in 1992. "Christmas counts" are conducted by bird enthusiasts almost everywhere, including American Samoa. The survey is conducted on a single day during the period December 14 to January 5. Counts are made within a 15-mile diameter circle. The numbers and species of birds seen will depend on the number of observer teams. On December 17, 1992, seven observers traveling in three parties recorded 1337 birds of 30 species on Tutuila Island:

227	Red-footed Booby
143	White Tern
131	Pacific Golden Plover
118	White-rumped Swiftlet
116	Wattled Honeyeater
97	Samoan Starling
91	Red-vented Bulbul (alien)
86	Brown Noddy
46	Jungle Myna (alien)
31	Brown Booby
30	Purple-capped Fruit-Dove
27	Cardinal Honeyeater
25	Common Myna (alien)
24	White-tailed Tropicbird
23	Ruddy Turnstone
21	Banded Rail
21	Collared Kingfisher
14	Pacific Pigeon
13	Reef Heron
12	Wandering Tattler
9	Polynesian Starling
7	Lesser Frigatebird
6	Bridled Tern
4	frigatebird spp.
4	Great Frigatebird
4	Many-colored Fruit-Dove
3	Sanderling
1	Purple Swamphen
1	Blue-gray Noddy
1	Rock Dove (alien)
1	Barn Owl

The count circle was centered at the peak of Matafao Mountain and included the entire island except the areas west of Fagamalo and Nua villages, and east of Aoa and Alofau villages. The total viewer-hours were: 3.5 hours on foot and 6 hours by vehicle. Participants traveled 2.5 miles on foot and 35 miles by vehicle. Percentage of time in each habitat was: 30% villages, 30% nearshore/reef, 10% plantations, 10% montane scrub, 10% rainforest, and 10% shore/scrub. Four species recorded were non-native introductions. The Rock Dove has not established a breeding population in the territory and the one observed was probably an escapee from a small colony of homing pigeons maintained by an individual in Tafuna. The Red-vented Bulbul has been established on Tutuila since at least the early 1960's. Both species of mynas became established here in the 1980's and are currently undergoing rapid range expansions in urban areas.

Gilbert S. Grant, Pepper Trail, DMWR

Appendix 1. Events of local interest, by year

1880	Navy stockpiles coal on harbor shoreline from 1880 to 1920.
1900	Population size in territory: 5,679. Size in 2009: 69,000.
1938	Outbreak of crown-of-thorns starfish reported.
1941	Build-up of Navy base in harbor.
1949	USS Chehalis sinks at fuel dock and still has fuel load aboard in 2009.
1954	Van Camp tuna cannery built in harbor.
1963	Starkist tuna cannery built in harbor.
1973	Rose Atoll National Wildlife Refuge estab.; PO in 1975 expands seaward boundary to 3 miles.
1974	American Samoa Environmental Protection Agency (ASEPA) established.
1978	Tutuila hit hard by crown-of-thorns starfish invasion; massive mortality of corals.
1980	Coastal Zone Management program established; enacted in 1990 (PL 21-35).
1981	Cyclone Esau
1982	Nutrient levels from cannery effluent in harbor exceed ASEPA levels from 1982 to 1991.
1985	Fagatele Bay National Marine Sanctuary established.
1986	Department of Marine & Wildlife Resources established (originally the Office of MWR).
1987	Cyclone Tusi (January 19); Manu'a heavily impacted.
1988	National Park of A.Samoa established (PL 100-571); 50-year lease agreement signed in 1993.
1988	Public Notification & Review System (PNRS) established to coordinate multi-agency reviews of land-use applications in territory.
1988	Tuna canneries required to transport high-nutrient wastes daily to dump zone 5 miles offshore.
1990	Cyclone Ofa (Feb. 3-4).
1990	Natural Resources Commission established for local endangered species (PL 21-39) but inactive.
1991	Cyclone Val (Dec. 6-10); major impact to buildings, rainforests, birds, bats, coral reefs.
1991	Hunting banned to allow birds and fruit bats recover after cyclones (ban still in place in 2009).
1991	Canneries required to stop wastewater discharge in inner harbor; effluent now piped to outer harbor.
1992	Rats eradicated at Rose Atoll due to their adverse impact on native flora and fauna.
1993	Longliner *Jin Shiang Fa* ran aground at Rose Atoll, spilling full fuel load, with long-term impacts.
1993	Taro blight (a fungus) wipes out local taro crop. Resistant strains imported from Palau.
1994	Widespread warm-water bleaching of corals in territory.
1994	Vaoto Marine Park estab. (PL 23-13, 18.0214) in exchange for dredging Faleasao harbor.
1994	Sewage treatment plants in Tafuna & Utulei upgraded to increase primary treatment capacity.
1995	Governor's interagency Coral Reef Advisory Group (CRAG) established.
2000	9 shipwrecks from cyclone in 1991 were removed from harbor reefs.
2000	Task Force on Population Growth produces report on unsustainable growth in A.Samoa.
2000	Collection of "live rock" (corals fragments) was banned to allow reef recovery (EO 002-2000).
2000	Governor directs ASG establish 20% of territory’s coral reefs as no-take Marine Protected Areas.
2001	Use of scuba gear while fishing was banned because reefs are overfished (EO 002-2001).
2002	Sea Grant program established at American Samoa Community College.
2002	Widespread warm-water bleaching of corals in territory.
2003	Widespread warm-water bleaching of corals in territory; coral disease (‘white syndrome’) common.
2003	Sea turtle & marine mammal sanctuary established in all territorial waters, 0-12 mi (EO 005-2003).
2003	Ocean Resource Management Process established to coordinate nearshore, harbor, offshore, and watershed management plans (EO 004-2003).
2003	Shark finning (taking fins only) banned in territorial waters (EO 066-2003).
2004	Cyclone Heta (Jan. 4-5); moderate damage to buildings, forests and coral reefs.
2005	Cyclone Olaf (Feb. 16); Category 5 cyclone slammed directly into Manu’a.
2006	Major invasive tree (*Falcataria moluccana*) removed from National Park (Tutuila Is.).
2006	Ecosystem damage to Rose Atoll persists 13 years after shipwreck and fuel spill there.
2009	Rose Atoll National Monument established.

