

Final Report.

Technical Report 136

INVENTORY AND MONITORING OF SEABIRDS IN  
NATIONAL PARK OF AMERICAN SAMOA

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## Report Summary

This first island-wide inventory and preliminary monitoring of American Samoa seabird populations has produced several significant results. The beginning of a seabird colony catalog has been established in a digital format. The protocol for surveying seabirds around Tutuila Island by boat is described, and future efforts can be compared to baseline results reported here. A detailed survey of the National Park lands around Tutuila is mapped and photographed and seabird distributions found in the 2000 round-island survey and 2003 partial-island survey are discussed. Our results support anecdotal evidence that the inaccessible north shore of Tutuila supports the majority of that island's resident seabirds. Greater than 90% of Red-footed Boobies and Great Frigatebird observations during the Tutuila round-island survey were made in NPSA areas. The north shore areas are important for coastal cliff nesters such as Brown, Black Noddies and Blue Noddies, a species of international significance. Bridled Terns are extending their pan tropical range to include Tutuila, including Park areas. White Terns and White-tailed Tropicbirds are more evenly distributed across forests in Tutuila within as well as outside NPSA areas.

The Ta'u Island unit of the Park provides critical habitat for globally significant populations of Tahiti Petrels, estimated to be in the thousands. A CD audio recording (PCSU Technical Report #131) of Petrel calls has been produced. Petrel DNA material was collected for analysis to test if the Samoan subspecies represents a full species, and it was determined it does not. Rodent trapping on Mt. Lata confirm the presence of invasive Norway Rats that pose a conservation threat for the Petrels, as well as for resident Spotless Crakes, a forest bird not seen on Ta'u since 1986 but found on Mt. Lata during this project. This project did not re-locate Herald's Petrels, Collared Petrels, Polynesian Storm-Petrels or Christmas Shearwaters that have previously been reported from Ta'u. Timing, accessibility, weather, and the presence rats on Mt. Lata may have affected our ability to detect these additional seabird species.

Seabirds should be part of long-term monitoring at NPSA based on the protocols we developed to fit within the current capabilities of on-site NPSA staff and technologies. This flexible approach was to

ensure the National Park can maintain a regular monitoring program on a realistic time schedule given its logistic challenges. The seabird species suggested for continued monitoring in our report have been selected for their relative ease to sample (some as adults in the air, and some as adults and chicks at breeding colonies), and their commonality in areas under NPSA jurisdiction as well as throughout the territory. Other recommendations include building a resources management shelter on Mt. Lata, effective rat control, regular seabird surveys in Park lands of Tutuila and Ta'u, experimenting with ornithological radar and audio recording stations at Ta'u, and updating of the American Samoa seabird colony catalog with GPS coordinates.

## Project Introduction

### **Background**

The purpose of this project was to assess the size and extent of resident seabird populations for the National Park of American Samoa (NPSA). Fieldwork to assess seabird populations and habitat extent within the boundaries of the National Park took place over several seasons, and the results were compared to similar populations and habitats outside the Park. The observations and data included were compiled from December 1999 – September 2003. The project was undertaken by the Pacific Cooperative Studies Unit (PCSU) of the University of Hawai'i and began in December 1999 with the hiring of a PCSU Ecologist at NPSA, Paul O'Connor, who worked on-site with NPSA employees Mino Fialua, Rory West Jr., Joe Aetonu, and NPSA volunteer Tau Papali'i through 2001. In 2001 PCSU contracted with Mark J. Rauzon to continue field visits. With the continued assistance of NPSA employees Mino Fialua, Ryan Monello, and Rory West Jr. and many volunteers in the Park, field research was completed in September 2003.

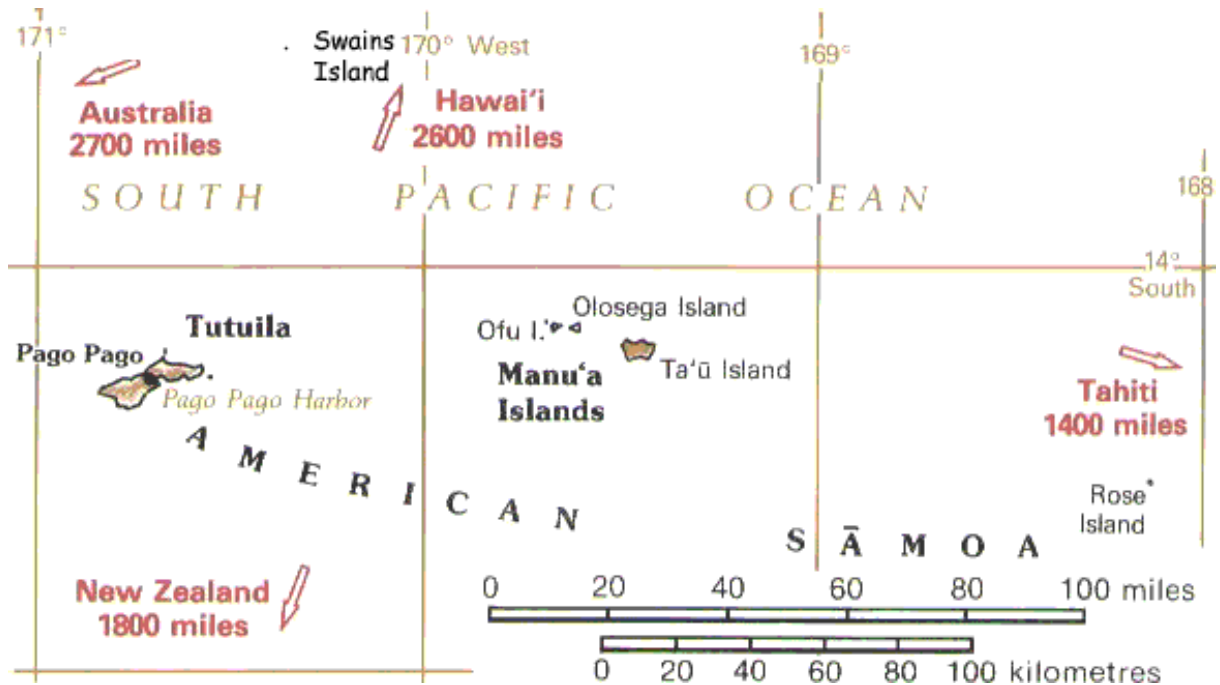




**Figure 1.** Location of Samoa Archipelago in the South Pacific Ocean.

### Study Area

American Samoa lies in the South Central Pacific Ocean (Figure 1) and is the southernmost U.S. possession. American Samoa consists of seven islands in the eastern portion of the Samoan Archipelago (14°S, 168-173°W): Tutuila, Aunu'u, Ofu, Olosega, Ta'u, Swains and Rose (Craig 2002). The National Park of American Samoa (NPSA) encompasses lands and waters of three islands in American Samoa: Tutuila, Ofu and Ta'u (Figure 2), representing the only areas in the U.S. Park Service that protect paleotropical (Old World) ecosystems. The Park is also the only U.S. National Park on leased lands and waters (NPS, 1997). Fifty-year leases have been negotiated under the *matai* (village chief) system of local government, and are an important consideration in conducting research and implementing conservation efforts.



**Figure 2.** Map showing relative arrangement of islands in the U.S. Territory of American Samoa. (Map courtesy of the Pago Pago Dive Club).

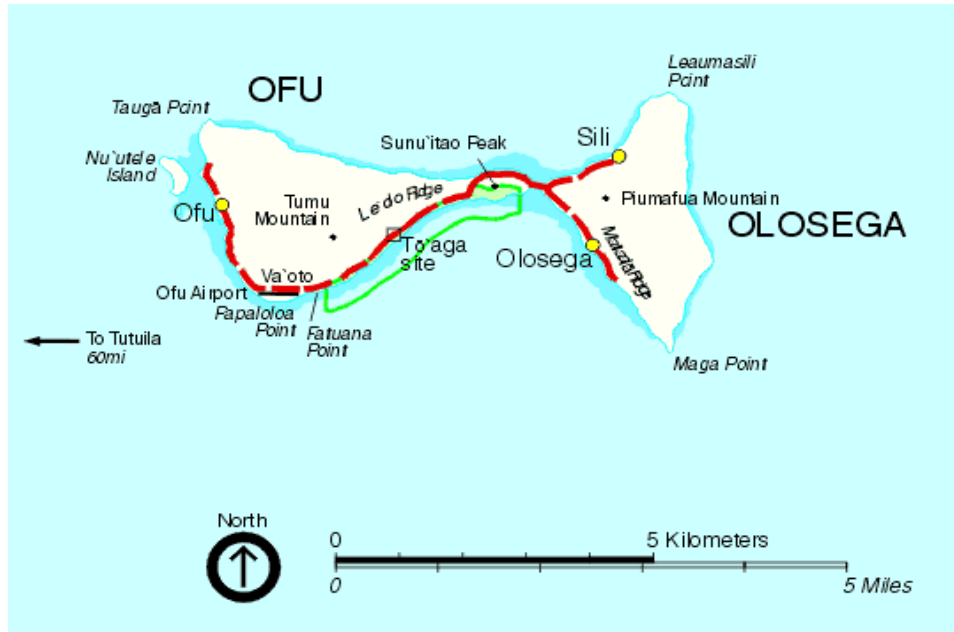
The National Park of American Samoa was authorized in 1988 by Public law 100-571 and established in 1993. The stated purpose of this 50th National Park designated by the United States Congress is “...to preserve and protect tropical rainforest coral reefs and archeological and cultural resources of American Samoa, to preserve the ecological balance of the Samoan tropical forest and to provide for the enjoyment of the unique resources of the Samoan tropical forest by visitors around the world” (NPS, 1997).

The Park’s main unit is on Tutuila Island (Figure 3a), and encompasses approximately 1,000 ha of steep ridges and cliffs, deeply cut stream valleys, paleotropical rainforest, and several isolated small rocks, islets, and associated reefs along the north shore of the island. The other two Park units lie 100 km east in the Manu’a islands group. The Ofu Island Unit (Figure 3b) is the smallest unit in NPSA, consisting mainly of coral reef ecosystem and the accompanying strand of beach and coastal vegetation. The Ta’u Island Unit (Figure 3c) includes a large portion of the island, encompassing 2,160 ha of coastal rainforest, upland and high elevation scrub forests rising from the eastern and southern

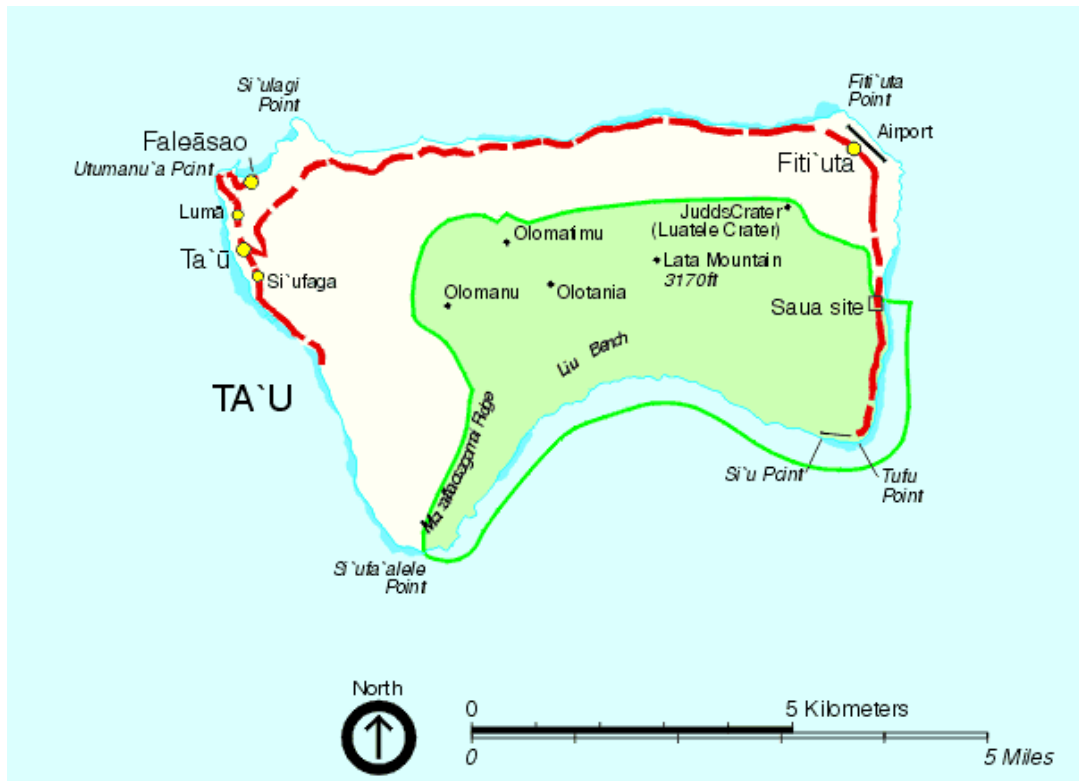
coastlines and reefs, to the Territory's highest elevation at the summit of Mt. Lata (966 m). The most remote and extensive ground nesting-seabird habitat in the Territory is found here (Figure 4).



**Figure 3a.** Map of Tutuila Island with Park unit highlighted. The red line represents the island's main road. (Map courtesy of NPS).



**Figure 3b.** Map of Ofu and Olosega Islands in the Manu'a Group. The Ofu Unit of the National Park is outlined in green. Red lines represent dirt roads. (Map courtesy of NPS).



**Figure 3c.** Map of Ta'u Island in the Manu'a Group. The Ta'u Unit of the National Park is highlighted in green. The red line represents the island's road (Map courtesy of NPS).



**Figure 4.** Liu Bench, Mt. Lata and the south facing cliffs of Ta'u Island Unit. (Photo: P. O'Connor, 2001).



**Figure 5.** View of dense summit scrub from base camp on Mt. Lata summit, Ta'u Island. *Cyrtaandra sp.* in left foreground (Photo: P. O'Connor, 2001).



**Figure 6.** *Clidemia hirta* (Koster's curse), a now widespread invasive melastome on the summit of Mt. Lata, Ta'u. (Photo: P. O'Connor, 2000.)

The summit of Mt. Lata in the Ta'u Island Unit of NPSA is the only high summit in the archipelago under the protection of the National Park Service. Mt. Lata is also of particular importance because as the highest, largest, and most isolated region in American Samoa, it's summit lacks significant human impact. In Polynesian culture, Ta'u Island is often referred to as the cradle of exploration, and in local legend as the home of the Samoan god Tagaloa. Much like today, in the island's earliest human history the summit remained remote and mysterious.

Mt. Lata is a cloud forest where climactic conditions are notably wetter, cooler and windier than elsewhere in the territory. The wet weather maintains an almost bog-like environment, and may be the reason for the predominance of ferns and understory shrubby species (Whistler 1992). The summit scrub is a dense tangle of ferns (*Cyathea spp.* and *Asplenium multifidum*), small trees and shrubs (many endemic to Samoa and the Manu'a Islands in particular;

*Cyrtandra* spp., *Melastoma* spp., and *Psychotria* spp.), and dense thickets of vines (*Freycinetia* spp.) (Figure 5). Epiphytes such as mosses and orchids are also common, as is the invasive melastome shrub, *Clidemia hirta* or Koster's curse, not known from Ta'u prior to 1976 (Figure 6).

## Study Species

The 1997 General Management Plan (GMP) for the National Park of American Samoa described a set of natural resources, and set forth strategies for managing these resources. One of the most significant resources of the Park's coastal and high elevations environments is its resident seabird population. The GMP notes that the Park contains very few complete ranges of native Samoa species, and has the authority to care for only a small portion of wildlife habitat in the Territory<sup>1</sup>. Therefore it is important to know what portion of the resident seabirds breed in the Park versus outside of the Park. Strategies to identify and successfully protect seabird populations and their habitats require determining the baseline population size, first by surveying and then monitoring for changes, and managing land habitat to remain protected and productive. Accordingly we present an overview of Park seabird populations relative to territorial seabird populations in the non-Park areas of American Samoa.

Historical seabird reports list up to 20 resident species in the Territory (Craig 2002). Our work focuses on the dozen or so seabird species most commonly observed and/or breeding in the Park (Table 1), including the nocturnal burrowing species (Family: Procellariidae) currently known only from the highest elevations of Ta'u and Tutuila. Although little known by modern Samoa culture, large and isolated local breeding populations of these ground nesters are globally significant because of their vulnerability to habitat degradation and introduced mammalian predators.

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<sup>1</sup> Paramount for Sulidae in American Samoa, NPSA contains the only known breeding colonies of Red-footed Boobies (*Sula sula*) on Tutuila Island, recognized as the only ones in the territory outside of Rose Atoll.



**Table 1. NPSA Seabird Species Surveyed in This Report**

Samoa Name	Common Name(s)	Abbrev.	Species	Breeding Island*	Colony Nester
tava'e sina	White-tailed Tropicbird	WTTR	<i>Phaethon lepturus</i>	Tu; Of; Ol; Ta; R	n
fua'o	Brown Booby	BRBO	<i>Sula leucogaster</i>	Tu; A; Of; Ol; Ta; R	y
fua'o	Red-footed Booby	RFBO	<i>Sula sula</i>	Tu; R	y
gogo	Brown Noddy	BRNO	<i>Anous stolidus</i>	Tu; A; Of; Ol; Ta; R	y
gogo	Black Noddy	BLNO	<i>Anous minutus</i>	Tu	y
la'ia	Blue Noddy	BGNO	<i>Procelsterna cerulea</i>	Tu; A; Of	n
gogo sina	White Tern	WHTE	<i>Gygis alba</i>	Tu; Of; Ol; Ta; R	n
gogo sina	Gray-backed Tern	GBTE	<i>Sterna lunata</i>	Tu; R	y/n
gogo sina	Bridled Tern	BRTE	<i>Sterna anaethetus</i>	Tu	y/n
atafa	Great Frigatebird	GRFR	<i>Fregata minor</i>	Tu; A; R	y/n
atafa	Lesser Frigatebird	LEFR	<i>Fregata ariel</i>	Tu; A; R	y/n
matu'u	Reef Heron	REHE	<i>Egretta sacra</i>	Tu; A; Of; Ol; Ta; R	y
ta'i'o	Tahiti Petrel	TAPE	<i>Pseudobulweria rostrata</i>	Tu; Ta	y
ta'i'o	Audubon's Shearwater	AUSH	<i>Puffinus l'herminieri</i>	Tu; Ta	y

All seabird species breeding in American Samoa face habitat loss as the human population grows, and invasive plant and animal species continue to spread into previously forested and remote coastal areas of the islands. Humans have been present in Samoa for at least 3,000 years, and have historically used seabirds as a subsistence food resource. Human factors expected to influence modern day seabird status include a locally enforced wildlife-hunting ban imposed by the American Samoa government following a series of destructive cyclones in the late 1980's and early 1990's. Currently, American Samoa culture does not rely on seabirds for food, although occasional seabirds are taken for food and sport, or are accidentally caught during fishing operations. Overall, the current distribution of seabirds reflects past human influences (Steadman 1993). An additional threat is reduction of seabird food resources as technologically advanced fishing methods deplete offshore and reef fish stocks<sup>2</sup>. Most extant seabird colonies and nesting sites in American Samoa are isolated from human populations. Many breeding colonies appear to be in those areas that are also removed from mammalian threats (i.e. on isolated near-shore islets)<sup>3</sup>. Other important breeding areas on the main islands remain, but most are infested with rats and exposed to other introduced mammalian predators.

## Methods

### General Methods

A limited number of bird inventory methodologies and site-specific protocols existed from previous forest bird surveys in areas of American Samoa now encompassed by NPSA. However, there were no established seabird survey methods<sup>4</sup>. This lack of repeatable methodology and an historical absence of specific data collection locations make comparisons with past information difficult. Seabird

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<sup>2</sup> As an initial assessment of seabird resources prior to the development of a monitoring plan for NPSA, this report is limited to discussing onshore threats to seabirds and their breeding areas. The depletion or manipulation of seabird food resources was beyond the scope of this current work, and is in need of additional study. With the closure of the North Pacific to long-liners in late year 2000, more ships can be expected to register for fishing permits in U.S. waters surrounding American Samoa.

<sup>3</sup> Only a handful of these islets are within the current boundaries of NPSA.

<sup>4</sup> The geographic exception to this paucity of seabird data in American Samoa is Rose Atoll. The US Fish and Wildlife Service (USFWS) and the American Samoa Government's Department of Marine and Wildlife Resources (DMWR) have been conducting seabird counts there for + 15 years.

data for the high islands of American Samoa (Tutuila, Ofu, Olosega, and Ta'u) included in this report can only be compared to incidental seabird reports noted during previous forest bird surveys in the territory (See Appendix A). The newly collected data contained herein should therefore serve as the baseline against which future comparisons of seabird populations, using similar sampling protocols, are made.

Some of the 26 seabird species so far reported from American Samoa are colonial nesters in along the coast, on rocky headlands, and on near-shore small islets (e.g. Brown, Black, and Blue Noddies, Gray-backed and Bridled Terns). Others are colonial ground-nesters breeding on cliffs (e.g. Audubon's Shearwaters), or in underground colonies burrowed among tree roots in the thickly vegetated rainforest and in the montane scrub forests (e.g. Tahiti Petrels). The remaining resident seabird species nest scattered in shrubs and trees throughout lowland and mid-elevation forests (e.g. White-tailed Tropicbirds, White Terns and Great Frigatebirds and Red-footed Boobies). All of these species presented particular difficulties for census, and determining reliable population estimates and breeding schedules. Variety in their habits and habitats required a variety of methods to assess their populations.

The geography of Samoa also necessitated a unique approach to this work, in the sense that seabird surveys from boats have not been done in similar environments in the tropics. Seabird surveys in the tropics usually take place on flat islands, and not steep-sided cliffs as are common to American Samoa. Accordingly, we developed a methodology that is simple and timely for use in steep coastal areas in the tropics with small boat access.

Data and observations from Rose Atoll included in this report were gathered in a more traditional manner, from on the ground surveys of a low lying coral atoll with obvious seabird nesting locations. O'Connor visited Rose Atoll with Dr. Beth Flint of the USFWS in April 2001.

## Complete Island Surveys

The main focus of our work has been to identify all locations of colonially nesting seabirds on the high islands of American Samoa, both inside and outside current Park boundaries, and outside of breeding time conduct counts. This was accomplished with repeated boat trips to all areas of Tutuila from 1999-2003 and one complete circumnavigation of Ofu and Olosega in 2000<sup>5</sup>, as well as several foot surveys from on-shore coastal vantage points on all four main islands and Rose Atoll<sup>6</sup>. In most cases, the presence of the boat alone was enough to flush birds into flight. During on-shore counts the waving of a white t-shirt in the air was used to similar ends. The data in this report reflect the total distribution of coastal seabird colonies on Tutuila, Ofu and Olosega, and a partial distribution from Ta'u, for 1999-2003.

The baseline survey employed uses water based observation. Because several resident species nest throughout low and upper elevation forests (e.g. Tropicbirds, terns), methods were developed for non-colony, in-flight and resting counts within discrete geographic units of the island of Tutuila. These counts involved a circumnavigation survey focusing on several seabird species in the same effort, and included colony nesting and widespread non-colony nesting seabirds. These counts provide an overall picture of seabird status at a given season, but which may vary throughout the year. We directly compared the seabird resources in the Park with those outside the Park within American Samoa, and also compared our findings with species accounts in the literature from elsewhere in the world.

The shoreline of Tutuila Island was divided into 150 sampling units using the 1989 USGS topographic quad (see Appendix B for site maps). The Park encompassed 21 of these Tutuila units. Aunu'u Island was similarly divided into six sampling units. Each of the

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<sup>5</sup> A complete, but somewhat fated trip as our hired boat sputtered out off the NE coast of Olosega. The tiny boat with owner, 2 volunteer observers and O'Connor drifted for 5 hours to sea. A cell phone call on a phone which had never worked in the Manu'a Islands prior to that call saved the day. A hearty welcome after a rescue tow to Ofu harbor capped what was perhaps the most exciting survey to that point...

<sup>6</sup> Rose Atoll data are maintained by the U.S. Fish and Wildlife Service in Honolulu, Hawai'i (Phone 808.541.1202).

sampling units roughly encompasses approximately a 0.5 km swath of coastline. Boundaries between units were determined using conspicuous natural features. Units were adapted to local geographic features where necessary to ensure proper view of the entire shoreline within each unit. On occasion, larger valleys necessarily were divided among two or more shoreline units, and other features besides obvious shoreline points were used as unit boundaries. Units are numbered sequentially in a clockwise direction around the island, beginning with Unit A1 at Breakers' Point on the east edge of the mouth of Pago Pago Harbor.

The single letter (A-D, H, P, or U) prefacing each unit number quickly identify in which quadrant of the island the unit is found. Letters represent a distinct section of coastline based on directional aspect, and in future work can offer additional association to common offshore feeding areas nearby to these quadrants. The letters A, B, C & D represent the southeast, northeast, northwest, and southwest facing coastlines respectively. The Tutuila Unit of the National Park spans B47 -B-49, omits B-50-51, continues again from B-52 through C-69, and includes P, the four sample units ringing Pola Islet. 'H' prefices sites in Pago Pago Harbor, and 'U' prefices the six sampling units for Aunu'u Island, located just off the SE coast of Tutuila (see Appendix B for complete list of site numbers, locations and boundaries).

To make best use of limited Park personnel resources, the first complete Island survey was a two-person effort. One person was the dedicated observer, and the other person operated the boat while providing back up data and recording bird observations. To make best use of GPS resources available, a second observer should be brought along to take GPS readings at each site while the main surveyor directs the boat operator, determines when to stop and takes digital photographs. If weather permits, counts are completed in a clock-wise progression around Tutuila over the course of five days, with an additional day for Aunu'u.

Counts were made by centering the boat midway between unit boundaries, as distinguished by geographic features on the shoreline (usually seaward extending shoreline points) and just outside the break. Any seabirds in flight or resting within the full

shoreline view of each sampling unit during a five-minute counting interval were recorded as to species and abundance. Birds occurring inland within a unit were counted, as well as birds flying or perching along the shoreline, birds occurring between the boat and shoreline, and birds within 100 m seaward of the boat as long as these birds are within the boundaries of the unit extended offshore. We also counted Reef Herons and Fruit Bats, noting locations of their roosts.

### **Fixed Location Counts**

Our second approach was designed to supplement the round-island counts. Periodic one-hour counts were conducted at specific on-shore locations within NPSA's boundaries on the north shore of Tutuila, and opportunistically on other islands in the territory. One particularly active counting site was established at Amalau Lookout at the Park's roadside interpretive pullout, along the main road to Vatia Village (Figure 7). Specific count sites for an ongoing survey program would include other areas of seabird concentration. Suggested sites based on our observations include the rock beach past Vatia village adjacent to Pola Islet on Tutuila, Maga Point on Olosega, and Cape Matatula, Tutuila.

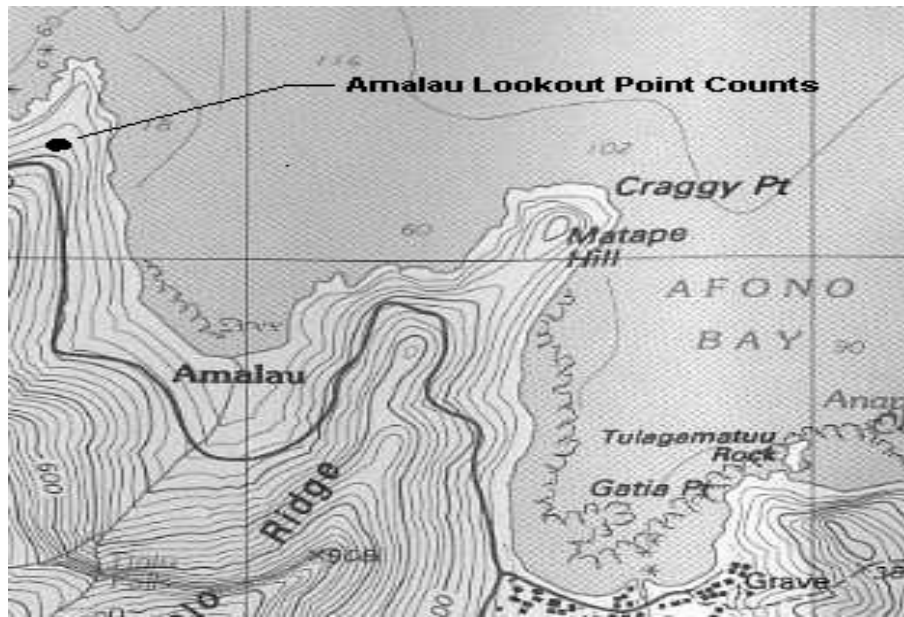


Figure 7. Location of Amalau Lookout point-count site inside the Park unit on Tutuila's north shore.

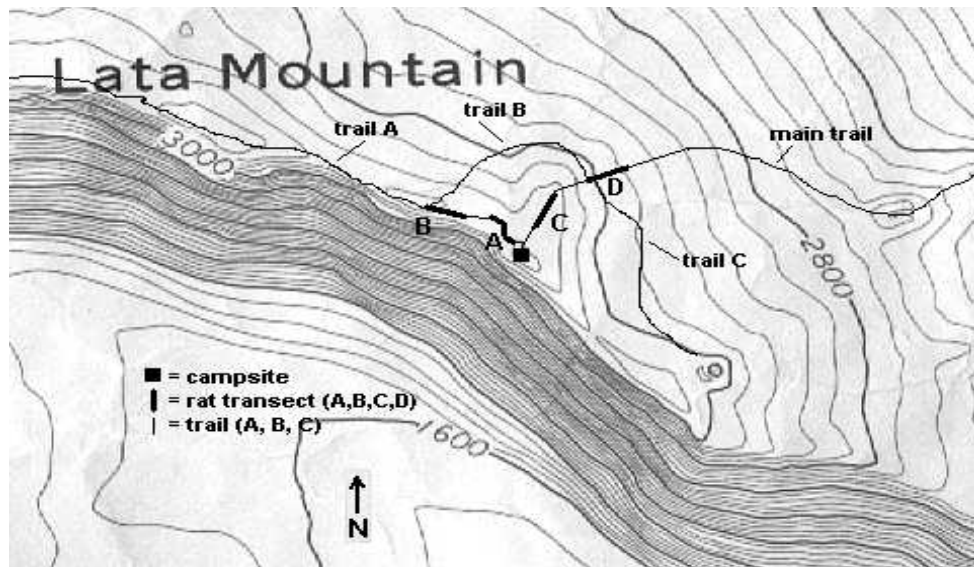


Figure 8. Summit of Ta'u, showing current trail system through Mt. Lata Procellarid colonies.

## High-Elevation Ground and Cliff Nesters

A third focus of our investigations was the Ta'u ground-nesting seabird species. Due to the importance of documenting the unique and important diversity of seabirds, we visited the Ta'u summit on 6 occasions, spending 2-5 days camping per trip. Visits were made on 9-12 Feb. 2000, 26-28 Jun. 2000, 9-11 Jan. 2001, 12-17 July 2001, 2-8 Dec. 2001, and 11-16 Dec. 2002. The primary purposes of these trips were listening and visual counts to determine extent of Tahiti Petrel and Audubon's Shearwater populations, and to ascertain if other species of ground-nesting nocturnal seabirds were present. Tape recordings of Tahiti Petrels were made for further analysis using sonagrams. See Appendix C for details about sound recording results.

The summit trail is an arbitrary path through Petrel habitat (Figure 8). While representative of the habitat, it is limited in scope and cannot be relied upon as the only vantage point for colony estimates of the Ta'u Petrel population. Owing to the dense vegetation and large scale of the summit environment, it is very difficult to render a population estimate. In order to estimate ground-nesting bird density and diversity, we walked the summit track of Mt. Lata after 1800 hrs. playing a recording of Tahiti Petrel calls made in the mountains of Moorea (Society Is.) in 1973 or 1974 by Dr. Jean-Claude Thibault. Tapes were provided by New Zealand seabird researchers Brian Bell and Les MacPherson. Equipment used included an inexpensive Sony tape player, and a professional Marantz PMD-222 tape recorder using Sony Hi-Bias 60 minute tapes. Calls were recorded using a Tesinga microphone with a Stith parabolic dish for amplification. The Kay Elemetrics DSP Sonagraph Model 5500 was used to analyze the tapes by creating sonagrams. The gender of the taped bird appeared to be a male, judging from the responses of some Ta'u birds to hearing it. On one occasion after hearing a taped call, a Petrel emerged from its burrow, sat on a prominent rock, and vigorously flapped its wings three times while calling. On another occasion, a bird was lured to within a few feet of the tape player before giving its call. These birds are presumed to be males acting to defend their territory from interlopers. We also found some birds were attracted to the tape that sat in the trail without calling, and we assumed these to be females.



Birds that responded to the played tape by walking into the trail, or were pulled from the vegetation following their response call, were measured for morphometric data. We placed captured individuals into a nylon holding bag and weighed them with a 500 gram Pesola scale. We measured beaks and legs using calipers, and collected two breast feathers from each bird for DNA sampling. Feather parasites were also collected (See Appendix D for details on parasite collection). Feathers were placed in separate envelopes for future analysis. Feathers were collected from 12 birds in total. Handled birds were examined for brood patches and rat bites before being photographed and released into burrows. GPS recordings of calling birds on the ground, feather sampling sites, and trail landmarks were made (Figure 9).

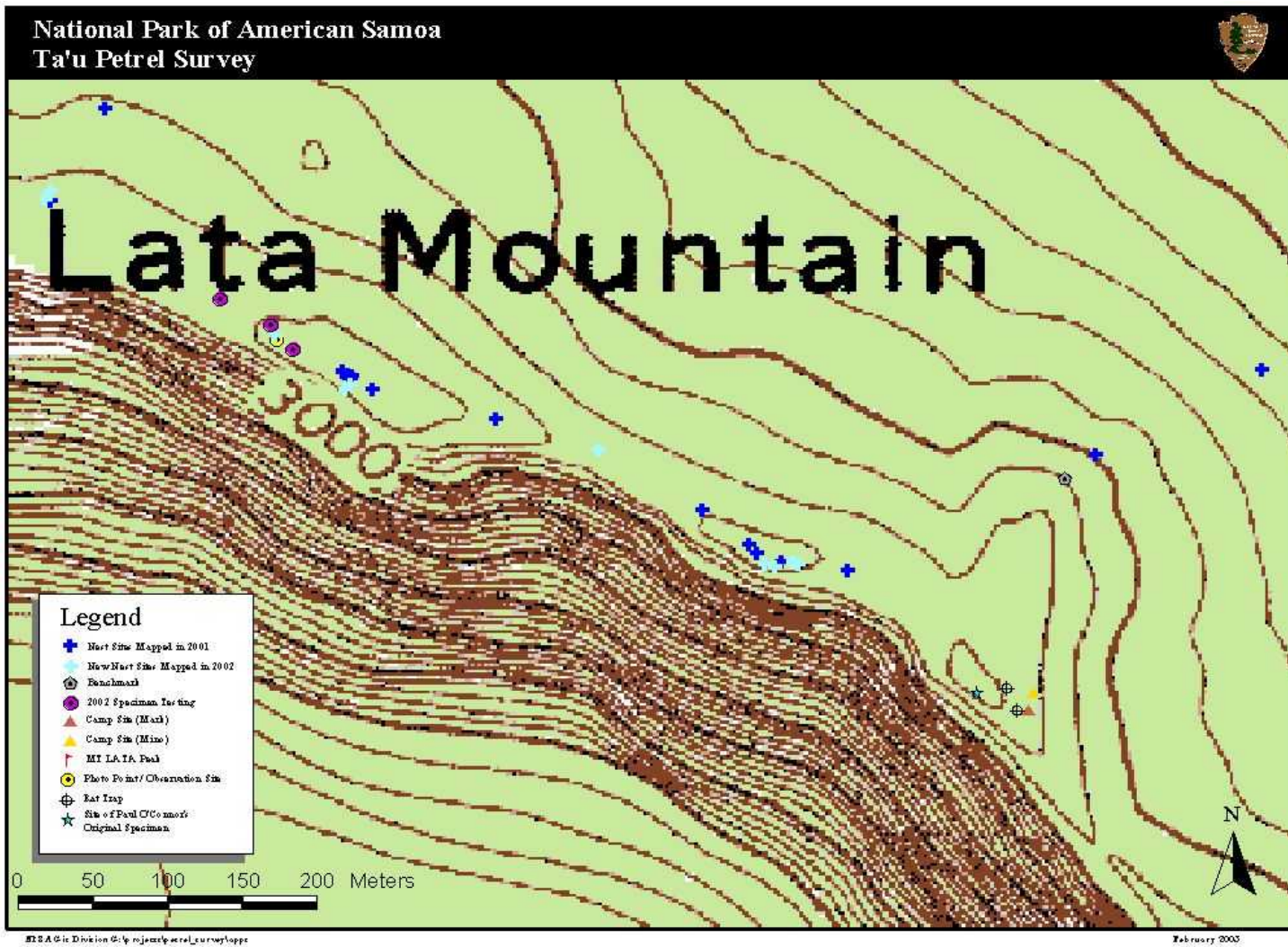


Figure 9. GPS recording locations from Ta'u summit.

## **Results and Discussion**

### **General Results and Discussion**

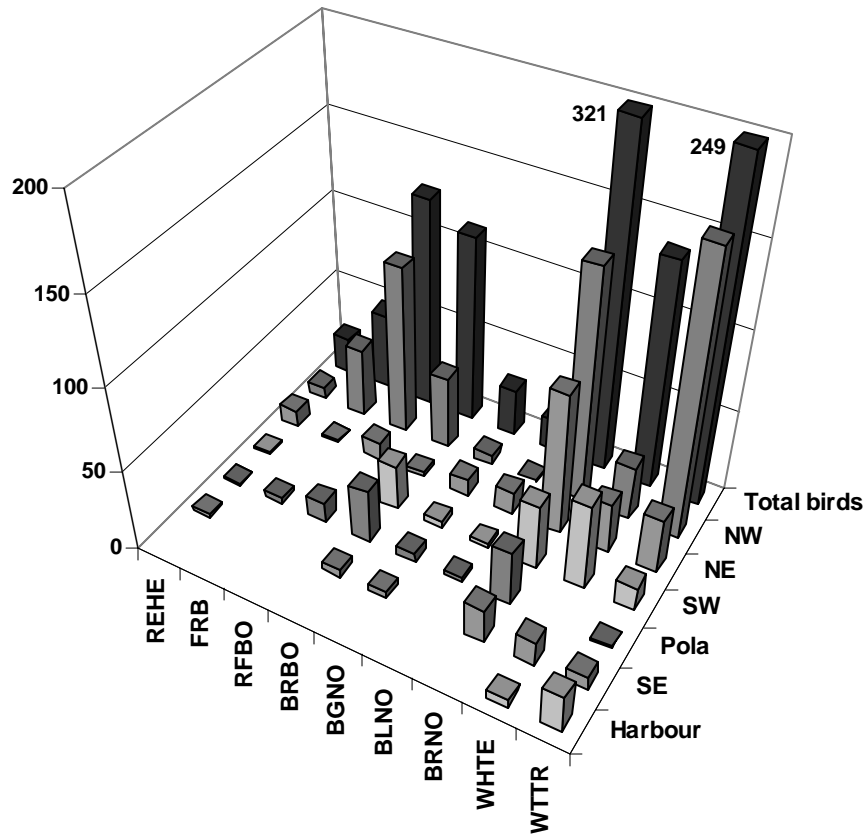
For further results of our findings by species, including discussion of our findings of general American Samoa and seabird populations relative to species findings both regionally and worldwide, see Appendix A. This appendix also includes rare, and new observations for the Park and America Samoa made during this project.

### **Complete Island Surveys**

The first circumnavigation survey of Tutuila and Aunu'u was made from 13-21 July 2000, by Paul O'Connor and Rory West Jr. The second survey was made from Aug-27-Sept. 4, 2003 by Mark Rauzon, Rory West Jr. Ryan Monello and Mino Fialua. Several additional less formal circumnavigations were made throughout 1999-2002 to supplement the formal seabird surveys. Survey data and selected trip reports from the 1999-2003 period are described here and in Appendices for several purposes. As Part I of the NPSA statement for surveying and monitoring seabirds at the National Park, they are intended to serve as a baseline for future NPSA monitoring. Because data were collected in a manner consistent to this goal, analyses are minimal and consist of simple data reduction and descriptive statistics. Now that large scale surveys have been made, future survey efforts can focus specifically on the study units lying within NPSA to ascertain bird numbers at different times of the day and year.

By examining seabird occurrences in relation to the geographic features of the Tutuila coastline, we can better understand the impact of Park protection in relation to the island as a whole (Figures 10, 11a-g). Park lands were represented within 21 of the 150 survey units, for an approximate total of 14% of the study units and 11% of the Tutuila coastline. This relatively small area contained 42% of the seabirds counted, while the remaining 86% of the study units, or 88% of the Tutuila shoreline contained 58% of counted seabirds (Table 2).

### Tutuila Round-Island Survey Results, July 2000



**Figure 10.** Side by side comparison of seabird totals observed by species and geographic area during July 2000 complete Round Island Survey of Tutuila Island, American Samoa. Numbers of individuals observed are on the y-axis; species are on the x-axis; and quadrants of island coastline where the sightings took place are on the z-axis. The final column on the z-axis represents total birds by species for the entire coastline during the week-long survey. Counts are best viewed as a relative measure of seabird abundance along the Tutuila coastline.

Figures 11a-g (below). From July 2000 complete Round Island Survey, percentage of sampling units in each Tutuila and Aunu'u coastline quadrant containing seabirds, by species. Varying degrees of ruggedness in the coastlines of each section of the island resulted in slightly uneven numbers of sampling units between quadrants.