Abbreviations: EO (Executive Order), PL (Public Law), PO (Presidential Order)

Appendix 2. Index of some Samoan plant names used in text

Samoan	Common	Scientific
'a'amati'e		*Elaeocarpus floridanus*
'ala'a		*Planchonella garberi*
āoa	banyan	*Ficus prolixa/obliqua*
asi, asi toa		*Syzgium inophylloides*
'atone	nutmeg	*Myristica inutilis (fatua)*
'au'auli	Samoan ebony	*Diospyros samoensis*
'aute	ornamental hybiscus	*Hibiscus rosa-sinensis*
esi	papaya	*Carica papaya*
fa'i	banana	*Musa x paradisiaca*
fetau		*Calophyllum inophyllum*
filimoto	Indian plum	*Flacourtia rukam*
fue lautetele	merremia	*Merremia peltata*
fue pepe	luecaena	*Leucaena leucocephala*
futu		*Barringtonia asiatica*
gasu		*Palaquium stehlinii*
gatae	coral tree	*Erythrina variegata*
'ie'ie		*Freycinetia spp.*
ifi	Polynesian chesnut	*Inocarpus fagifer*
ifilele		*Intsia bijuga*
lau pata		*Macaranga spp.*
lōpā	red seed tree	*Adenanthera pavonina*
ma'ali		*Canarium vitiense*
māgele		*Trema cannabina*
mālili		*Terminalia richii*
mamala		*Dysoxylum samoense*
māmālava		*Planchonella samoensis*
mamalupe		*Faradaya amicorum*
maota		*Dysoxylum maota*
masame		*Glochidion ramiflorum*
mati	fig	*Ficus spp.*
moso'oi	perfume tree	*Cananga odorata*
niu	coconut	*Cocos nucifera*
nonu	Indian mulberry	*Morinda citrifolia*
'o'a		*Bischofia javanica*
oliolī	tree fern	*Cyathea spp.*
pālulu	morning glory	*Operculina turpethum?*
poumuli		*Flueggea flexuosa*
pua lulu		*Fagrae berteroana*
pulu	Indian banyan	*Ficus bengahalensis*
pulu māmoe	Mexican rubber tree	*Castilla elastica*
sogā		*Pipturus argenteus*
talo	taro	*Colocasia esculenta*
taputo'i		*Elattostachys falcata*
tava		*Pometia pinnata*
tī	ti plant	*Cordyline fruticosa*
togo	mangrove	*Bruguiera/Rhizophora*
to'ito'i	scaevola	*Scaevola taccada*
teuila	ginger	*Alpinia purpurata*
'ulu	breadfruit	*Artocarpus altilis*
vae povi	orchid tree	*Bauhinia monandra*
vavae	kapok tree	*Ceiba pentandra*

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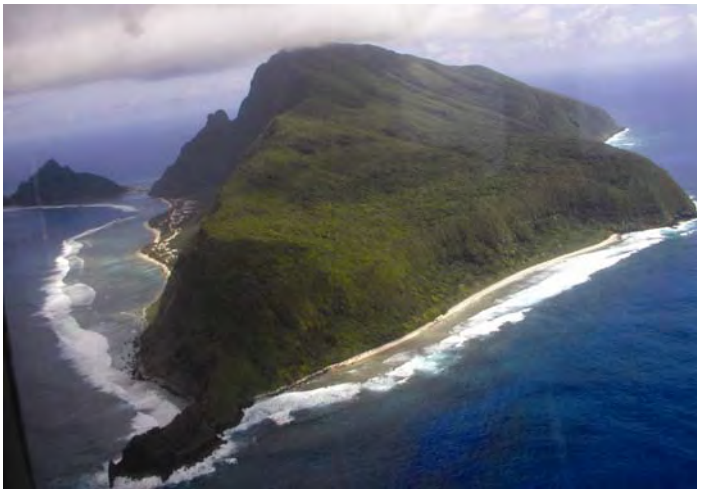
Manu'a and Aunu'u: islands and villages



Olosega Island

Ofu Island

Faleasao, Ta'u Island

Ta'u Village, Ta'u Island

Fitiuta, Ta'u Island

Aunu'u Island

Tafuna area, Tutuila, 2005