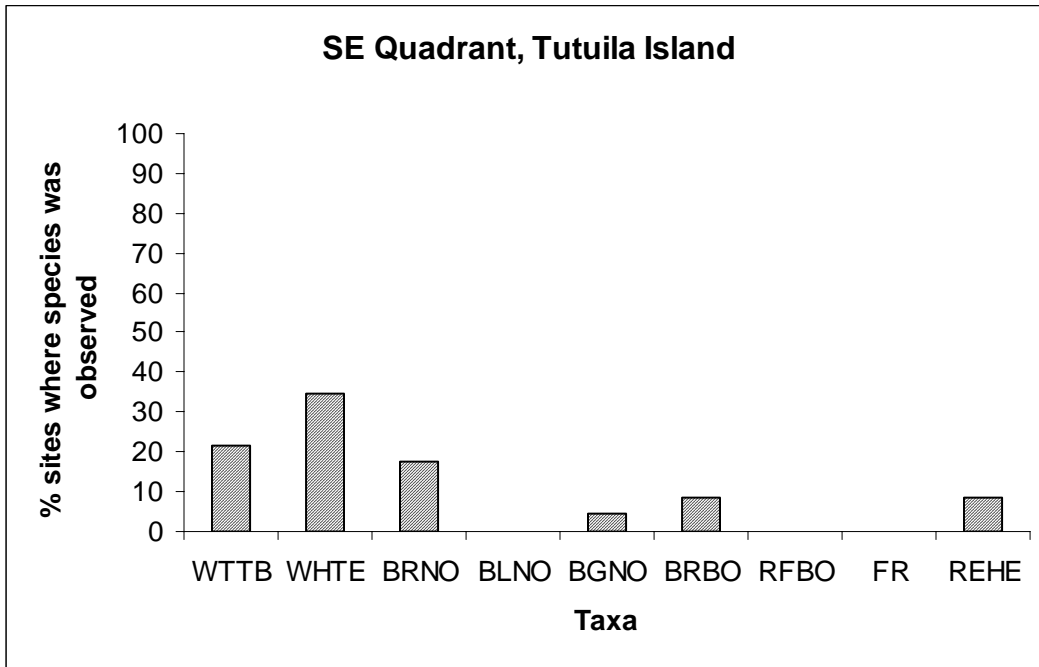
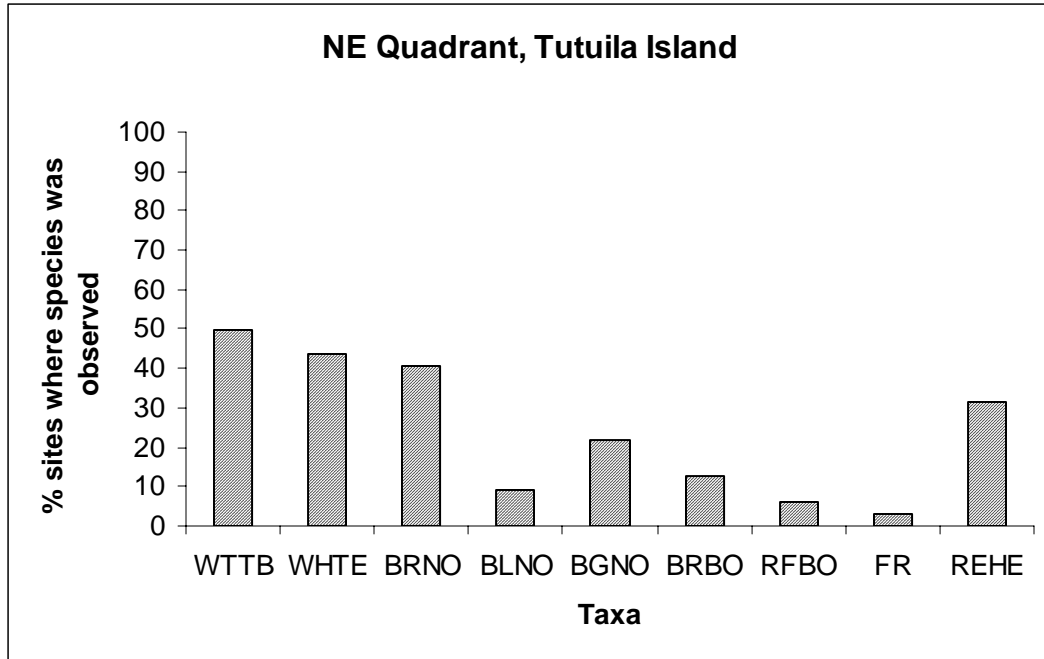
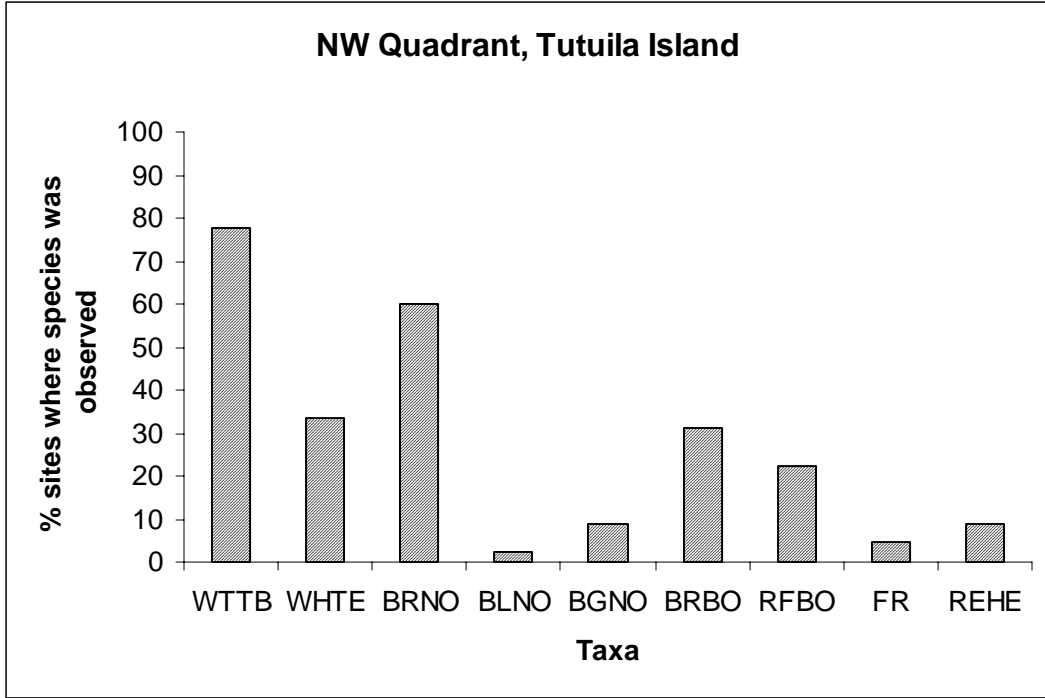


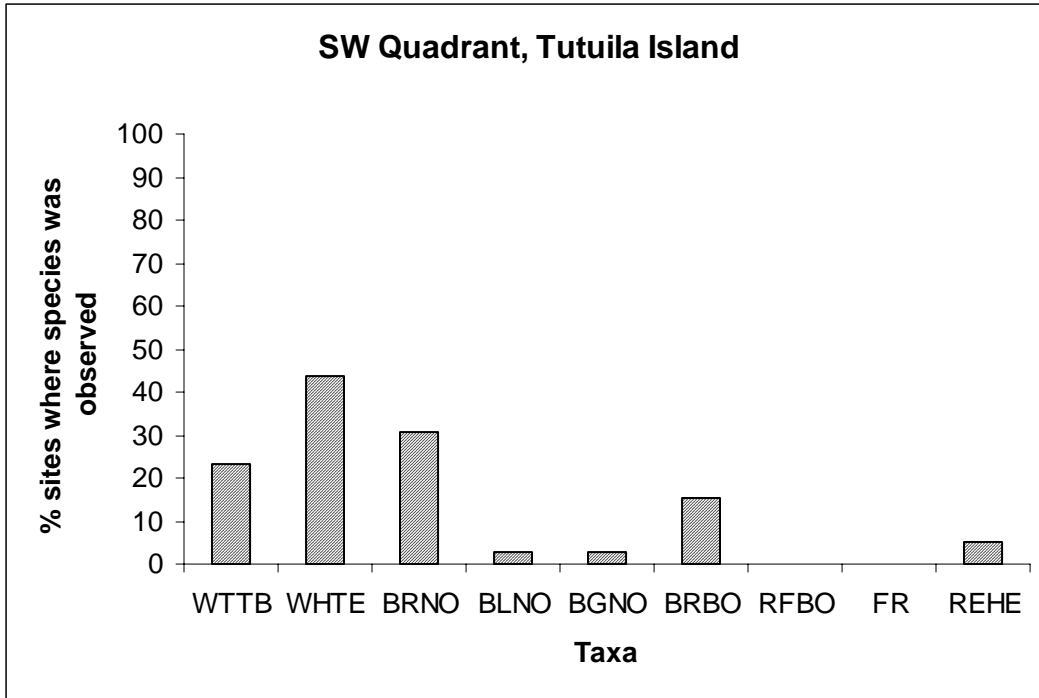
Figure 11a. Percentage of sampling units in SE coastline quadrant of Tutuila which contained at least one individual of the species noted. The SE quadrant is made up of 23 sampling units (A1 - A23) encompassing the southern and eastern coastlines of Tutuila from Breaker's point at the mouth of Pago Pago Harbor to Cape Matatula.



**Figure 11b.** Percentage of sampling units in NE coastline quadrant of Tutuila which contained at least one individual of the species noted. The NE quadrant is made up of 29 sampling units (B24 – B52) encompassing the eastern half of the north shore from Cape Matatula to Pola Islet.

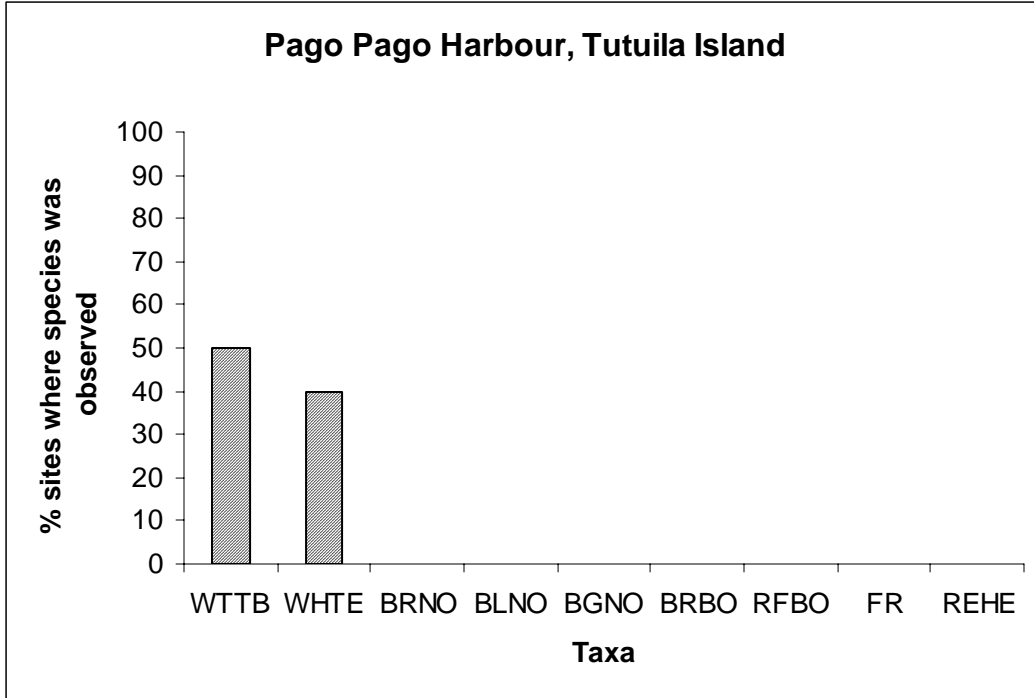


**Figure 11c.** Percentage of sampling units in NW coastline quadrant of Tutuila which contained at least one individual of the species noted. The NW quadrant is made up of 45 sampling units (C57 – C101) encompassing the western half of the north shore from Pola Islet to Cape Taputapu.

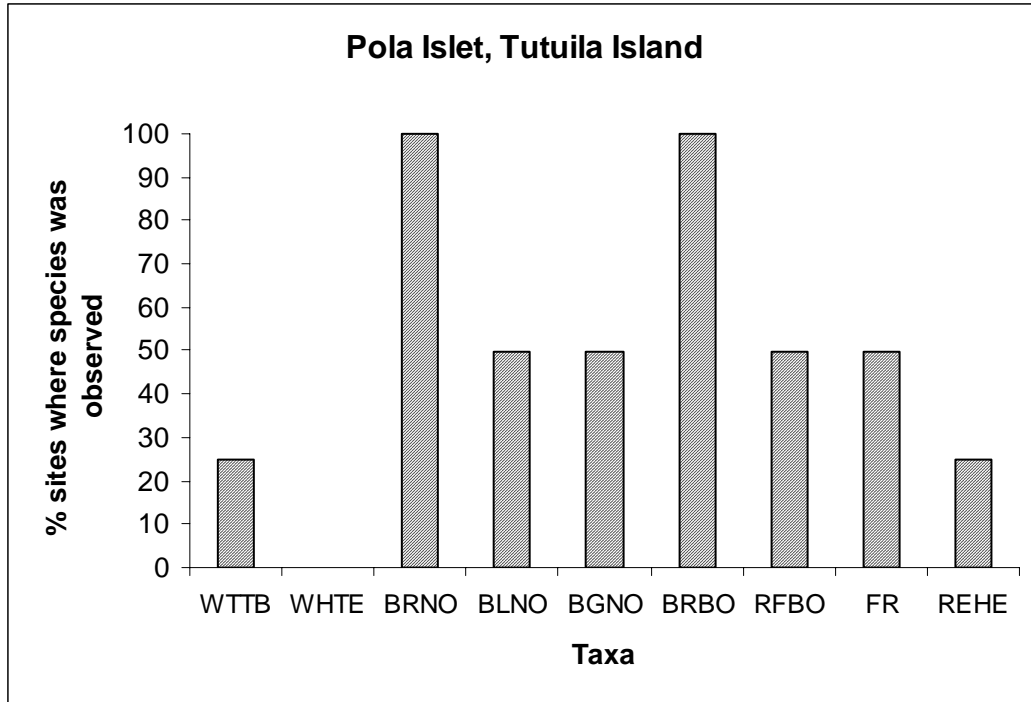


**Figure 11d.** Percentage of sampling units in SW coastline quadrant of Tutuila which contained at least one individual of the species noted. The SW quadrant is made up of 40 sampling units (D102 – D140) encompassing the western half of the south shore from Cape Taputapu to the mouth of Pago Pago Harbor.

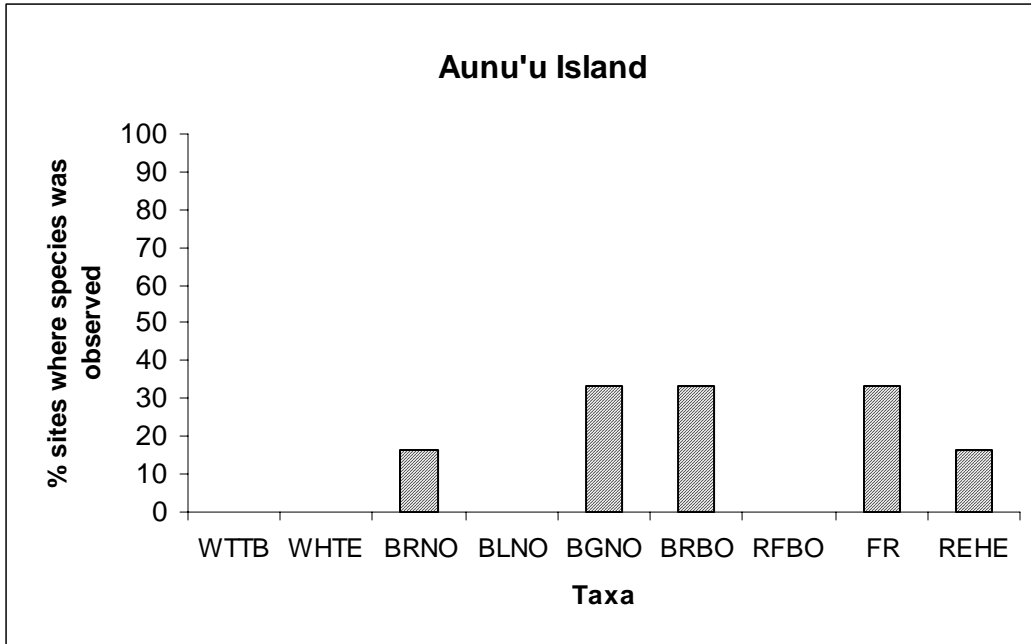




**Figure 11e.** Percentage of sampling units in Pago Pago Harbor section of Tutuila coastline which contained at least one individual of the species noted. The Harbor section is made up of 10 sampling units (H141 - H150).



**Figure 11f.** Percentage of sampling units at Pola Islet section of Tutuila coastline which contained at least one individual of the species noted. The Pola Islet section is made up of 4 sampling units (P53 – P56) with the east and west faces of the Pola equally divided.



**Figure 11g.** Percentage of sampling units on Aunu'u Island coastline which contained at least one individual of the species noted. Aunu'u is divided into 6 sampling units (U151 - U156).

**Table 2.** Summary of July 2000 and September 2003 Tutuila Island Surveys, Comparing Seabirds Sighted in Park and non-Park Sampling Units

LOCALE / DATE	BIRDS	WTTB	WHITE	BRNO	BLNO	BGNO	BRBO	RFBO	GRFR	TOTAL
Park 2000	# sighted	75	30	123	5	9	57	126	46	414
	% of species	18%	7%	30%	0	2%	14%	30%	11%	100%
	% of total	30%	22%	38%	25%	31%	50%	99%	98%	
Non-Park 2000	# sighted	174	107	198	15	20	57	1	1	573
	% of species	30%	19%	35%	3%	3%	10%	.01	.01%	100%
	% of total	70%	78%	62%	75%	69%	50%	1%	2%	
Park 2003	# sighted	66	49	378	0	40	26	221	178	958
	% of species	7%	5%	39%	0	4%	3%	23%	19%	100%
	% of total	45%	13%	43%	0	53%	41%	70%	99%	
Non-Park 2003*	# sighted	80	323	494	5	36	38	95	2	1073
	% of species	7%	30%	46%	0.5%	3%	4%	9%	0.5%	100%
	% of total	55%	87%	57%	100%	47%	59%	30%	0.1%	
Total Jul 2000		249	137	321	20	29	114	127	47	987
Total Sep 2003*		146	372	872	5	76	64	316	180	2059*
* not including D quadrant										

The dominant feature of Tutuila's south shore is the main road, whereas along the north shore forests stretch mostly uninterrupted from seacoast to summit. The north shore is subject to less boat and airplane traffic than the south shore with its large harbor, and is dominated by cliffs, rocky points and offshore islets which are often unaffected by introduced mammalian predators. As evidenced from our complete round-island surveys, regular circumnavigations, and colony visits couple with regular anecdotal information gathered from local residents, seabird concentrations are indeed to be found mainly in the remote, unpopulated areas of Tutuila which are labeled in this study as the NE, NW, and Pola Islet quadrants. However, notable exceptions exist and should be recognized by all parties involved in seabird protection and monitoring in Samoa.

The south shore does have remote features scattered along its length. In these areas, seabird concentrations are found, with largest concentrations on the capes at the eastern (Cape Matatula) and western (Cape Taputapu) ends of the island. If each Cape were analyzed as a single geographic unit, rather than split between quadrants as analyzed in this report, data would more strongly reveal their importance for Tutuila breeding seabird populations despite both areas being outside of NPSA. Both Cape Matatula and Cape Taputapu have special federal designation, but neither has the potential to be protectively managed as closely as NPSA areas have within the National Park Service, or Fagatele Bay National Marine Wildlife Sanctuary has within NOAA. Cape Matatula does have a NOAA meteorological station on site.

The distinct physical features of the Capes also appear to act as directional signals for birds navigating to offshore feeding areas from their breeding locations elsewhere along the north shore. O'Connor observed at dusk year-round, Brown and Red-footed Boobies passing directly over these features on their return flights to colonies from the open ocean. Similarly, in the interior of Tutuila at Rainmaker Pass over which the road from Pago Harbor to Afono village travels, was found to be another important flyway for boobies returning to their Pola and Pola'uta ridge breeding colonies at dusk. On most occasions O'Connor surveyed from December 1999 to December 2000, dozens of boobies were counted in the space of 45 minutes or less coming from the Harbor mouth, passing around

the western face of Pioa and continuing over the pass towards the Pola area and into Park lands. At the same time, often 200 or more native fruit bats (*Pteropterus spp.*) would be observed heading in the opposite direction along Pioa mountain.

Additionally along the south shore, Larsen's and Fagatele Bays offer remote rocky shorelines sheltered from the open ocean. Fatu Rock, just west of the entrance to Pago Pago Harbor and within one of the most heavily trafficked areas of the island, hosts the only Reef Heron rookery we could locate along the south coast of Tutuila, as well as provides nesting sites for 2-3 breeding pairs of Blue Noddies. Such small isolated rocky features offer the overwhelming majority of seabird breeding habitats for the SW and SE quadrants of the surveys (see maps in Appendix B). Tree nesters such as White Terns and White-tailed Tropicbirds are noted from sampling units in all quadrants of Tutuila, and appear to find the south facing slopes suitable for nesting habitat. At present, concentrated human settlements along the south coast rarely exist more than a few dozen meters upslope of the main road.

While the north shore provides a majority of critical breeding habitats for coastal colony nesting seabirds on Tutuila, large mixed-species seabird flocks are easily noted feeding offshore of all geographical aspects of Tutuila, including the heavily impacted south shore. From Coconut Point, flocks of hundreds of BRNO can be observed gathering high in the sky most evenings before flying en masse over the western flanks of Mt. Matafao, likely returning to colonies on the north shore. White Terns and White-tailed Tropicbirds were the main species noted in any number in Pago Pago Harbor during the daytime counts, however, Red-footed Boobies were observed flying over the ridges from their north shore breeding areas to feed at sea. White-tailed Tropicbirds and White Terns are probably still commonly found in Pago Pago Harbor due to the steep forested slopes of the volcanic ridge that envelopes the harbor, and also because, consistent with findings worldwide, WHITE are known to do well in areas of heavy human concentration.

Because the Tutuila Unit of NPSA focuses on the north shore the Park includes important coastal seabird breeding habitats, particularly for RFBO, GRFR and LEFR, GBTE (and now BRTE), and

also BRBO to a slightly lesser extent. Respectively, ninety-nine and ninety-eight percent of Red-footed Boobies and Great Frigatebirds sighted on the Round Island survey in 2000 were observed along NPSA shorelines, even though the Park unit accounts for only 11% of the island's total coastal area. In 2003, perhaps because sampling was conducted at a different time of day than the 2000 survey was conducted at, more RFBO were seen outside of the Park, flying to and from 'the Pola' (Pola Islet), likely enroute to pelagic feeding areas.

Pola Islet is the most significant geographical feature on the north shore of Tutuila, and is known presently and historically as a key seabird breeding locale. The only known breeding colonies of Red-footed Boobies in the territory outside of Rose Atoll are located here, and nearby to the west on Pola'uta Ridge. Great Frigatebirds may nest on top of the Pola, although we were unable to do an on the ground survey there. Boat access is difficult if not impossible given consistently rough water conditions and regular presence of sharks. Vatia villagers have accessed the islet in the past, as evidenced by the planting of coconut trees on top. O'Connor observed on many occasions year-round more than 60 Frigatebirds in flight at a single time over the Pola, including Lesser Frigatebirds, and all age classes of both species. The Pola is where most of our north-shore sightings of Gray-backed and Bridled Terns took place, although the waters within and near to Fagatele Bay on the south shore (SW quadrant) revealed similar numbers of Gray-backed Terns when O'Connor surveyed there in 2001.

Varying the surveys seasonally between years can determine seabird breeding phenologies. For example, surveys in September failed to locate any Gray-backed and Bridled Terns in the north coast area; nor did they appear on the July surveys undertaken by O'Connor. But during a shorter boat reconnaissance in December, about 50 were present and appeared to be breeding, (See notes on those species). September appeared to be a non-breeding period for boobies and noddies, yet they were resident, and not migratory as the terns appear to be. While some individuals of tropical seabird species breed year-round, during this season (which season?) some male Frigatebirds were seen displaying, Red-footed Boobies were

gathering nesting material and one Brown Booby pair had a very large chick.

Future surveys should focus on Park lands and should attempt to survey as early in the day as possible, before birds disperse. Boobies return to the roost at sunset and disperse at daybreak so the earlier surveys are done, the more birds may be counted in their breeding locale. This may in fact be the reason more boobies were counted in 2003 than in 2000 since we counted dispersing birds in the morning. An effort to camp on the beach near the Pola would likely be instructive since night roosting birds may be seen, as well as night calling birds heard.

A complete, detailed circumnavigation survey of the Tutuila coastline can be done by boat either annually, or dependant on park priorities, every two to five years on a fixed interval. These surveys (for Tutuila, taking approximately one week to complete, for Aunu'u, and Ofu and Olosega, less than one day each, and for Ta'u, expectedly 2 days) should continue to be conducted as often as possible around Tutuila and Aunu'u, and for the near future once every five years in the Manu'a Group<sup>7</sup>

### **Fixed Location Counts**

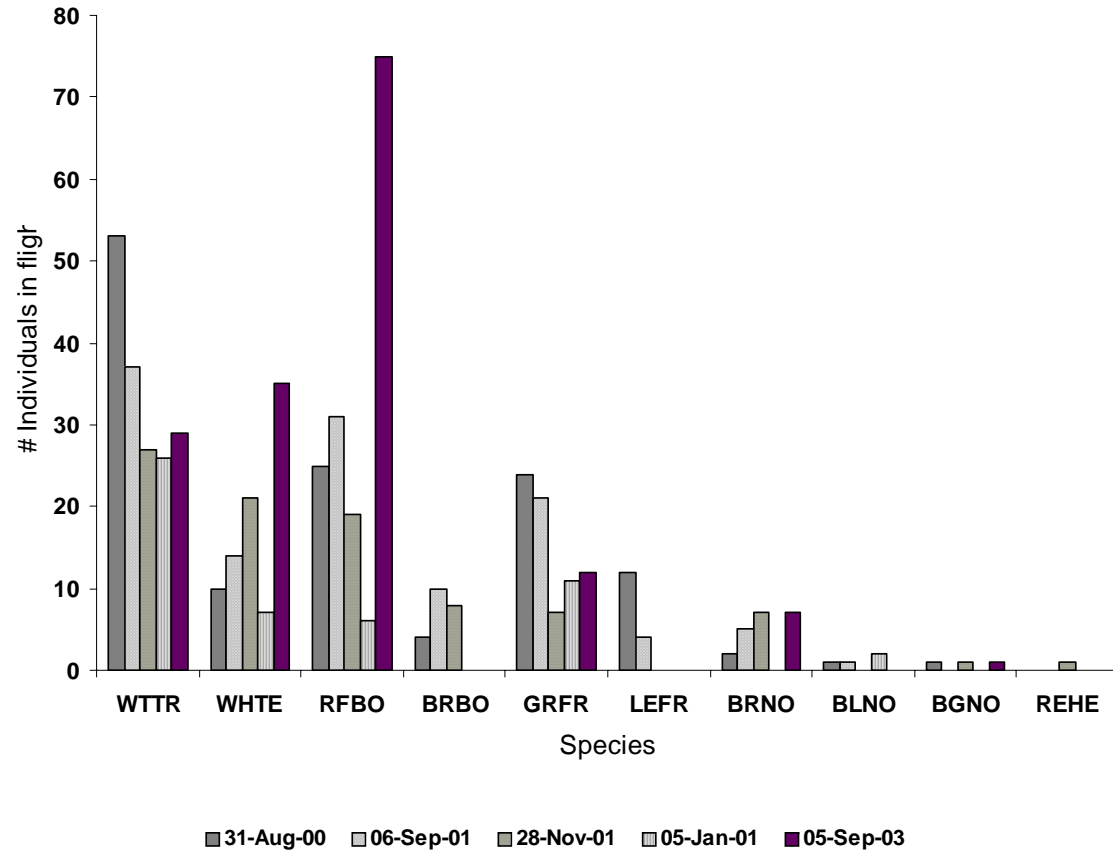
The information gained from fixed location counts include relative abundance and species diversity of the seabird resource. Some degree of seasonality may be indicated by differences in species abundances recorded. The disadvantage of this type of survey is that few specific observations can be determined about seabird densities. The view shed from certain vantage points is subject to many environmental variables: tree growth obscuring view, unknown limits of survey area, wind direction, recounting flyovers. However, counts displayed in Figure 10 suggest a change in Booby numbers. We counted more of Red-footed Boobies, both at the lookout and in the coastline survey in 2003 than in 2000. The previous high count at Amalau was 38, verses in 75 counted in September 2003. Because these surveys were done at the same time

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<sup>7</sup> The suggestion for sampling every 5 yrs. is based on the current staffing and field capabilities of NPSA in the Manu'a group. If a Park boat becomes available in Manu'a sampling can be conducted on an annual basis. Ofu, Olosega and Ta'u are small enough to be surveyed in a single day each.



of morning, after most boobies have dispersed for the day, it provides a standardization not seen in the boat counts, and may be indicative of a real trend.



**Figure 12.** Amalau Lookout results for 60 minute, in-flight seabird point counts conducted from 1000-1100 hrs. (Note Jan. -01 count was only 15 min in length).

## Seabird Colonies

### Coastal breeders

All coastal breeding colonies of diurnal seabirds were located, noted, and visited on repeated boat trips around Tutuila (Figure 11; GPS data are deposited with NPSA, See Appendix H for current maps). Coastal colonies on Ofu and Olosega were observed and recorded from a single round island trip, and confirmed with repeated overland visits. No boat trips were could be arranged for Ta'u during the project, but should be a priority for continued documentation of seabird resources by NPSA. Land based observations suggest relatively heavy use of the coastal strand forest on the east coast of Ta'u within NPSA boundaries, from the Sau'a archeological site to Siu Point, by several seabird species. However, no large colonies of Black Noddies noted in previous years were found.



**Figure 13.** Relative locations of Tutuila coastal seabird colonies. Highest concentration of colonies appears to be within NPSA jurisdiction, however there are significant seabird nesting

concentrations elsewhere on the island and on Aunu'u, in areas with few human settlements. Abbreviations are as follows: BB = Brown Booby, RFB = Red-footed Booby, BN = Brown Noddy, BGN = Blue Noddy, RH = Reef Heron, GBT = Gray-backed Tern, GFB = Great Frigatebird. (Base map outline courtesy of NPS).

## High Elevation Ground and Cliff Nesters

### Species Present

At the summit of Mt. Lata on Ta'u, we confirmed large colonies for several Procellarid species, both on cliffs and in heavily vegetated plateau areas. On most of our research trips, during our listening counts from the vicinity of the summit we could hear perhaps as many 200 birds calling from adjacent lower elevations.

Approximately five miles of summit rim exists, and Petrels are likely distributed along most of its length, as well as on Olotania Crater (Figure 14) and on the south-facing cliff-side of the mountain (Figure 15). Relatively smaller colonies of similar ground nesting species were documented in scattered locations on Tutuila (< 3 areas) where small numbers of Procellarid seabirds should be breeding. No colonies were noted during trips to the summits of Ofu and Olosega, although historical reports have recorded Procellarid calls from the cliffs of Mount Piumafua on Olosega (Engbring and Ramsey 1989).



**Figure 14.** Olotania Crater from main trail on summit of Mt Lata, Ta'u. (Photo P. O'Connor, 2001)



**Figure 15.** South facing cliffs directly below summit base camp, Mt. Lata, Ta'u. Audubon Shearwater calls were common in from these areas. (Photo: P. O'Connor, 2001)

At the summit of Mt. Lata on Ta'u, Petrels were nesting in the area along the summit trail and at the small lava peaks near the trail's end (see Figure 8). However, numbers sighted and heard varied greatly, even among consecutive nights during a single summit trip. Weather can, and did, vary wildly on the summit, and thus affect observers abilities among trips.

On the 9-11 January 2001 Mt. Lata trip, the main activity of adult Petrel returns to the breeding colonies was relatively late, beginning in earnest around 0000 hrs, and continuing until 0200 hrs. We believed their arrival could have been delayed by a full moon that illuminated the notably clear summit on these nights. The eve of January 10th was the clearest, and approximately 50 birds per hour were seen amongst the blowing light mists passing over the main summit track to the research camp.

The following is described from field notes for 9 January:  
...calls began as early as 1500 hrs and continued for more than 90 minutes, in low numbers (1-6 distinct calls), and were believed to be chicks in burrows. These early calls were all coming from locations on the top of the summit ridge extending west from the summit camp, and reaching us from a distance of up to one kilometer. The

remarkably clear weather made this the easiest of all the summit trips to distinguish the overall areas where calls were coming from. At 1823 a Tahiti Petrel adult, very distinct and large, flew directly at O'Connor. At 1830 'scree-whistles' began increasing in number, until by 2100 dozens of Tahiti and Kermedec Petrel-like calls could be distinguished. Some calls were distinctive from those of Tahiti Petrel adults, consisting of a simple single note screech, increasing in pitch and intensity, with no change upon ending, suggesting a Kermedec Petrel screech. By around 1930 calls more typical of the Tahiti Petrel were heard, with a rising 'peurrr', but lacking a final 'up-note'. Beginning at approximately 0530, dozens to 100 - 200 calls of Audubon's Shearwaters could be heard from the cliff faces directly below our summit camp, and one Audubon's Shearwater was seen three times, almost hitting our tent on two occasions. Also important to note was a very white speckled, smaller Procellarid that passed through camp at 0600 on 9 January. The bird was notably smaller than the Tahiti Petrel.

On most of our summit trips, Petrels began calling about one half-hour after sunset and called actively until around 2200, although some flight calls could be heard all night and into the early morning hours. Densities of calling Petrels on the ground were highest near the summit of Mt. Lata, and below the summit plateau to the west. Densities of shearwater calls were greatest from the cliffs below the summit to the south. Although wet weather conditions were not very suitable for using tape recordings, we sampled most evenings, and depending on the time of year, heard Tahiti Petrel and Audubon's Shearwaters.

O'Connor reported also possibly hearing Wedge-tailed Shearwaters and Phoenix Petrels. Over time, several calls distinct from those of the Tahiti Petrel and Audubon's Shearwater were heard here at the Ta'u breeding colonies, and also at the Tutuila breeding colonies near Pioa (Rainmaker) Pass, and suggest the presence of at least one, if not more, additional resident petrel species. These calls are best described as a shrill warble, increasing in intensity, until dropping off with a 'wet' descending gurgle.

During our visits to Mt. Lata, Tahiti Petrels were recorded using audio, photographic and GPS equipment. Audio recording of their

vocal repertoire were made. See Pacific Cooperative Studies Unit Technical Report 131: "The Tahiti Petrels- Night on Mt. Lata" is available online via (MP3 format) at: <http://www.botany.hawaii.edu/faculty/duffy/131.htm>. With a sound-collecting parabola, we recorded two 60-minute tapes in order to gauge the densities of seabirds in the area. The parabola recordings give another perspective of bird activity in the area below the summit. It is not possible to determine how far down the cliff birds could be heard, although it may have been only 150 ft (this website). A cone of air space several hundred feet long and tens of feet wide was sampled for two evenings. We recorded the flight calls of Tahiti Petrels and noted that the long drawn out calls of birds on the ground are condensed into a swift ascending pitched whistle. This piercing call may be used by birds approaching the nesting area in the dense fog and darkness and may have echo-location qualities. The whistle of the Petrel may travel far and the amphitheater of the cliffs may enhance or echo calls.

In the past, Crossin, (Amerson 1982) reported Tahiti Petrel as an uncommon resident during a May visit, heard from Olotania crater to the summit and beyond, ranging deep into the forest. He noted it was the most common Procellarid, and the number of calling birds indicated that thousands are present. We spent over ten nights on the summit listening and recording Petrel calls. Thousands present is still an appropriate estimate with our 'new' perspective of listening and recording with a parabolic microphone. Roughly based on the known density of calling birds and extensiveness of the potential habitat, several thousand pairs may be present over the Ta'u summit area.

## Nests

We searched for nest sites along our freshly cut summit tracks. Approximately 30 potential nests were located and mapped in 2001, and another 20 were noted in 2002 (see Figures 8 and 9). Along the summit track, the Tahiti Petrel nesting habitat is characterized by hollows dug under a tree root system (Figure 12). It is possible this warren system is created by the activities of Petrel diggings over hundreds of years. Many, if not all, tree tops were damaged in the 1991 hurricane, and this canopy destruction may have contributed



to the present extremely dense undergrowth of vines. Other petrel areas are under very dense tangles of vines and ferns. It is not known if, or where, the Petrels nest on the vast cliffs.

Repeated trips to the summits of Ofu and Olosega by O'Connor did not reveal obvious Procellarid breeding sites. A limited patchwork of sub-vegetative tunnels similar warren systems at the summit of Mt. Lata on Ta'u was noted, suggesting Procellarids may have formerly nested there, or may continue to nest on a seasonal or opportunistic basis. No shell fragments or other bird sign was present. The summits of Ofu (518 m) and Olosega (669 m) are lower than that of Mt. Lata (966 m), and contain large trees and several alien plant species including small but thick groves of bamboo. These paired summits are also areas of prior human habitation, having been important areas for large Samoan populations on the islands prior to Western contact (Kirch 1993). In contrast, the summit of Mt. Lata on Ta'u according to local tradition was never inhabited by humans.



**Figure 16.** Tahiti Petrel burrow underneath summit track, with opening to south-facing cliff, Mt. Lata, January 2001. (Photo: P. O'Connor 2001)

### **Petrel Distributions elsewhere in American Samoa**

Tahiti Petrel calls can be heard numbering in the dozens on Tutuila from December-March at Rainmaker Pass along the road from Pago

Pago Harbor to Afono Village on the north shore. Joe Aetonu (NPSA) also reports hearing calls of Tahiti Petrels at night from the edges of Aloaufou Village in the vicinity of Oloava Crater and Olotele Mountain. Burrows were located in 1986 by Engbring and Ramsey on Tau Mountain, which overlooks Nu'u'uli Village on the Tafuna Plain, the most densely human populated area of Tutuila. Land owners toward the end of the Vaitele stream valley appeared ready to allow access to the Mountain, but trips could not be arranged during the project. A Tahiti Petrel was reported grounded on Tutuila in 1986 (Amerson 1982). Groundings are compiled in the records at DMWR offices. We were informed there are approximately one or two groundings a year, but our requests to include these records here were denied. A fisherman asked if Petrels come aboard their boats when they fish at night along the north shore waters replied that Petrels did not come onboard.

Audubon's Shearwaters were seen and heard calling at the summit of Mt. Lata (Ta'u Island), and Rainmaker Pass (Tutuila Island). They are less common than Tahiti Petrels on Mt. Lata, Ta'u in December, and more prevalent in July. We are not certain if their numbers are changing within the year, or they are relatively more obvious in the absence of the greater density of Petrels. They do not nest on the summit track, but probably on the cliffs below. The 2000' cliff that defines the southern flank of Ta'u Island features large tree ferns, caves and overhangs that provide nesting habitat for shearwaters, Tropicbirds, White Terns, and possibly petrels and Storm-petrels. (see Figure 4).

### **Petrel Collections and Natural History**

Tahiti Petrels may be a relic species of former wider distribution in past epochs (Warham 1992), and the population in Samoa was believed to possibly be distinct from other insular populations. To help substantiate the uniqueness of Tahiti Petrels, we collected feathers to test if genetic isolation has led to sub- or full-speciation. We collected feathers and morphometric measurements from captured birds, and photographed these birds before release (Figure 13). Two calling petrels were caught, measured and weighed in an attempt to link gender and recorded voice profiles. Six measurements of culmen, tarsus and weight were also taken with a

500 g. Pesola scale. Two of the calling birds exceeded the maximum measure of the scale, so exact weights are not available for these possible male birds (See Table 3).

We collected one bird found in a burrow and deposited it with the Smithsonian Institution in Washington, D.C. (Catalogue number USNM 622745). Twelve sets of feathers were collected from live Tahiti Petrels from the Ta'u population for DNA analysis and are held at the Smithsonian Institution. Feather and specimen collection was possible with a letter of permission and a permit for export signed by the U.S. Park Service and the American Samoa Department of Marine and Wildlife Resources (DMWR). The feathers and specimen were hand-carried to Hawai'i. US Customs and USFWS Enforcement were notified. The feathers and rodent voucher specimens entered Hawai'i and were passed to the USFWS in Honolulu, the Bishop Museum, and then to the Smithsonian Institution, care of Dr. Storrs Olson. Ecto-parasites collected from live birds in the Ta'u population were deposited with Dr. Ricardo Palma at Te Papa, National Museum of New Zealand, Wellington. See Appendix D for parasite information.

The feathers were analyzed by the U.S. National Zoo - Genetics Program. "The first set of sequences from the feathers were contaminated." (Carl McIntosh, pers. comm.). Another portion of Cytochrome B was analyzed in early 2003 but sequences were incomplete. By late 2003, Cytochrome B analysis was completed. For complete results on this DNA work contact Carl McIntosh, Smithsonian Institution.



**Figure 17.** Tahiti Petrel captured on Mt. Lata, December 2002.  
(Photo: M. Fialua)

**Table 3.** Data on Handled Tahiti Petrels at Mt. Lata, Ta'u

Bird	Sex*	Mate	Weight (g)	Culmen (cm)	Tarsus (cm)	Collected Date
1	F	2 (?)	445	3.62	5.23	12-09-02
2	M	1 (?)	500+	3.66	5.68	12-09-02
3	F	-	447	3.67	5.27	12-10-02
4	F	-	420	3.44	5.26	12-10-02
5	M	-	500+	3.62	5.14	12-11-02
6	F	-	490	3.38	4.95	12-11-02
7	M	-	350			01-10-01**

\*An assumption based on their demonstrated behavioral responses to call playback.

\*\* Specimen catalogued at Smithsonian Institution as USNM 622745.

Additional Notes for Table 3:

Bird 1 was a challenge to implement procedures on, took several measurements and averaged. Collected feathers 12/09/02.

Bird 2 collected feathers, photographed on 12/09/02.

Bird 3 responded to tape and came into trail, called and was recorded on Tape 1, Side A. Feathers collected 12/10/02.

Bird 4 looked for brood-patch but none found. Caught in trail, responded to tape? Feathers collected 12/10/02, all lack feather odor typical of *Pterodroma*.

Bird 5 brood-patch evident. No feather odor.

Bird 6 caught in trail using parabola, perhaps responding to taped calls. No brood patch found.

Bird 7 Measurements provided by Smithsonian Institution: Male: left testis 3 x 4 mm. testes not enlarged, specimen emaciated, weight 283 g. wing chord 295 mm; wing span 820 mm; culmen 39.1 mm; tarsus 53.4 mm; tail 117 mm; middle toe with claw 57.3 mm; bill depth (through hump and hook) 17.3 mm.

## Rose Atoll Seabirds

For relative comparisons amongst seabird numbers in human populated vs. unpopulated areas in the Territory, we provide seabird estimates from surveys conducted at Rose Atoll.

**Table 4.** Seabird Populations at Rose Atoll NWR, American Samoa

Number of active nests (egg or chick)*		
Species	14 Oct - 5 Nov 1990	12-24 Aug 1998
Red-tailed Tropicbird	12	21
Masked Booby	12	12
Red-footed Booby	420	160
Brown Booby	5	12
Great Frigatebird	11	-
Lesser Frigatebird	29	31
Frigate sp.	-	24
Sooty Tern	~18,000	~67,500
Brown Noddy	7	28
Black Noddy	-	566
White Tern	18	5
Gray-backed Tern	2	3
Total**	18,516	68,362

\*these values represent the number of nests with eggs or chicks in them. To estimate total numbers of birds using the atoll you could multiply number of active nests by 4. This accounts for 2 members of a pair and the numbers of pre-breeding birds typically associated with a seabird colony. Using the larger total (68,362) approximately 273,000 seabirds use Rose Atoll, significantly more than the rest of American Samoa combined.

\*\*includes estimated values of Sooty Tern.

## Conclusions

### **Monitoring, And Its Future at NPSA**

Seabirds hold a unique position in Samoa as indicators not only of their own population health and that of associated marine life, but also of forest integrity, invasive species impacts, and effects of human population expansion and associated habitat loss. Prior to the creation of the Park, there was abundant anecdotal evidence for presence of several seabird species and breeding areas. Due to a lack of reporting and recording communication, and a lack of trained observers, there was no established way to monitor resources or gauge success of conservation goals in the new National Park. This plan helps rectify this insidious deficit.

Regardless of their national protection status, seabirds are essential in long-term monitoring at NPSA, and their monitoring should be based on protocols established with this study. The goals of a monitoring plan are dependent on the species targeted and the need for data (USGS-BRD (Draft), 2000). Because a monitoring plan was recognized as an essential goal during this initial seabird assessment, we developed methods that fit within the current capabilities of on-site NPSA staff and technologies. Given the uncertainties of day-to-day operations and fieldwork in this remote location, it was apparent the best way to develop survey methods was on an adaptive management basis. Our flexible approach was to ensure the National Park could maintain a regular monitoring program on a realistic time schedule given its logistic challenges. Now that monitoring has begun, it is necessary to follow a consistent sampling schedule to reliably measure changes in populations (USGS-BRD-Draft, 2000). Consistency is an important consideration particularly when monitoring highly mobile and seasonal species such as seabirds, and especially when observers are expected to change through time (NPS 1988).

Monitoring results are only as good as the interest and training of the persons conducting the effort. Given the inherent work-load and habitat management demands, seabird monitoring is likely to be a low priority. Annual seabird monitoring does not always occur even in well-known Hawaiian colonies on a regular basis (e.g., Kileaua Pt.

NWR, Kaua'i; Ulupa'u Crater, O'ahu) and we should not expect Samoa to be different. If annual surveys are impossible, we suggest a three- or five- year repeat of surveys to be planned into long-term budgeting.

Efforts to enlist local community college students or volunteers in the Park (local or international) with a special interest in seabirds could be effective in meeting the data needs of the Park. This is particularly true for the stationary counts at Amalau Lookout where minimal travel and effort is needed. We have outlaid and tested two straightforward monitoring strategies, one that tracks specific colonies of seabirds, and one which follows the general status of seabirds in a given area. Repeated surveys from a fixed location (e.g., Amalau Lookout) can be compared even with partial observations. Amalau is a place to train observers, and offers a clear opportunity to monitor booby numbers in the least to see if the increase noted in 2003 continues.

The seabird species suggested for continued monitoring have been selected for their relative ease to sample (some as adults in the air, and some as adults and chicks at breeding colonies), and their commonality in areas under NPSA jurisdiction and throughout the territory. Some coastal colony nesting seabird species in American Samoa appeared to breed year-round (e.g. Red-footed Boobies). Other species (e.g. Brown and Black Noddies), did not have young present at the time of any visit during this project although adult birds were observed using colonies on Tutuila year-round as single individuals and in pairs. Several years of colony visits may be needed before preferred breeding seasons and sampling periods can be accurately determined.

Because many seabird species groups have low reproductive rates, deferred sexual maturity, and high adult survival rates, significant changes in their populations would be expected to incorporate large-scale environmental effects (Croxall and Rothery 1991). These changes can act as signals of both insidious and acute impacts. Any changes in one of the most commonly observed local species may signal a more widespread problem in American Samoa that could also be affecting other seabird and non-seabird species.



Boat surveys of the Manu'a Group (Ofu, Olosega, and Ta'u) should now be conducted using similar techniques. This should be done as soon as possible and in the future once every five years in the Manu'a Group<sup>8</sup>. Logistics and a lack of safe boating options in the Manu'a islands have thus far prevented any comprehensive surveys at sea. Overcoming these barriers is essential to develop a coastal and breeding colony seabird catalog for the Ofu and Ta'u Island Units. An effort to complete the inventory of Park seabirds is needed in order to finalize a colony catalog, and to determine the full status of the rare seabirds of the region.

### **Seabird Population Status**

The majority of seabird populations and seabird habitats is legally protected in American Samoa. Various U.S. Federal jurisdictions including NPSA, Cape Taputapu National Natural Landmark, Fagatele Bay National Marine Sanctuary, and Aunu'u Island National Natural Landmark protect seabird habitat to varying degrees on and near Tutuila, the most populated island in the Samoa archipelago. In the Manu'a group, the Ofu and Ta'u units of the NPSA also protect some seabird habitats from development. Simply by their geography and isolation, forested cliffs and rocky promontories throughout the islands naturally provide some protected habitat. The Park very importantly provides breeding habitat for Red-footed Boobies and Great Frigatebirds. Such habitat is not present elsewhere in American Samoa outside of Rose Atoll National Wildlife Refuge, which is administered by the U.S. Fish and Wildlife Service.

Arboreal nesting species such as White-tailed Tropicbirds, White Terns, and Brown Noddies account for half of the number of birds observed on Tutuila surveys. The numerical superiority of these three species almost equals the other seven species of seabirds recorded in the July 2000 round island survey of Tutuila (Table 2) combined. As tree nesters, the three most common species (Brown Noddies can also nest on the ground, and do so on rocky cliffs of Tutuila's north shore) are protected from some mammalian predators such as pigs, and non-arboreal rats. They are still subject

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<sup>8</sup> The suggestion for sampling every 5 yrs. is based on the current staffing and field capabilities of NPSA in the Manu'a group. If a Park boat becomes available in Manu'a sampling can be conducted on an annual basis. Ofu, Olosega and Ta'u are small enough to be surveyed in a single day each.

to disturbance from cats and arboreal rats. These three seabird species are also commonly found throughout Pacific islands where human and predators are established (Flint 2002). Other less common species in our surveys, such as boobies and Frigatebirds are also arboreal nesters, but these large-bodied species are more subject to human disturbance, (i.e., poaching, flushing from nests and capture at sea by fishing), compared to the smaller-bodied species, at least on heavily populated Tutuila.

In total, the number of nesting seabirds on the main islands of American Samoa is relatively small. The Ofu and Olesega Park Units have relatively few seabirds. Human disturbance and habitat modification can limit population recovery. Among American Samoa's main islands, only on Ta'u are seabird resources relatively large and diverse. Steep and isolated terrain limit human disturbance, and there are only a tiny fraction of the human population and their related boat activities exist on Ta'u in comparison to Tutuila. Significant Procellariid populations have only been seriously accessed during this study, and Ta'u populations likely exceed the total number of seabirds counted from Tutuila.

Mt. Lata in the Ta'u Island Unit is the most important and diverse seabird breeding area of NPSA. However, due to the challenge of the summit environment of Ta'u, determining what species occur and breed on Mt. Lata has been difficult throughout the years. In addition, petrels and shearwaters represent some of the most taxonomically complicated species in the world. Close similarities among genera, combined with the confusing visual identifiers and morphometrics listed in identification and field guides, exacerbate this problem. For example, Tahiti Petrels closely resemble Phoenix Petrels (*Pterodroma alba*); Herald Petrels (*P. heraldica*) resemble Collared Petrels (*P. brevipes*); and Collared Petrels resemble Gould's Petrels (*P. leucoptera*). On Tutuila, confusion of Gray-backed Terns with Bridled Terns renders some older records questionable (e.g. Amerson et al. 1982) (Mostello et al. 2000) See Appendix A for further discussion of our findings in relation to species accounts from other areas in the region and around the world.

Clearly, proper identification is the first step in determining what species remain extant on Ta'u. The lack of Herald's Petrel presence

during our work raises concern about their continued presence at what was their only known colony in Samoa. The discovery of Norway rats is a significant finding, with profound conservation impacts of them and their environment. The solution to this predator problem and the many challenges to research on Ta'u and in other remote areas of American Samoa are discussed further along in this section.

### **Field Access and Operations**

Reaching the summit environment of Ta'u is difficult. Accessing remote back-country via continual and repeated trail cutting, physical exertion, communication problems, expense of operations, lack of freshwater, inclement and often severe weather, impenetrable vegetation, and dangerous terrain, all confound efforts to survey colonies within the short time frame for research trips the National Park can support. As recognized by NPSA when establishing this project, these are challenges to overcome to understand and protect the unique natural resources of Mt. Lata. Our work has attempted to identify and solve these problems while gaining insights about the species breeding on Ta'u and throughout American Samoa. Any safe and reliable management efforts (i.e. monitoring, controlling introduced predators) in an extremely remote location with no reliable means of logistical support are impossible without significant future commitments. However, with assistance and guidance from the National Park Service, U.S. Fish and Wildlife Service and other authorities, we believe Park staff can overcome these obstacles.

There is no other ecosystem like the summit of Mt. Lata within the jurisdiction of the U.S. National Park Service, and there are very few known places for ground nesting seabirds remaining in the world which can match, in either scale or diversity, the summit of Ta'u. The U.S. Federally protected summit environment of Ta'u Island may represent last strongholds of Tahiti Petrels, as well as the native land bird species Spotless Crakes, in this major Pacific archipelago. The minimum threats to these unique populations include predation from introduced rats and the loss of breeding habitat to alien plants.

During this research effort it seems like petrels and shearwaters may have diminished in presence along the Mt. Lata trail system. When O'Connor et al. first ascended Ta'u in February 2000, he observed many birds in flight, and located a bird in a burrow near camp. His next two trips revealed fairly similar results, although there was an apparent seasonality in numbers. In December 2001, Rauzon and Fialua (NPSA) saw few birds in flight and no active burrows near camp. We recorded even fewer birds in December 2002, on a trip that took place only one week later in time than the one in 2001, although timing and inter-annual variations more likely affected comparison. The burrow photographed in Figure 12 shows a substrate disturbed by Petrel movements. We noted many burrows where moss has grown over the substrate suggesting no activity in the burrow.

Other reasons for lower numbers include that birds along the trail have habituated to the taped calls, the weather, or presence of rats/humans have resulted in burrow abandonment. The timing of our visits is a reasonable assumption for the lower numbers in later surveys. Nesting season may have changed slightly, or birds may have been feeding at greater distance, and thus returning at greater multi-day intervals.

### **Developing Additional Survey Methods**

On-the-ground censuses of night birds in dense vegetation like that of Ta'u, given current timing and resources, are virtually impossible. Other methods are evolving in the field that enable researchers to monitor population size and changes after restoration actions. Most promising is the use of radar in censusing Procellariids. The Newell's Shearwater of Kauai, Hawai'i, has been monitored for several years and changes in population size have been detected. Recent demographic models of the Newell's Shearwater population suggest the population is declining at a rapid rate from an estimated population of 84,000 (range 57,000-115,000) (Ainley et al. 1997a). Ornithological radar data from 1993 and 1999 indicate a 14% decline. In 2001, 17% decline per year noted by recent radar studies (Telfer pers. comm). These studies took place from a land-based radar system, which may or may not be possible to use on Ta'u.

We present in Appendix F a review of a recent attempt to monitor small nocturnal seabirds (*Xantus's Murrelet*) at sea with marine radar, in the Channel Islands National Park, California. Xantus' murrelets at Channel Islands present challenges similar to those that Tahiti Petrels pose at NPSA. Their work is included at length in Appendix E as a means of identifying the challenges and requirements for a survey to occur in American Samoa (Hamer & Schuster, 2003).

## Invasive Species

### **Invertebrates**

Non-native snails were observed, and incidentally captured in rodent traps. Rosy wolf snails (*Euglandina rosea*) were seen alive and giant African snail (*Achatina fulica*) shells were seen on native hermit crabs (*Coenobita spp.*). Alien ants, mosquitoes and a native terrestrial amphipod were collected by Rauzon. Dr. Duffy received the insects while Dr. Rosie Gillespie of UC Berkeley, received the amphipod. O'Connor's collections Mt. Lata from include three ants aspirated from baits on unsprung rat traps, a small snail from a leaf of *Cyrtandra spp.*, three Diptera (one Tipulidae), and one earwig. These invertebrates were deposited for identification with Mike Richardson, USFWS entomologist in Honolulu. O'Connor collected Tahiti Petrel ecto-parasites (lice) and deposited the specimens with Dr. Ricardo Palma at Te Papa Tongarewa, National Museum of New Zealand (Appendix D).

### **Vertebrates**

Historically, feral cats, pigs and rats pose the greatest threats to ground nesting seabirds on Pacific islands. In support of anecdotal claims by previous research visits to the summit, the summit scrub environment of Mt. Lata appears free of large mammalian predators. On our several trips to the summit of Mt. Lata neither pigs nor vegetative damage resembling pig sign were observed. Although cats were not specifically targeted by our trapping efforts, no cats were found on our trips or on previous documented trips to the summit. Given the extremely wet conditions of the summit, cats wouldn't be expected to thrive. For similar reasons, rats also weren't expected.

However, Norway rat (*Rattus norvegicus*) were first noted at the summit during this project and sampled using Victor snap traps. Discovery of Norway rats is surprising, because of their rarity in montane forests elsewhere, for example, in Hawai'i (Sugihara 1997).

Live traps were used to a lesser extent, because they were found to be relatively ineffective at captures. No rats were captured in 72 trap nights using a variety of live trapping methods (Hagaruma traps, squirrel traps) and baits (peanut butter, Spam™) in 1999 and 2000. The first hard evidence of rat presence was found during a summit trip in 2001. A tent cached on the summit after our first ascent was found with an apparent nest chewed into it. O'Connor collected droppings from the nest and brought them to the Fish and Wildlife Service in Honolulu for identification. They were thought to be of rat origin, but because they had been swollen with ambient moisture, determining what species of rat they were from was not possible. During the February 2001 research trip, a member of the field crew witnessed food being taken from inside a tent by a rat, while he himself was present in the tent. The rats were bold and unintimidated by our presence. While sleeping outside the tent O'Connor observed two rats repeatedly in camp during the night, even repeatedly approaching his sleepsack. Chewed vegetation reminiscent of rat-damaged flora were evident in several areas of the summit.

In December 2001, Rauzon placed only 20 Victor rat traps along the trail leading from the campsite to the summit of Mt. Lata. Single traps were not set in any particular distance from each other but placed in areas likely to catch rats. Each trap was baited with a small piece of coconut smeared with peanut butter. The traps remained in place for five nights (100 trap nights) and caught 8 rats for a trapping success 0.08%. On the first night, a female Norway rat was caught. Its abdomen was swollen and appeared pregnant. Another trap simultaneously killed two sub-adult males. One adult male was taken in addition to another adult female. The other three rats taken were sub-adult males. See Figure 16.

In contrast, in July 2002 six male rats were caught when 44 traps ran for 4 nights (176 trap nights) over a linear area of approximately 440 m (1324 ft.) long. The December 2001 trapping

effort caught more rats than in July (0.08% verse 0.03%), with greater gender/age diversity. Based on trapping success, rat densities were highest in areas nearest the camp, which are also areas without Petrels. Rat-trap success in Petrel nesting areas was zero, although in consideration of potential non-target injuries, trapping was limited. Some traps were sprung by unknown animals or mechanical dysfunction. Trap operation was impacted by rust and compromised springs, and thus were not as sensitive on latter trapping dates.

In December 2002, we were prepared to repeat the rat trap-line survey with 20 snap traps. The existing traps had rusted and deteriorated significantly in the year and a half on Mt. Lata. Voucher specimens were also requested by USFWS to confirm rodent identification. Because we required export permits from the Dept. of Marine and Wildlife, and due to the remote possibility of accidentally catching a Spotless Crake in a snap trap, DMWR provided the permits with the stipulation that only live traps be used and the rats hand-suffocated. DMWR provided us with 10 folding live Havahart™ traps. We were able to transport five of these bulky and heavy traps to the summit. From our experiences at camp we learned that the resident rats were partly diurnal. Not hearing any Spotless Crakes in the area, we set three snap traps for three nights, and four live traps for two nights for a total of approximately 20 trap nights, and caught 4 rats for a capture rate of 20 %, the highest yield thus far.

Although only Norway rats were captured, other species may be present. Norway rats dominate food sources, and it takes about 10 traps nights to eliminate them before Pacific rats (*R. exulans*) are able to be captured (D. Vietch pers. comm.) O'Connor reported seeing a rat he tentatively identified as a Pacific rat in camp.



**Figure 18.** Norway rats captured on Mt. Lata summit, December 2001. (Photo: M. Rauzon)



**Table 5.** Rat Morphometric Data Collected on Ta'u, December, 2002

1). <i>R. norvegicus</i> -female lactating, rump balding, 165 g. caught 12/10/02 by camp at night using tuna oil and cracker. Voucher specimen to USFWS. See Fig. 7.
2). <i>R. norvegicus</i> -male 200 g. caught 12/11/02 by camp during daylight using tuna oil and cracker.
3). <i>R. norvegicus</i> -immature male 45 g. caught 12/11/02 by camp during daylight using tuna oil and cracker.
4). <i>R. novegicus</i> -male 140 g. caught 12/12/02 in Petrel colony using tuna oil and cracker Voucher specimen to USFWS.

### **Rodent Control**

The presence of Norway rats atop Ta'u is a significant ecological problem, and could mean an eventual extirpation of breeding Petrels along the ridgeline, as well as extirpation of crake populations (Rauzon and Fialua 2004). 'Class A' burrow or ground nesting species such as the ones recorded on Mt. Lata cannot long survive with introduced mammalian predators as large as *R. novegicus* (Flint 2002). It is difficult to know with certainty if rat activity is destructive to Petrels, however Flint 2002 posits that any rodent species other than house mice (*Mus musculus*) means eventual bird extirpation. By the time it is determined rodents are having effects, it will be too late for remedial action. None of the six Tahiti Petrels we handled birds showed rat bite marks.

Norway rats can weigh over 200 grams. They can wreak havoc on Petrel and crake eggs and chicks, as witnessed on numerous islands around the world. Moors and Atkinson from 1984 reports, "For example, ...only 22 Dark-rumped Petrels were known to have fledged...from 185 eggs laid (11.9%). Over 90 percent of the losses of eggs and chicks were due to *R. rattus*, predation being severest during the 20 days on either side of hatching. Adult Petrels also suffered heavy predation at the colonies." At least 27 species of seabird are known to be preyed on by *R. novegicus* and many more likely to be recognized as being vulnerable to predation as further studies are made. Eggs as well as chicks are taken and predation of

adults is much more common with *R. norvegicus* than with the other two species of commensal rats, a fact that can be related to its larger size. (Moors and Atkinson 1984).

More recent examples come from Kiska Island, Alaska, where Norway rats are preying on Least Auklets (*Aethia pusilla*) and near total reproductive failures were noted in 2001 and 2002 (Major and Jones 2004.) Invertebrate populations and native vegetation are greatly affected by rat predations (Allen et al. 1994, Campbell and Atkinson 2002). It is possible that the environment on Mt. Lata is undergoing similar impacts. The relatively inaccessible cliff faces may offer some refuge, because *R. norvegicus* are less agile climbers than black rats (*R. rattus*). The cliff faces of Pioa (Rainmaker Mountain) on Tutuila may offer similar refuge, on an island with a very sizeable rat presence. O'Connor estimated dozens of Tahiti Petrel pairs nesting there in 2000. We did not relocate the Herald Petrel that was discovered in 1986 in the Olotania Crater area by Pyle et al. (1990). It is possible the small population of this open ground nester was extirpated by rats, however we were not able to visit this area to confirm rat presence.

The total removal of rats from the summit is improbable given the size and terrain of Ta'u Island. Rat control is possible but has unique risks and challenges. After witnessing the long lasting effects of even our conscientiously controlled presence on Mt. Lata, it is obvious that rat control efforts would create a hugely disturbed area, ripe for invasive plants to colonize. It could be possible that trail cutting facilitates rat movement. Haleakala National Park on Maui has limited alien species invading the most ecologically sensitive areas where resources management staff enter, by using helicopters for access. Early on at Haleakala, researchers and resource managers had to hike in along repeatedly cut trails from low-elevation, weed infested areas. As a result they spread invasive species along the way. Helicopter access is not possible in American Samoa given emergency response considerations, expense and a basic lack of suitable aircraft. Thus, the continued use of trail access at Mt. Lata, Ta'u can be expected to impact the summit environments. (See Figure 17). In the future, feral pigs and possibly even cats could reach the summit, and invasive mosquitoes could carry diseases to the bird populations. Placing high priority on assisting the

prevention of further introductions of other egg and hatchling predators will help to maintain relatively healthy species populations<sup>9</sup>. To ignore this hastens extirpation of these species, or creates an emergency situation which will require more time and funding to attempt to correct.

Rats could also be seriously affecting Park seabird habitats and species breeding success in areas such as Pola'uta Ridge, Tutuila. Additional research is necessary in order to determine if predation problems exist here. If trapping reveals high rat densities, rodent control protocols should be developed here and if effective, later applied to Ta'u.

Currently key rodenticides are registered only for use around buildings and other man-made structures, although it is still not clear if temporary structures (e.g., water tanks and tent platforms) qualify. It is currently illegal to use rodenticide in bait stations in non-agricultural settings in U.S. territories, because most, including American Samoa, do not have an administrative entity that oversees pesticides similar to the Pesticides Branch within the Hawai'i State Dept of Agriculture. In February 2002, USFWS met with the EPA to request changes in Section 3 national registration, applying to any area under US control, including American Samoa. They discussed Ta'u, comparing it to the Aleutian Islands which also have human settlements, and ensured that the registration will apply to such situations where outright eradication would not be possible, but where control of invasive rodents for conservation purposes is possible. New registrations for brodifacoum and diphacinone, bait stations and hand and aerial broadcast were submitted to the EPA in late 2003. The review process and state acceptance will take longer, and useage may be available within the next few years. The fact that the rodenticides will be restricted for use by federal conservation agencies should expedite the registration process.

If the Park chooses to control rats on Ta'u, it would be appropriate to begin to seek funding, plan methods, monitor techniques for both rodent numbers and bird numbers, and identify what NEPA and public outreach needs to be done. No matter what legwork is done

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<sup>9</sup> Important exceptions to the 'relatively healthy' populations are the Petrels and Shearwaters of Ta'u and Tutuila whose breeding success in the presence of introduced rats is still unknown.

upfront, without sustained funding the implementation of rat control will be difficult to achieve. Inaccessibility of the Lata summit site for bait station maintenance is prohibitive. Care needs to be taken to ensure bait stations are both, crake and Procellarid (petrel/shearwater) proof. A design exists for simple and cheap bird-proof bait containers (J. Murphy USDA. pers. comm. 2003). In this design, plastic buckets are fitted with a baffle entrance, allowing rats to enter but excluding land birds like crakes. The plastic enclosure also keeps the bait drier than if it were exposed to the elements. Bait packets are wrapped in plastic film and aluminum foil to prevent spoilage until rats can access them.

Park Service resources are very limited on Ta'u. To leverage support, management initiatives could be conducted in cooperation with other private, local and federal natural resource entities. In 2003, during a discussion initiated by Willamette College, Oregon, about establishing a "Field Station" on Ta'u, labor for rodent control was considered as a service students could provide. The USFWS is planning to hire an outreach coordinator for rodent control in Hawai'i, in order to inform the public about the use of approved rodenticides in watershed situations. Similar efforts to secure community support for rat control should be developed for Ta'u from USFWS materials.

### **Human Impacts**

Given the long history of human settlement in the Samoa Archipelago and the presence of human commensal species (rats, pigs, dogs, cats, goats, etc.), current seabird colonies in American Samoa are restricted to areas receiving little or no human disturbance. A similar pattern has been observed regarding modern day seabird distributions in other Pacific Islands (Carter and Carter 2000, Flint 2002). Provided that no new land development occurs in the Park, as mandated in the lease agreements between the villages and the National Park Service, remote seabird colonies in NPSA should be able to perpetuate themselves. However, there are many influences outside NPSA boundaries that impact Park seabird populations. Although some subsistence consumption of seabirds still occurs in American Samoa, it is a rapidly disappearing tradition. The use of dogs to hunt Tahiti Petrels at Ta'u has not occurred in

over fifty years. It appears that more seabirds are taken as by-catch during fishing operations than are intentionally hunted at colonies, although seabirds in unknown numbers are still randomly taken for sport and food.

Thus far, the eco-tourism industry has not affected the coastal seabird colonists through disturbance. A potential threat is the promotion of sea kayaking as a recreational activity around the Pola Islet, and thus lending disturbance to seabird populations through repeated flushing of breeding adults from nesting sites. Boobies are particularly sensitive to flushing disturbance, often with fatal results for chicks knocked to the ground by the fleeing adults. O'Connor found two chicks on the ground on a first visit to the Pola'uta ridge Red-footed Booby nesting areas. These abandoned chicks are easy prey for land crabs (native predators) and rats (invasive predators). In Channel Islands National Park, human activities, compounded by illegal landings by kayakers, threaten seabird colonies, especially those in sea caves and arches. Prominent landforms in Samoa such as the currently designated Natural National Monuments and Marine Sanctuaries would be likely magnets of kayaker interest.. Regulations should be considered and a brochure developed in anticipation of this activity.

### **Recommendations**

#### **Tutuila Unit**

Annual comprehensive boat survey of Tutuila Park shorelines and islets.

Quadrennial comprehensive boat survey of all Tutuila Island shorelines.

Finalize Seabird Colony Catalog for Tutuila, American Samoa. Rectify seabird census and Tutuila database with colony maps, survey sectors, GPS readings and digital photos for web-placement.

Confirm breeding status of Bridled Terns in Tutuila Unit during the month of December.

Develop Samoa seabird identification material and training session for park Staff at Amalau lookout.

Develop park interpretive materials for Amalau Lookout. Amalau lookout easily functions as public education opportunity for park visitors interested in seabird resources.

Obtain seabird stranding data from DMWR on Tahiti and Collared Petrels.

### **Manu'a Units**

Quadrennial comprehensive boat surveys of Ta'u, Ofu and Olosega (offset every two years from Tutuila round island surveys)

Determine feasibility of pilot-project ornithological radar, and/or at-sea censuses at Ta'u.

Survey Olotania Crater on Mt. Lata Ta'u in the month of July for Herald's Petrels.

Survey Mt. Lata opportunistically. To facilitate continued research on Mt. Lata, develop water catchment system on summit, develop Mt. Lata campsite structure using recycled plastic materials placed off-summit to avoid lightning (See Appendix F).

Demonstrate rat predation on the Tahiti Petrels using dummy wax eggs or real eggs in burrows.

Determine if rats are present on Mt. Lata cliff face.

Begin rodent control on the summit of Mt. Lata, Ta'u, and along Pola'uta Ridge, Tutuila

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APPENDIX A  
Seabird Accounts for American Samoa

Comparisons of known historical accounts with data by island (see abbreviations key at bottom), for seabird species recorded in the U.S. territory of American Samoa. The following table was generated by the Internet Assistant Wizard for Microsoft Excel.

Species	Common Name(s)	Samoa Name	Clapp Sibley (1966)	King (1967)	Crossin (1971)	Amerson et. al (1982)	Harrison (1983)	Engring Ramsey (1989) *focused	O'Connor (2001)	Notes
<i>Pterodroma externa</i>	White-necked Petrel	ta'i'o				at sea (dozens)				
<i>Pterodroma rostrata</i>	Tahiti Petrel	ta'i'o			Ta (1000's)	Ta (500)	Ta (100's to 1000's); Tu (1c&r), (OI)	Ta (100's); Tu (100's) (1 coll)		
<i>Pterodroma heraldica</i>	Herald's; Trinidad Petrel	ta'i'o					Ta (10's)			Pyle et al. ta'u (10's) (1coll) (1989)
<i>Pterodroma brevipes</i>	Collared; White-winged Petrel	ta'i'o				Ta at sea	(Ta); (OI 1-4 heard)			morph closely resembled herald's
<i>Pterodroma alba</i>	Phoenix Petrel	ta'i'o						Ta (10's)		
<i>Puffinus</i>	Short-tailed Shearwater;	ta'i'o		migrant			migrant			

<i>tenuirostris</i>	Muttonbird									
<i>Puffinus pacificus</i>	Wedge-tailed Shearwater	ta'i'o	at sea	breeding		at sea (6 seen)				
<i>Puffinus nativitatus</i>	Christmas Shearwater	ta'i'o				Ta (olotania and laufuti); at sea			Tu (2 at sea 16 km off south shore)	
<i>Puffinus l'herminieri</i>	Audubon's Shearwater	ta'i'o			(10h)	Ta (200?); at sea (10's)		Ta (100's); Tu (10 heard at Tau Mt., 10's heard at Pioa Mt.); at sea (20)	Ta (10's heard); Tu (10's heard)	
<i>Nesofregatta fuliginosa</i>	White-throated; Samoan Storm-Petrel	ta'i'o		breeding			breeding		Tu (12 seen)	
<i>Phaethon rubricauda</i>	Red-tailed Tropicbird	tava'e ula	1 coll			R			Rose	
<i>Phaethon lepturus</i>	White-tailed Tropicbird	tava'e sina				All including swain's and rose (est 3700)		A (426 seen; est 2312)	All (Swain's not visited)	
<i>Sula dactylatra</i>	Masked Booby	fua'o				R (est 25-240); at sea (5 seen)		Tu (2 seen pola); OI (1 seen maga pt)	Rose; Tu at sea (1 adult, 1 juv seen)	

<i>Sula leucogaster</i>	Brown Booby	fua'o				Tu; N; OI		Tu (100-200 seen pola; 6 seen fagatele); nu'utele (12 seen); olosega (53 seen maga pt)	Tu; Of; N; OI	Amerson and Engbring & Ramsey's Tu sites are only the Pola and Fagatele
<i>Sula sula</i>	Red-footed Booby	fua'o				Tu; R		Tu (30 seen pola'uta ridge); OI (4 seen)	Tu	O'Connor in 1999-2001 observed same behaviours, almost exact same # of RFBO on Tu as Engbring Ramsey (1985)
<i>Fregata minor</i>	Great Frigatebird	atafa				Tu; N; OI; R		Tu; A; OI	Tu (avg 64 at pola; 2(nest)coc onut pt); Of; OI; R	
<i>Fregata ariel</i>	Lesser Frigatebird	atafa				Tu; Of; OI; Ta; R		Tu; A	Tu; R	
<i>Egretta sacra</i>	Reef Heron	matu				All		Tu; A; Of;	Tu	O'Connor

		'u						OI (noted as uncommon)	common (only colony at Fatu rock); Of (including a white morph); OI; R	2000 first white morph documented in Am Sam
<i>Sterna lunata</i>	Grey-backed; Spectacled Tern	gogo sina				Tu (125 fagatele & larsens); A (30 seen); R (6 seen)			Tu (10's seen fagatele, pola rocks, north shore dec-mar); R (4 seen sand isle)	no specimen from Am Sam
<i>Sterna anathetus</i>	Bridled; Brown-winged Tern	gogo 'uli			Tu					
<i>Sterna fuscata</i>	wideawake; sooty Tern	gogo 'uli				Tu; R (est 300,000)		Tu at sea (6 seen)	R (est 10,000)	Amerson may've overest. Rose pop.; his forest bird # were reduced by Engbring (many by >90%); Clapp (1968) S
<i>Sterna bergii</i>	Crested Tern	gogo		vagrant		Tu at sea				

<i>Procel-sterna cerulea</i>	Blue-grey Noddy	laia	T; A; N; Ol			Tu; A; Of; Ol; Ta		Tu (56 seen); A (2 seen); Nu'utele (2 seen); olosega (2 seen maga pt)	Tutuila (10's seen)	
<i>Anous stolidus</i>	Brown; Common Noddy	gogo				est 16000		Tu (est 4000) at pola, fagatele, amalau, Ta in forest higher than blacks; N	Tu; Of; Ta; R. 10+ colonies Tu, evening congregati on coconut pt (avg 100 birds)	most common seabirds on Tu
<i>Anous minutus</i>	Black; White Capped Noddy	gogo	2 birds at sea in 6 Tu trips	forages 80k offshore		nests Tu (pola islet (200), pola'uta ridge); Ta (siu point rd (5000)); R; S		Tu (200 10km offshore larsen's cove fishing w/ browns (greatly outnumbering them) 25 june 1986; 3 wks later only browns seen); Ta	Tu	



								so. shore to laufuti, 1000's 19-20 july 1986; Of 11; usually <12 Of & OI		
<i>Gygis alba</i>	White; Fairy Tern	gogosina				All (4200). Although commonly nests in trees, report colonies on maga pt (OI), cliffs on A and N		Tu (est 11,269 from a pt count) highest avg density but pt counts not best to count the species acc to report	All (Swain's not visited); Tu (many more on south shore than north)	
T=Tutuila; A=Aunu'u; N=Nu'utele; Of=Ofu; OI=Olosega; Ta=Ta'u; R=Rose; S=Swain's; All=All islands in Am Sam										
10's = tens of individuals; 12's = dozens of indiv.; 100's = hundreds of indiv. etc...										

## Comparisons to regional and global populations

We present here a review of the seabirds found in American Samoa and compare their local populations to regional and global numbers so the local resources can be appreciated in an international context. Notes are in relative order, from the most to the least abundant species, as found during our surveys. Special emphasis is given to the Tahiti Petrel because of its unique status in the Park.

### Brown Noddy (*Anous stolidus*; BRNO)

Brown Noddies range pan-tropically on subtropical islands 30 degrees north and south of the equator and breed on suitable islands from the Marianas, Hawai'i, Samoa, Society, and Tuamotu Island groups and Australia. The most concentrated populations are in the Phoenix and Society islands. Brown Noddy world population is estimated from 300,000 to 500,000 breeding pairs, (del Hoyo, 1992) with the Hawai'i population reported at 93,000 pairs. BRNO are the most common seabird in American Samoa, occurring on more sampling units and in higher numbers than any other seabird species. We counted about 1,000 on the Tutuila round-island survey in 2003 (872 on the incomplete survey). Tutuila is the stronghold for BRNO where they nest on cliffs and offshore rocks. However, Rose Atoll only supports about 30 pairs. (See Table 4). The American Samoa population is about 2,500 pairs. Population trend in Samoa and worldwide is believed stable.

The species is dominant in Samoa because it has flexible nesting preferences. Brown Noddies can be ground nesters, cliff nesters or arboreal nesters, and are often present on inhabited tropical islands where humans and their commensal pests are present. In the Tutuila unit of NPSA, they are primarily coastal cliff nesters. In July 2000, 38% of Brown Noddies observed were found in or over Park property, with a total of 321 individuals counted island-wide, thus making them the most commonly occurring species in the survey. In the September 2003 survey of Tutuila, they were again the

most commonly observed seabird, although second in number of locations where they were sighted.

White-tailed Tropicbird (*Phaethon lepturus*, WTTR)

White-tailed Tropicbirds are the most numerous of the three Tropicbird species. In the Pacific, this pan-tropical species breeds on remote oceanic islands - including the Line Is., Marquesas and Tuamotu Is., Mariana Is., American Samoa, and Palau. A few pairs nest at Wake and Midway Atolls and 500-3,000 pairs nest in the main Hawaiian Islands. It does not occur at Rose Atoll.

WTTR are mainly pelagic feeders, but are often seen far inland soaring over cliffs. Both colony residents and migratory WT

wander extensively, sometimes as far as 1,000 km from their nests. Little is known about the Samoan population of this species, but it is assumed there are several thousand pairs distributed among the islands. White-tailed Tropicbirds are common on all islands of American Samoa, nesting in forests and cliffs on each of the islands. In the July 2000 round-island survey of Tutuila, about 30% of the observed population was in Park lands with the remaining majority flying over high ridges near shore waters in other areas on Tutuila. In 2003, we saw fewer than in 200, but percentages in the Park were higher, perhaps due to the incomplete nature of the survey which missed a large proportion of outside Park area. Identification at a distance can be confused with White Terns. However WTTR flight patterns are distinct from those of terns and they are often observed higher in the sky and occurring over all forests. Their population trend is likely stable in cliff habitats, and may be declining in some forests due to logging.

#### White Tern (*Gygis alba*; WHITE)

WHITE have a migratory and breeding range covering three oceans: the Atlantic, Indian and Pacific Oceans between 30 degrees (N and S) and the equator. World population is approximately 100,000 pairs with concentrations in Samoa, Tokelau, the Line Islands and Phoenix Islands. It is a common breeder in the Hawaiian Islands, with about 15,000 pairs, and there is a small population on O'ahu, estimated at approximately 300 pairs. White Tern populations on Midway Atoll have increased dramatically in the past 75 years, due to the introduction of ironwood trees and addition of human made structures, which provide nesting sites safe from introduced ship rats (*Rattus rattus*) (Flint et al. 2001). Rose Atoll supported 18 nests in 1990 and provides very little habitat. World population is stable (del Hoyo et al. 1992).

Like the WTTR, arboreal nesting habits allow them to escape most tree-climbing rats and ground predators, thus they are present in areas on many tropical islands where other seabirds are absent (e.g. congested Waikiki neighborhoods of O'ahu). O'Connor found only about 22% of WHITE observed on Tutuila in the Park unit, while Rauzon found an even smaller percentage of 13% observed in the

Park, suggesting the Park is not essential habitat for this species' long-term survival in American Samoa.

## Tahiti Petrel

These medium-sized Petrels occur in the Tropical Pacific Ocean and breed in French Polynesia and New Caledonia as well as American Samoa, Fiji and perhaps Tonga. Widespread dispersal to eastern and subtropical Pacific from Mexico and Peru to Taiwan has been noted (Ballance et al. 2004). Range overlaps with similarly appearing Phoenix Petrel in waters around Kiribati as far as 7° N. Tahiti Petrels are usually seen singly, and do not follow ships. They are prone to vagrancy with records from Eastern Indian Ocean, Coral Sea, Banda Sea to New Guinea and New South Wales, Australia (Enticott and Tipling 1997). One live specimen was found in a yard in Agat Guam 31 March, 1986 (Wiles, et al. 1987). The only previous record in Micronesia was from an unknown location in the Caroline Islands in the mid1800s. (Baker 1951).

Tahiti Petrels are southern summer breeders and breed in November in Samoa at remote mountaintops and ridges. Because they are very difficult to census, the Samoan population size remains unknown, but likely numbers in the thousands. In American Samoa, Crossin (in Amerson 1982) reported Tahiti Petrel as an uncommon resident in Ta'u, heard from Olotania crater to the summit and beyond, ranging deep into the forest in May. He notes it was the most common Procellariiform. The number of calling birds indicates that thousands are present and he collected several. In January 1976, one was seen over Olotania crater, also heard in Oct, 1976 Banks (1984) reports a courting pair were collected at the base of Olotania Crater in Oct, 1976. Engbring and Ramsey report capturing a Tahiti Petrel atop Ta'u Mountain in the Tafuna plain in southwest-central Tutuila in 1986 (USFWS report 1986). Tahiti Petrels fledglings that have become disoriented by urban lights are picked up by people on Tutuila and turned in to the Department of Marine and Wildlife Resources 'rather frequently' (J. Seamon, pers. comm). O'Connor found no evidence of active colonies at the summits of the smaller Manu'a Islands in 1999, although the inaccessible southwest cliffs may hold nests, and USFWS reported hearing a Tahiti Petrel call from Olosega Island in 1986.

Tahiti Petrels are currently classified as 'near threatened' over the extent of their known range by BirdLife International. The Globally Threatened Bird Forums: Threatened Pacific Birds is investigating whether this status is accurate given a decline approaching 20% over 10 years, and an extent of occurrence <20,000 km<sup>2</sup> and declining, with populations <10,000 individuals and declining. Under the revised IUCN criteria the threshold for 'vulnerable' status has increased to a decline of 30% over 10 years or three generations. However, three generations for this longer-lived species is more realistically to be 45 years (much longer than the trend period of 10 years used in previous assessments). Declines have been noted in the Society Islands. This species may soon be upgraded to 'vulnerable', based on declines of >30% in 45 years (IUCN 2003).

Researchers in New Caledonia report that at one islet on the southern lagoon of New Caledonia, the population declined from 50 pairs in 1986 to less than ten pairs in 1998. Feral cats have colonized the tops of mountains in New Caledonia. A fresh Petrel carcass, found at about 1,100 m, looked like it had been consumed by a feral cat (signs indicated that the bird had been killed on site). (Jorn and Sophe Rouys, pers. comm.).

Reports from Fiji researchers indicate:

This is clearly a poorly-known species and we should be cautious from extrapolating from Ta'u to other countries with large populations. I would guess that most of its major nesting islands have had Black Rats for many decades. In Fiji, there appears to be have been a recent increase or range-extension, and this species is now regularly seen from inter-island ferries and crashing into flood-lit hotels on Taveuni. Fiji There are no data on population sizes or trends from Fiji or the mainland colonies on New Caledonia. The extensive Whitney South Sea Expeditions only collected this species in French Polynesia, suggesting that the apparently large populations in New Caledonia and Fiji (at least) have increased in the last few decades. Given our poor knowledge, I would prefer to retain this species as Near Threatened, pending further data from core colonies.

(Guy Dutson, pers. comm.).

In French Polynesia we don't have recent and accurate data to determine the present status of the Tahiti Petrel which has colonies on most of the high volcanic islands (Society, Marquesas, Gambier). Rat impact is unknown. One identified threat is feral cats. Predation by cats is a problem on low breeding site. Electric power lines in the mountains can also be a problem. Tahiti Petrels are regularly found in the urbanized part of Tahiti around Papeete attracted by light at night (mainly around new moon). It is often young birds at their first flight. Most of them are found between July and December. We maintain a database of these findings (useful to learn about the breeding season). A new population had been discovered in the Gambier about 6 or 7 years ago. Some genetic research was done at that time to compare Tahiti, Gambier and New Caledonia populations. No difference was found between Tahiti and Gambier populations (Vincent Bretagnolle, CNRS Chizé. pers. comm.). The New Caledonian bird has been named as a separate subsp. *P. r. trouessarti* based on heavier bill and larger size. However, Rob Fleischer, NMNH, says they can't find any genetic differences between those published by the French, the Samoan bird, or those collected in the central Pacific. For more info on genetics, contact Bretagnolle :breta@cebc.cnrs.fr.” (Philippe Raust, pers. comm.).

In the Eastern Tropical Pacific, six years (1988-90, 1998-2000) of shipboard surveys were analyzed for Tahiti Petrel occurrence. Absolute abundance of tropical seabirds varied from year to year and was likely explained by movement of birds into and out of the study area, however only the Tahiti Petrel showed a significant decrease over time. Researchers suspected this was due to a deteriorating condition on the breeding colony as opposed to adverse marine conditions in the Eastern Tropical Pacific (Ballance et. al 2004).

#### Red-footed Booby (*Sula sula*; RFBO)

This pan-tropical species is found in the Pacific, Atlantic, and Indian Oceans where water temperatures exceed 22°C. Mainly pelagic in their feeding habits, RFBO are the smallest of all Booby species. Breeding sites are usually coral atolls and volcanic islands. In the Pacific, RFBO breed within the Hawaiian, Society, Line, Austral, Marshall, Gilbert, Phoenix, Marquesas, Tuamotu and Marianas Island groups and at Palmyra Atoll, Christmas Is., Johnston Atoll, and Wake

Island. The Palmyra colony is thought to be the largest single colony in the Pacific, with 25,000 birds counted in the 1960's (E. Flint-USFWS pers. comm.). Red-footed Boobies also breed in the Main Hawaiian Islands, with colonies on O'ahu and Kaua'i. They are common in American Samoa with numbers in the low hundreds. Rose Atoll supports a population around 1,000 birds. A tuna commensal, Booby declines/increases may be linked to food web alterations related to the tuna fishery (Rauzon et al., In-prep). Populations elsewhere in the Pacific are expanding and this may be occurring in American Samoa. Historical counts are about the size of O'Connor's present estimates while Rauzon's counts are about 50% larger.

Like the previous common seabirds in Samoa, Red-footed Boobies roost and nest primarily in trees. In NPSA, pairs nest along the crest of Pola'uta Ridge and on the Pola Islet in trees. The dark-backed phase is most prevalent in American Samoa, but several all white phase birds, probably from Hawai'i, were noted and they may be increasing in frequency since only singles were seen previously. Rauzon counted about 300 RFBO in the park in 2003. O'Connor counted 127 or 99% of birds observed on Tutuila in the Pola and Pola'uta Ridge areas of the Park. The birds disperse to the fishing grounds in the morning, thus an early morning count at the colony should be done if the maximum number of roosting birds are to be encountered.

#### Brown Boobies (*Sula leucogaster*; BRBO)

Brown Boobies are distributed throughout the tropical oceans. Possibly the most numerous and widespread Booby species, their total population is thought to be around several hundred thousand individuals. The birds mostly feed in near-shore and offshore waters. In some areas, they prefer cliff ledge sites for easier take-off, but will also nest on sandy islands, and bare, coral atolls. In American Samoa, Brown Boobies nest on rocky headlands and offshore islands. They were present in about equal numbers in and outside the park when O'Connor counted 114 individuals in the Tutuila round island survey in July 2000. In December 2003, Rauzon counted 64 total, half of what O'Connor counted in 2000, during a survey that did not include Larsen's and Fagetele Bays.



Brown Boobies also occur in a colony on the southern tip of Olosega in Manu'a, and are present in low numbers on Rose Atoll. O'Connor also observed a few breeding sites on the south side of Aunu'u island in July 2000.

#### Great Frigatebird (*Fregata minor*; GRFR)

Frigatebirds are found in the tropics of the Pacific, Atlantic and Indian Oceans. Hawaiian birds show an inclination to wander to Johnston and Wake Atoll, but research on birds from the Philippines indicate further migration for segments of the Pacific population that follow the winds west to the Coral Sea, northeast to Australia, and even Japan. Worldwide population trend is believed stable, estimated at half a million to one million birds (del Hoyo et al. 1992). There are 64,000 pairs in Hawai'i (Harrison 1990) and up to tens of thousands of pairs in the Pacific region. O'Connor found 97% of individuals observed on the Tutuila round island survey within park territories. He counted 46 in July 2000. In September 2003, Rauzon counted about 180 in flight over the Pola, where again upwards of 99% of observed birds occurred. They are reported to nest on Pola Islet by Park personnel and we saw males with inflated red gular pouches in September 2003, but no nests were identified. They also nest in low numbers at Rose Atoll.

#### Lesser Frigatebird (*Fregata ariel*; LEFR)

LEFR are found in all three tropical oceans. The largest colonies are found in South Central Pacific, where Phoenix and Line Islands hold tens of thousands of pairs. Kiritimati (Christmas Island) may have 3,000 pairs. Adults are sedentary with dispersal of juveniles and non-breeders to the tropical seas. Although known for ground-nesting on sandy atolls, LEFR have been reported historically from the main islands of American Samoa (NPS 1988), and are suspected to nest on top of Pola Islet off the north shore of Tutuila. O'Connor counted several dozen over the course of surveys from 1999-2001, with most sightings in the vicinity of the Pola, over Coconut Point on Tutuila's south shore, and above Aunu'u Island off Tutuila's SE coast. Rauzon observed one male LEFR off Fitiuta village, Ta'u, in December 2002 and one male over Cape Tapatapa in September 2003. They also nest at Rose Atoll, (~30 pairs) and are more

common there than Great Frigatebirds while the reverse is true in the main islands. Further investigation into the presence of this species is warranted for definitive understanding of its position in American Samoa and NPSA.

#### Black Noddy (*Anous minutus*: BLNO)

Black Noddies nest on oceanic and offshore islands throughout the tropical Pacific and Atlantic. There are seven different subspecies. Two forms are breeding residents in Hawai'i: *A. m. melanogenys* occurs on sea cliffs and caves on islands in the main Hawaiian Islands; *A. m. marcusii* nests on trees and bushes in the Northwestern Hawaiian Islands and in the western Pacific. The largest concentration of the latter is in the Line and Phoenix island groups. Ironwood tree growth at Wake Island has allowed them to recolonize, where approximately 500 nesting pairs are present. Worldwide BLNO total population includes over 200,000 pairs. Population appears stable or slightly decreasing (Geiger 1999).

They were uncommon on the 2000 Tutuila island survey. O'Connor counted five in the park, and 15 outside the park over the entire week-long survey. On other trips along the south coast of Tutuila, O'Connor observed Black Noddies in large, mixed species feeding flocks offshore of Fagatele and Larsen's Bays. Rauzon did not find any birds on a December 2002 circuit, and in September 2003, counted only five. Confusion with Brown Noddies can possibly confound enumeration, especially when BLNO are in low numbers and are seen briefly from a rocking boat in harsh midday light. However, with daily sightings over a two year period, Brown Noddies clearly outnumbered Black Noddies on the main islands of American Samoa. On Rose Atoll, the reverse is true, where the USFWS counted ~ 600 in 1998.

On Ta'u, BLNO were common at sea off Fitiuta village area on 15 December, 2002. They were in feeding flocks with White Terns and Brown Noddies. Black Noddies were reported in a colony from the Saua area of Ta'u on July 28, 1998 -19 nests; December 15, 1998 - 12 nests; April 7, 1999 -1 nest. (Peter Craig, pers. comm.). This colony was not relocated in February 2000.

Blue Noddy (*Procelsterna cerulea*; BGNO)

The Blue Noddy has been recently designated a full species from the five races of the Blue-gray Noddy that are widely distributed within the Central and South Pacific regions. The total world population of BGNO may be around 100,000 pairs (del Hoyo et al. 1992).

Worldwide, populations on inaccessible islands are believed stable, increasing on newly predator-free islands. Breeding takes place from early December to March in Hawai'i, from May to December in the Line Islands, and year-round in the Phoenix Islands. In the Northwestern Hawaiian Islands, there are 4,000 breeding pairs; most breeding on Necker and Nihoa Islands. French Frigate Shoals and Gardner Pinnacles have small colonies. They also breed in the Line and Phoenix Islands, Kiritimati (Christmas I.), Howland, Baker and Jarvis I. National Wildlife Refuges.

They are not present at Rose Atoll and are uncommon on Tutuila. Small loose colonies of breeding pairs are reported to nest on almost every coastal cliff area around Tutuila. They are one of the most significant seabird species occurrences in NPSA. O'Connor in July 2000 survey counted 9 (30% of total individuals observed) in Park territory, and 20 outside of Park lands, outnumbering observations of Black Noddies on Tutuila. Rauzon saw approximately ten on cliffs on west quadrant of island. Breeding and roost defense behaviors were observed by O'Connor year-round in cliffs at Fatu Rock and Cape Matatula on Tutuila (with 3 pairs and young observed at both colony sites). On Aunu'u, O'Connor noted that roosting sites are limited to small ledges below and above rock faces with > 90° slopes. This was not the case on near shore rocks and islets separated from the mainland of Tutuila, where the slope of the cliff face varied.

Gray-Backed Terns (*S. lunata*) and Bridled Terns (*S. anaethetus*)  
Gray-backed Terns are endemic to the Pacific while Bridled Terns are pan-tropical. GRTE are endemic to the tropical and subtropical Pacific from the Northern Mariana Islands to the Northwestern Hawaiian Islands, through the Phoenix and Line Islands to the Tuamotu Islands. The breeding population is loosely estimated at 70,000 pairs and the total population may be twice that size. Possibly (at least formerly) GRTE were found at Easter I, American

Samoa, Marshall Is, Society Is and the Moluccas. Very little is known about their migratory behavior.

BRTE total population probably exceeds 200,000 pairs with a stronghold in the Persian Gulf where 130,000 pairs may breed. The species also occurs in Africa, Australia, India, Japan, Philippines, and the west coast of Mexico and Central America, northern South America, and West Indies (In US, locally off the Florida Keys, regular in summer in Gulf of Mexico and the Gulf Stream to N. Carolina, rarely to New Jersey, and after tropical storms to New England). Usually absent in the central and eastern tropical Pacific. The species is a common to abundant resident of Palau, and accidental on Bikar, Marshall Is. Published records for other places (Hawai'i, Samoa, Tonga, Fiji) are possibly based on confusion with Grey-backed Tern.

GBTE replace BRTE in the central and NE tropical Pacific Ocean (Mostello et al. 2000), but it appears that BRTE are expanding their range into the south-central Pacific region and are recently reported to breed in Upolu, Samoa (Watling 2001). Unfortunately there has always been confusion about their residency in Samoa.

Amerson (1982) reports that Gray-backed Terns were resident breeders on Tutuila, and Bridled Terns were considered a vagrant in 1967, appearing in Craig (2002) as a "seabird visitor". King (1967) noted one record and several sightings with no details (Amerson 1982). R.S. Crossin reported collecting a specimen off Tutuila but no details were available. Amerson and Sesepasara report 8-10 Gray-backed Terns in Fagatele Bay on 17 Feb. 1976. About 100 birds in Larsen Bay were flying around an inaccessible cliff. Their behavior suggested they were nesting there. During 12-16 July 1976, about 125 adult birds and an immature bird were seen, suggesting breeding occurs. Gray-backed Terns have also been reported as breeders from Rose Atoll and visitors to Annu'u Island.

O'Connor suspected Bridled Terns were present in 2000, having made several sightings he temporarily recorded as 'new' terns pending further identification on most of his trips to the Pola. Joshua Seamon of DMWR also reported birds he suspected were BRTE. Rauzon identified and photographed Bridled Terns in 2002

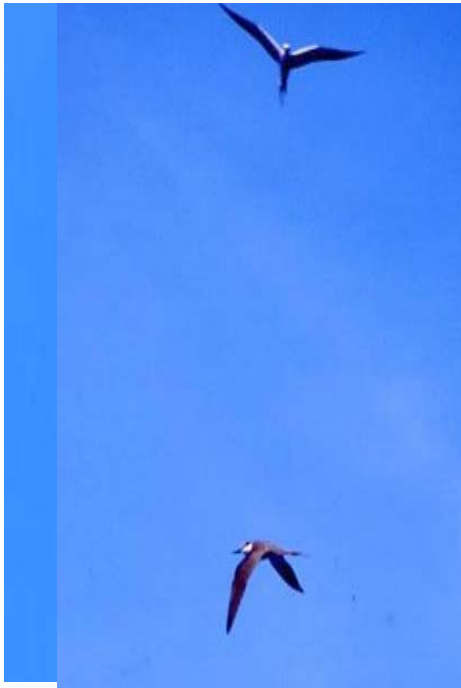
suggesting that they are migratory breeders. Approximately 50 BRTE were seen and confirmed as a new Park species at the Pola during the Dec. 2002, yet none were seen in Sept. 2003. Rauzon photographed several in flight and carefully noted a pair flying between the Vaiava Strait, National Natural Landmark. One BRTE was also seen flying along the shoreline of Ta'u on 12/16/02. Breeding confirmation is needed.

O'Connor reported four GRTE inside Park lands and three outside of the Park on the round island survey in July 2000. On other smaller Pola focused surveys O'Connor reported 10's of GRTE, and 'new' terns, BRTE. O'Connor reports dozens of GRTE from various boat and shore surveys of the Fagatele and Larsen's coves areas in the southwest quadrant of Tutuila from 2000 and 2001. Mixed groups totaling hundreds of birds of WHITE, BRNO, BRBO, BGNO, BLNO and GBTE were also common in O'Connor's surveys in the offshore areas directly south of Fagatele Bay in the SW quadrant of Tutuila. Bridled Terns are a significant sighting for Park lands because the species may be expanding its range into the Park. However, this pan-tropical species is common elsewhere, and a Samoa population is not expected to be critical to overall species health. In the least, their presence increases the bio-diversity of the seabird community in the Park. Plumage similarities between these two species of terns may have led to confusion in early records of both species in Samoa. Voucher specimens would be useful (Amerson 1982). We also experienced some confusion as did DMWR personnel (J. Seamon pers. comm.) trying to identify terns from the moving boat because it seemed the actual status of their presence was the reverse of the published status. Initially O'Connor and then Rauzon identified the terns as gray-backs but outnumbered by *S. anaethetus*. The only vocalizations Rauzon clearly heard resembled the 'churr' call of a gray-back Tern given as a warning call for intruders (Mostello et al. 2000). Note that a gray/brown color on the upper back, even on Brown Noddies, is difficult to distinguish in strong sunlight. Harsh lighting can easily complicate judgement of brown and gray shades (Western Birds 1996, 2001, 2002). We present figures of terns that show how Gray-backed Terns can appear darker than they actually are (Figure 15). Heavily worn gray-backs at the beginning of pre-basis molt have darker brownish cast on outer secondary covert but inner coverts and back remain medium gray readily distinguishable

from dark brown of Bridled Terns. (Western Birds 2002). There may be color variations in upperparts in the western Pacific forms of bridled terns (P. Pyle, Pers. comm.) but all subspecies have white outer tail feathers (rectrices).

Since determination of true back and wing color is problematic, we focus on underwing patterns of light and dark. In Bridled Terns, the extensive dark underwing primaries contrast that of Gray-backed Terns light primary under-wings, and may be the most diagnostic field marks. We provide here some photographic evidence, taken in early December 2001 that suggest Bridled Terns are breeding residents in the Park. Also included are photographs of Gray-backed Terns for comparison. Rauzon also viewed terns from land near the Pola where the late afternoon light was less harsh. Flying between the arch were a pair of Bridled Terns; later, a single Bridled Tern chased away a Brown Noddy then landed on a cleft on the seawall wall. This site had a clump of grass growing on it. The tern slowly moved around it and Rauzon saw the darker brown head, back and wings, and noted the upright posture was like a Sooty Tern (*S. fuscata*), not angled and low like Grey-backed Terns, a lesser used field mark (Pratt et al 1987). See Figure 10.

Gray-backed Tern (left). Christmas I. (Kiritimati). Note reduced black primaries under the wing in spite of darker upper primaries. Bridled Terns at right and below, Note underwing dark primaries.



Audubon's Shearwater (*Puffinus lherminieri*: AUSH)

AUSH are widespread and abundant, Pantropical breeders found throughout the Atlantic, Indian and Pacific Oceans. Found in Galapagos, Vanuatu, New Caledonia, Solomon Is., Palau, Kiribati (2,000 birds), Fiji, Tonga, Samoa, Society Is, and Marquesas Is. In US Pacific Islands, extant on Ta'u and Tutuila, American Samoa, and Jarvis I. Absent in Hawai'i and Marianas Islands. Line Island population increasing at Jarvis I. (~100 prs) in response to cat eradication, decreasing at Kiritimati (~2000 prs?) where the long-term future is not secure. Norway rodents may limit birds at Ta'u, A. Samoa, as well as at other colonies worldwide. Populations may be locally abundant, but sedentary. A detailed genetic analysis of *Puffinus lherminieri/assimilis* taxonomy will likely show the taxonomy of this group must be completely rearranged. Many populations could be considered rare and vulnerable. Pelagic movement is not well known. Total world population may be several tens of thousands of breeding pairs.

A rough estimate of 500 breed in cloud forest on Ta'u (Amerson 1982). Calls heard number from a few dozen to 100-200 on summit of Ta'u in 1999-2001 (O'Connor). On Tutuila, Audubon's Shearwaters can also be heard calling from the cliffs on the face of Pioa (Rainmaker Mountain) from December through July. This species is the second most common Procellarid after Tahiti Petrels, and their populations are likely stable due to inaccessible cliff-nesting habitat. In 1985, on Ta'u, one was recorded breeding 5-10 m. up a tree in dense epiphytes (Watling 2001).

Christmas Shearwater (*Puffinus nativitatus*: CHSH)

This species range covers the Central Pacific from Easter I. Pitcairn I., Line and Phoenix Is. and Hawaii. The species breeds on oceanic islands, inhabiting slopes often among rocks or in lava fields. Christmas Shearwaters are colonial breeders which nest under dense vegetation or in rock crevices. The largest colonies are on Laysan (1,500-2,000) and Lisianski (400-600 pairs). They are not abundant in any location, and although exact size of population is unknown it is estimated at several tens of thousands of breeding pairs. In the



Hawaiian Islands, the total population is mostly likely less than 15,000.

A pair of shearwaters was observed at close range in the open ocean 10 miles south of Pago Harbor by O'Connor and West Jr. from the Park boat. The medium, all-brown birds with short, wedge-shaped tails, distinct dark Procellarid beaks and dark legs were flying close to the water's surface and were curious about the boat, staying with the boat and criss-crossing overhead for several minutes while we traveled at low speed. Because of their size, could also possible be Short-tailed Shearwaters, however, the underwings were markedly brown, with no hint of silver.

Sooty/Short-tailed Shearwater (*Puffinus griseus/tenuirostris*)  
Grant and Clapp (1994) report two live Sooty Shearwaters were found. Migrants from Australia and New Zealand, Sooty and Short-tailed are very similar in appearance. O'Connor reported a Short-tailed Shearwater in flight along the beach adjacent to Va'oto marsh on Ofu.

Crested Tern (*Thalasseus bergii*)  
Rauzon saw one from Ofu Beach in 1995 and reported to D. Watling for his 2001 book.

Masked Booby (*Sula dactylatra* MABO)  
MABO breeding range stretches across all three oceans. The breeding range in the Main Hawaiian Islands is limited to Ka'ula (200-400 pr.), Moku Manu (40 pr.) and Lehua (5-10 pr.). Most of the population is in the NWHI. The Hawaiian population is projected around 6770 birds (1). The largest colony in the region is Jarvis Island NWR where up to 5,000 have been counted. The MABO population is widely dispersed and therefore difficult to estimate, but the pan-tropical population is thought to be large. The total world population estimate is several hundred thousand birds and declining.

A pair was observed in flight NW of Cape Matatula on Tutuila by O'Connor and Squier from the Park boat on 27 December, 2000. The birds were easily distinguishable at close range from the scarce

white-phase Red-footed Boobies. Masked Boobies do not occur at Rose Atoll.

#### Spotless Crakes (*Porzana tabuensis*)

Not globally threatened. This resident flighted rail is present over much of Australia, New Zealand New Guinea and many oceanic islands as far west as the Tuamotu and Marquesa Islands where populations are very small. Approximately one-third of the 133 species within the Rallidae family are threatened with extinction due to habitat loss. For lack of information, some species are becoming endangered before a conservation strategy can be devised. With rats in their Ta'u habitat, this population of rail is highly vulnerable. See Appendix G for more discussion.

#### Hypothetical Seabird Occurrences

##### Collared Petrel (*Pterodroma brevicipes*)

Collared Petrels also occur at in Fiji, Cook Is., Vanuatu, and possibly Solomon Islands. A new form is recently described from New Caledonia. It is possible that Collared Petrels breed in Samoa but should be considered hypothetical. An adult was turned into DMWR, photographed and released alive by Joshua Seamon (DMWR) in 2002 on Tutuila. This Collared Petrel is a significant find since it fuels the assumption that they breed somewhere in American Samoa. Watling (2001) concludes that there were probably never any Collared Petrels in Samoa and those reported on Ta'u were Herald Petrels, however Herald's are distinctive in their breeding colony habits as diurnal visitors. Rauzon saw digital photos of the bird but no data of time and location of stranding was available. Other specimens have been picked up before on Tutuila.

The specimens collected thus far may be passing through the Samoan archipelago and get disoriented. However sightings of them made in Oct. 1976 by Amerson on Mt. Lata suggest they are resident breeders that thus far deny confirmation. O'Connor, Fialua, Aetonu and West Jr. observed a medium to small sized uniformly grey / white faintly mottled Petrel in flight at night over Ta'u in February 2000. Distinctive from the Tahiti Petrels with their more sharply defined colorations, the bird did not have a black hood, but was more uniformly grey/white in color. (See Mottled Petrel below).

### Mottled Petrel (*Pterodroma inexpectata*)

Mottled Petrels breed in New Zealand and are transients offshore Samoa enroute to the North Pacific; one on top of Ta'u must therefore be considered hypothetical. One was possibly sighted by O'Connor et al. during Mt. Lata research trip in February 2000 but identification could be easily confused with Collared Petrel above. The bird was medium to small in size and grey to mottled-white in coloration, possibly with black markings scattered throughout. The gray-white coloration was unique after viewing several dozen darker patched Tahiti Petrels at the same time. The individual was close by when gliding above the brush, and was not observed to dive into the vegetation as Tahiti Petrels were commonly doing. The bird was attracted to our lights but flew off out of sight without landing.

### Phoenix Petrel (*Pterodroma alba*)

This endemic Pacific tropical species population center appears to be at Kiritimati, Kiribati (Christmas Island, Central Pacific Ocean). This colony was believed to be the largest in the world, estimated to be 20,000-25,000 in 1980-82 but today the population may be as high as 10,000 pairs, and its range is contracting and threatened at all sites.

Phoenix Petrels are residents of low tropical atolls and are diurnal at the colony, so they are considered here as hypothetical. Birds calls were heard by O'Connor both on Mt. Lata and on the vegetated cliff faces of Pioa (Rainmaker Mountain) on Tutuila that resembled this species. Phoenix Petrels are very similar in appearance to Tahiti Petrel, although slimmer and smaller. On our first summit trip to Mt. Lata, O'Connor and crew observed several Petrels in flight different from the more distinguishable Tahiti Petrel in that they were smaller in size, and our first thoughts from written descriptions were Phoenix Petrels.

### Polynesian Storm-Petrel (*Nesofregetta fulginosa*)

The Polynesian Storm Petrel may be on the verge of extinction. Very rare in US Pacific Islands, found only at Jarvis I. and American Samoa. Three birds were seen on Jarvis I. in 2000, Seen at sea near

Samoa. Breeds at Kiritimati, Kiribati (Christmas Island, Pacific Ocean). In 1967, population estimated to be 350-450 (+/-5%). In 1980-82, an estimated minimum of 1,000 pairs was recorded. Population may number in several hundred pairs. Breeds in the Gambier Is, recorded on two. The population could be between 10-100. May also breed at Fiji and Vanuatu, possibly Sala y Gomez. The world population very small and declining, probably increasing at Jarvis I. Believed to be a resident breeder, this is a very rare species in Samoa where sightings have not been made in several decades. Last seen on Ta'u summit in 1976 (Amerson et al. 1985).

O'Connor reports seeing a few tightly formed flocks of 3-4 individuals each flying along the eastern shoreline of Pago Pago harbor seen in June 2000 from the Park boat. Because these birds are nocturnal and are open ocean birds, they are unlikely to be seen in groups near shore in daylight, and because they have not been recorded in over 25 years they are considered as hypothetical until better documented.

#### Wedge-tailed Shearwater (*Puffinus pacificus* -WESH)

WESH are abundant with total population well over one million breeding pairs. WESH distribution covers the tropical and subtropical Indian and Pacific Oceans. Their marine range stretches as far as China, New Zealand, Easter I. and the Bismarck Archipelago. Breeding ranges from Madagascar to Western Australia in the Indian Ocean and in the Pacific Ocean from Japan to East Australia, Marquesas Is. Pitcairn Is. The Hawaiian population spans the Archipelago from the offshore islets of the main Hawaiian Islands to Kure Atoll and is as high as 323,900 pairs. The Johnston Atoll population is 2,500 and Wake Atoll is 50 pairs and increasing. Line Is population likely decreasing due to losses at Kiribati once estimated at 1,000,000 birds (Naughton 2003).

WESH may nest on Pola and Mt Lata on Ta'u but are not confirmed, nor considered to by recent workers (Watling 2001). However, O'Connor may have heard calls resembling those of WESH at Mt. Lata summit area in June 2000, when large numbers of Tahiti Petrels were not present. WESH were believed to have been extirpated by early Polynesian colonists, however, specimens have

been collected from American Samoa in the 1970's and may be in the Kansas State Museum.

## Historical Seabirds<sup>10</sup>

Onshore appearance of seabird species that are not resident breeders has been well documented. Grant and Clapp (1994) describe new records of two live Sooty Shearwaters (*Puffinus griseus*), one Newell's Shearwater (*P. auricularis newelli*) and a wing from a dead White-faced Storm-Petrel (*Pelagodroma marina*).

Archeological research also suggests disoriented seabirds were eaten, and from their presence in archeological excavations were later interpreted to be part of the endemic fauna. Steadman (1993) conjectures that there may have been a resident seabird very similar to Sooty Shearwater, extirpated by Polynesians but Grant and Clapp (1994) report two live specimens found. A common migrant passing through the region today, some may have been blown ashore in the prehistoric past when the birds were even more numerous. Other results create a picture of pre-Polynesian species that are no longer extant at sea level:

### Archaeological bird findings from Ofu, American Samoa

Species Found	Number of Bones
Wedge-tailed Shearwater	11
Sooty Shearwater	15
Audubon's Shearwater	2
Tahiti Petrel	6
Herald Petrel-like spp.	2
<i>Megapodius spp.*</i>	2

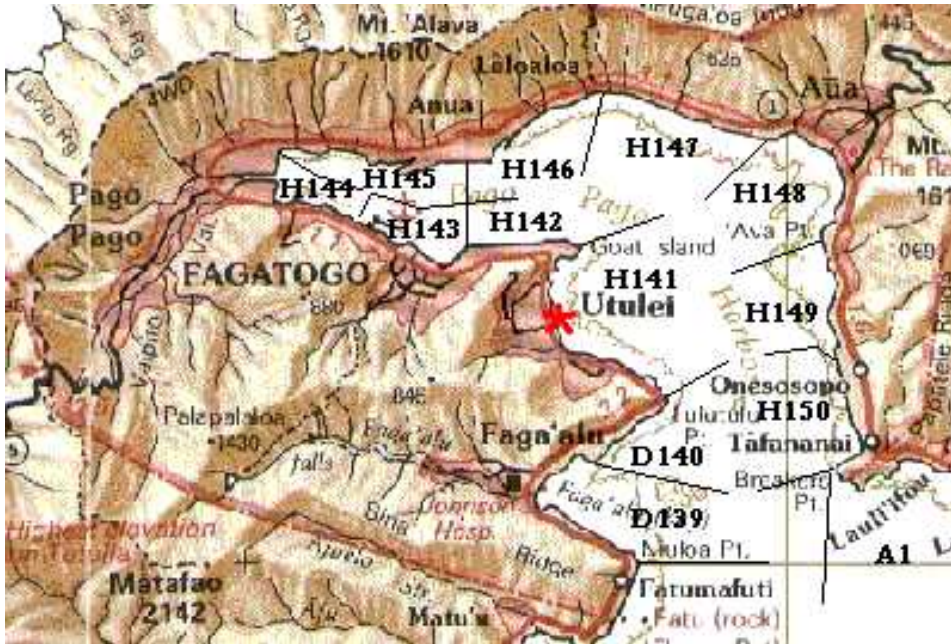
\*Steadman found 2 bones of a *Megapodius spp. richardii* type from Tonga that are now extirpated in Samoa, suggesting people ate the last of these flightless ground-nesting land birds.

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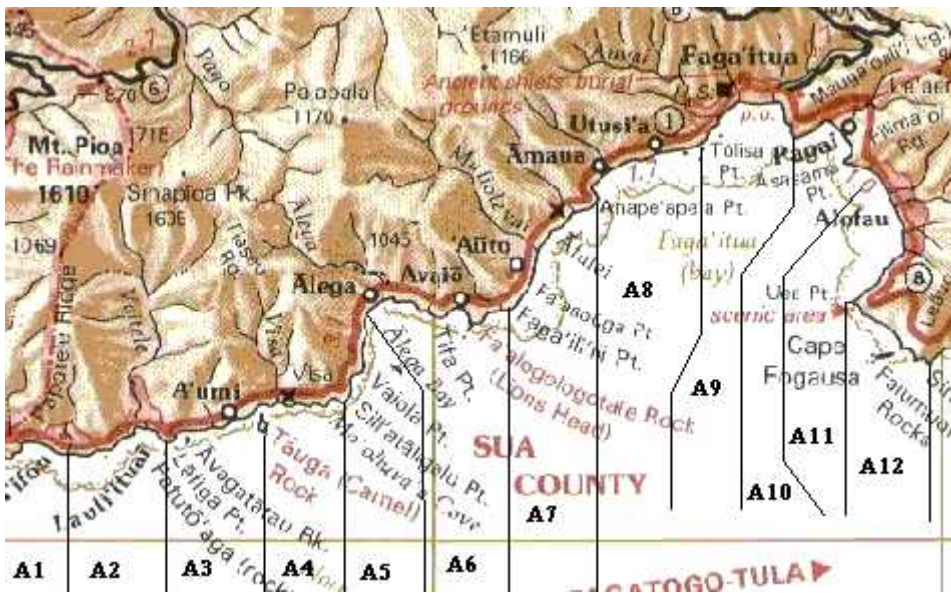
<sup>10</sup> See **Appendix A** for complete literature review, including estimated population numbers, of published accounts of seabird surveys in American Samoa.

APPENDIX B

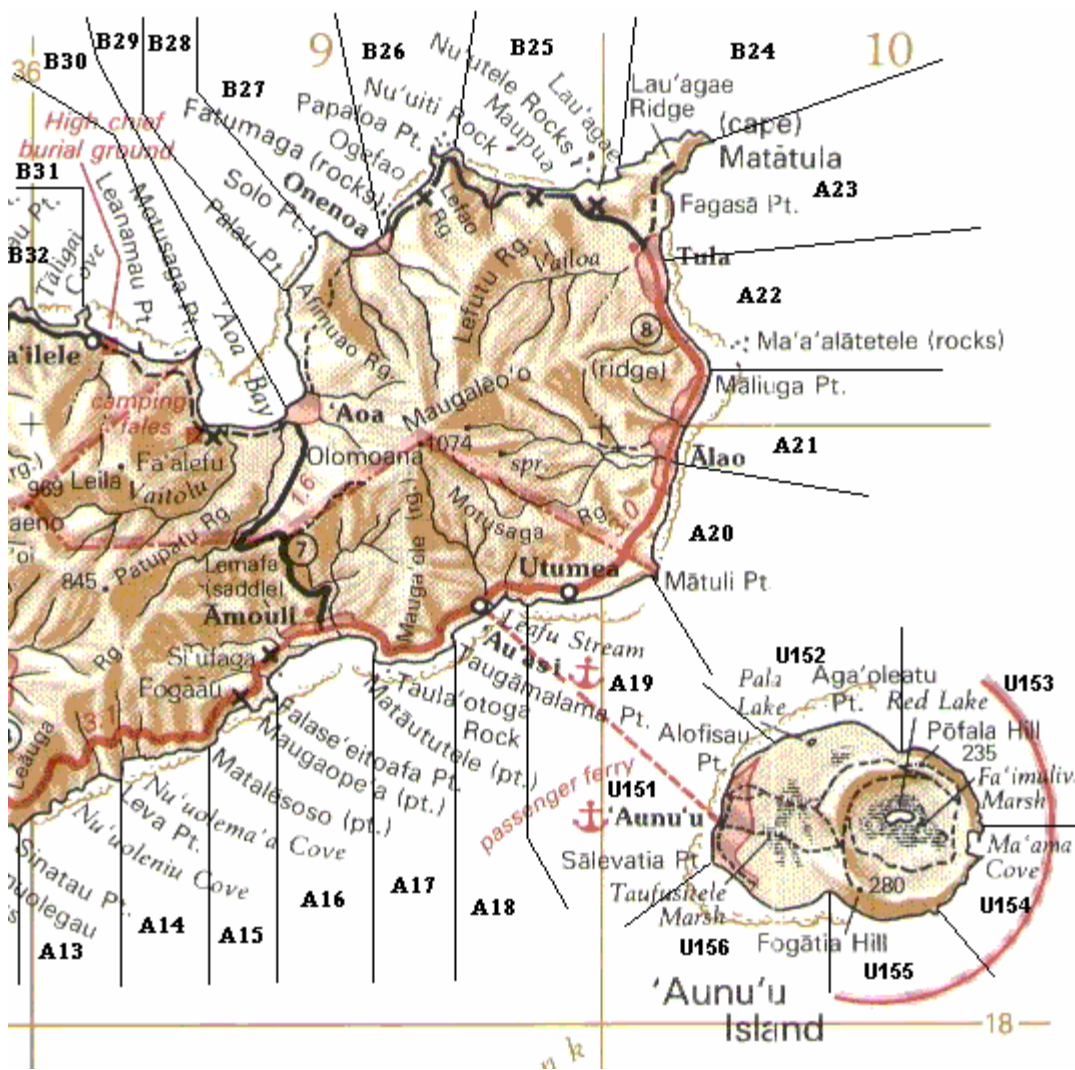
Tutuila and Aunu'u Islands, Round Island Survey Site Maps



Start of Survey at Southeast Quadrant Unit A1  
End of Survey at Southwest Quadrant Units D138-D140 & Harbor  
Units H141-H150,



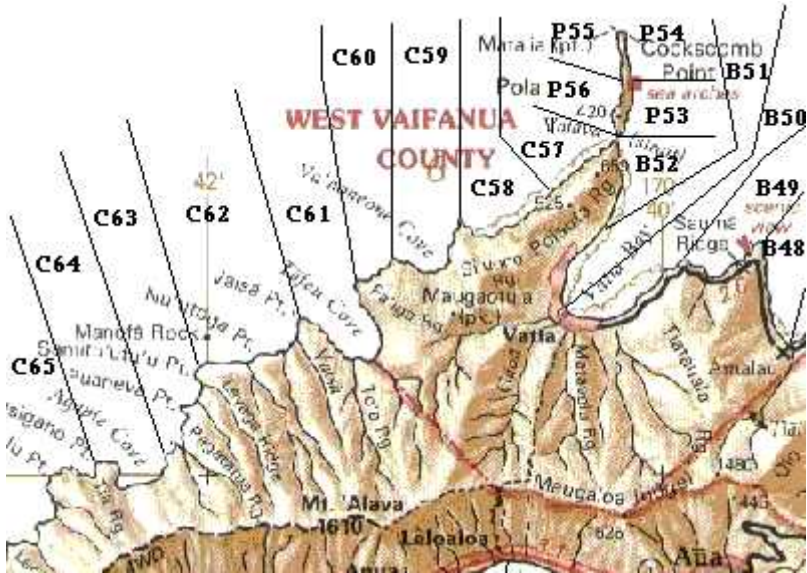
Southeast Quadrant (Units A1-A12)



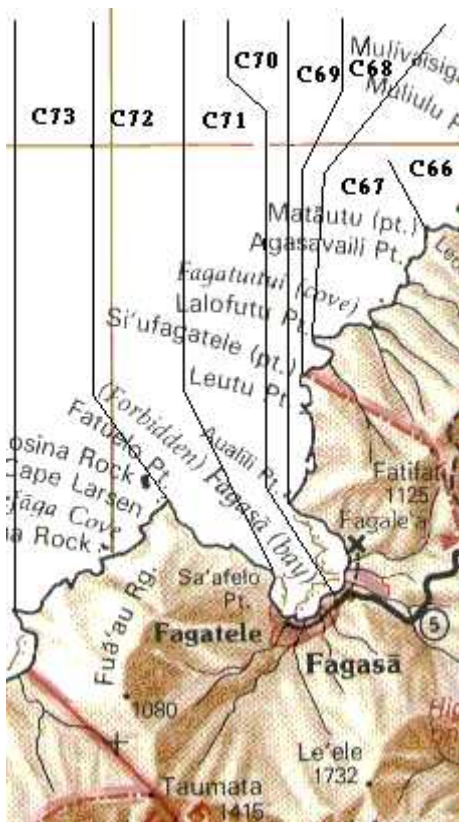
Southeast Quadrant Units A13-A23, Northeast Quadrant Units B24-B32, Aunu'u Units U151-156



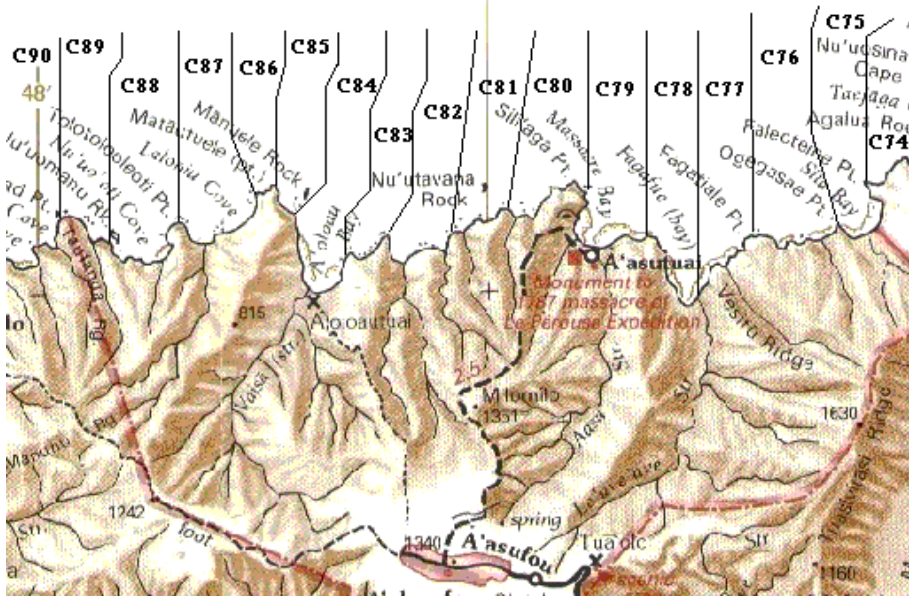




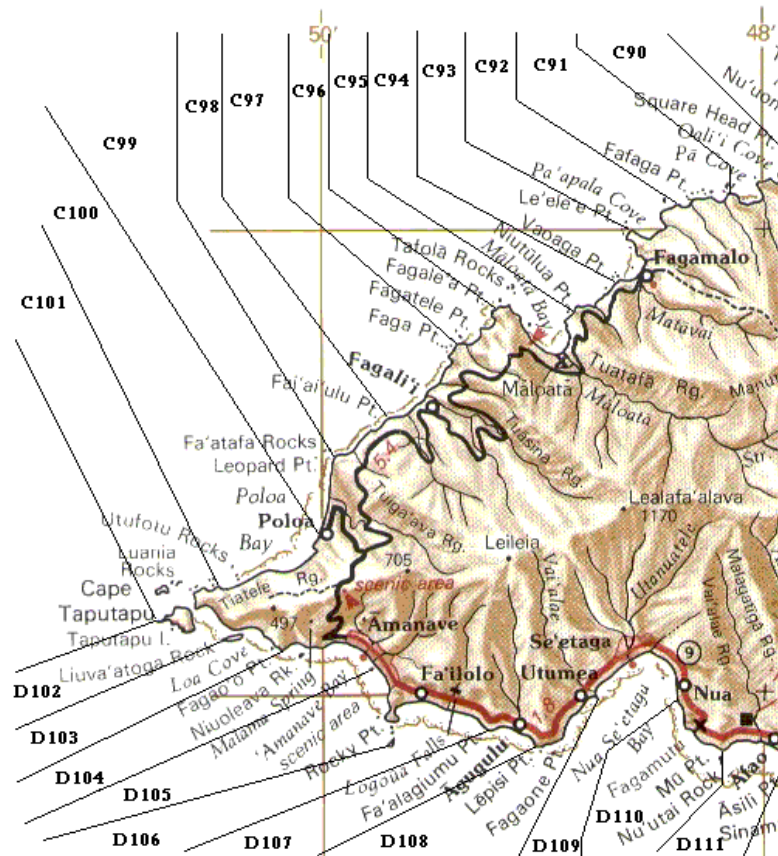
Northeast Quadrant Units B48-B52, Pola Islet Units P53-P56,  
Northwest Quadrant Units C57-C66



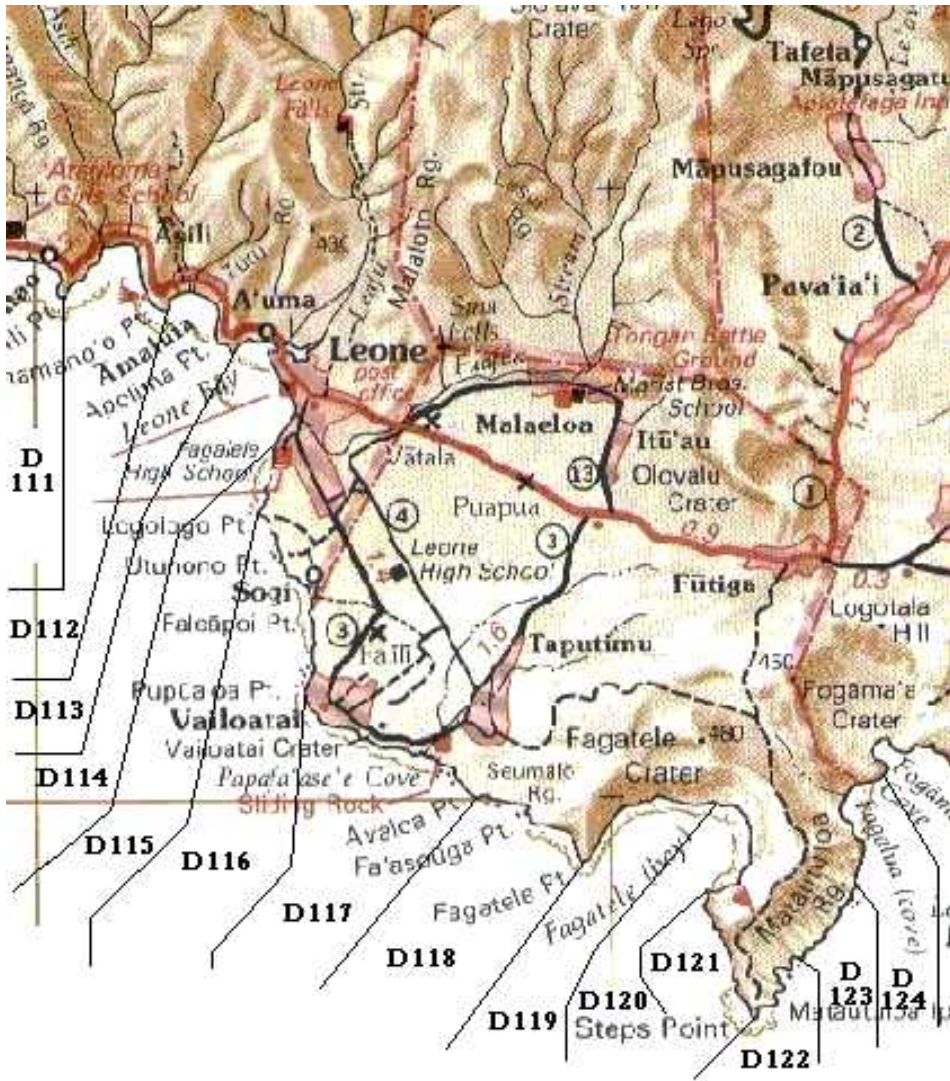
Northwest Quadrant Units C66-C73



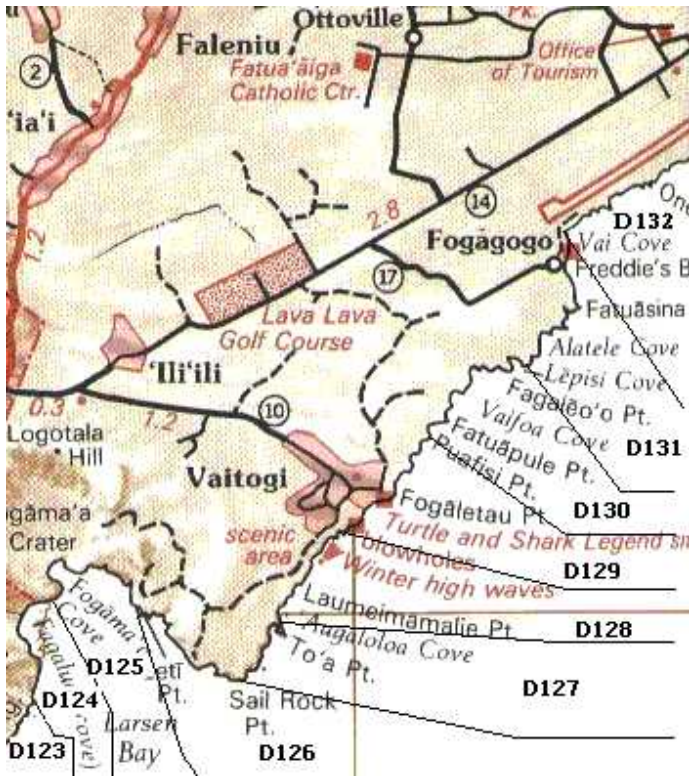
Northwest Quadrant Units C66-C73



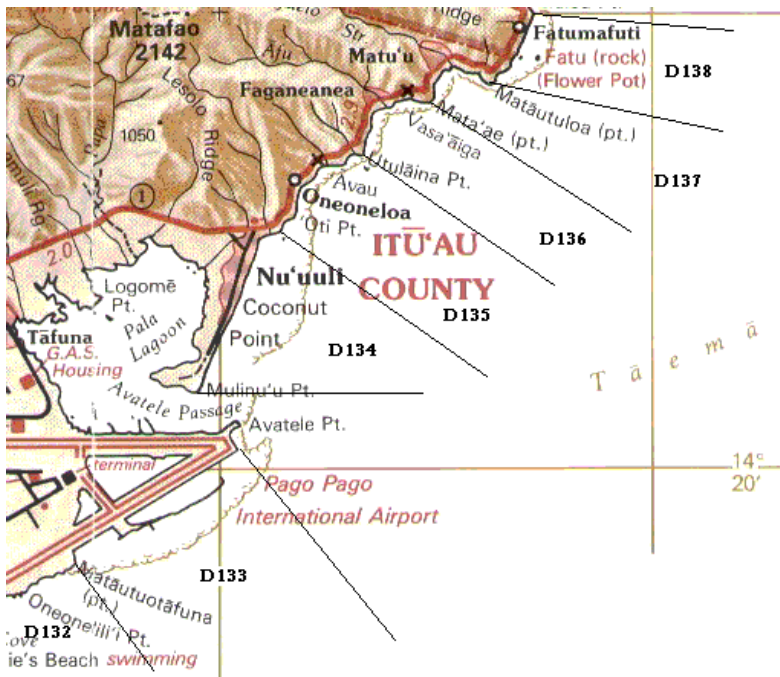
Northwest Quadrant Units C74-C101, Southwest Quadrant Units D102-D111



Southwest Quadrant Units D112-D124



Southwest Quadrant Units D123-D132



Southwest Quadrant Units D132-138

## Tutuila Island Survey Sampling Units

Unit	Left-hand starting point	Right-hand ending point
A1	Breakers pt	to mid-Lauliifou
A2	mid-Lauliifou	to Fatutoaga rock
A3	Fatutoaga rock	to Tauga rock
A4	Tauga rock	to east edge mooliuvaa cove
A5	east edge mooliuvaa cove	to Tisa's barefoot
A6	Tisa's barefoot	to Fagailiili pt
A7	Fagailiili pt	to Anape'ape'a pt
A8	Anape'ape'a pt	to Tolisi pt
A9	Tolisi pt	to Leanaosaualii pt
A10	Leanaosaualii pt	to rock west of Alofau
A11	rock west of Alofau	to Uea pt
A12	Uea pt	to Sinatau pt
A13	Sinatau pt	to Leva pt
A14	Leva pt	to Matalesolo pt
A15	Matalesolo pt	to Falaseeitoafa pt
A16	Falaseeitoafa pt	to Matauluele pt
A17	Matauluele pt	to Taugamalama pt
A18	Taugamalama pt	to Maatulaumea pt
A19	Maatulaumea pt	to Matuli pt
A20	Matuli pt	to 1/2 way to Maliuga pt
A21	1/2 way to Maliuga pt	to Maliuga pt
A22	Maliuga pt	to mid point of Tula village

A23	mid point of Tula village	to Cape Mataatula
B24	Cape Mataatula	to west edge pt of Laugae ridge
B25	west edge pt of Laugae ridge	to east edge of Papalooa pt
B26	east edge of Papalooa pt	to mid Onenoa village
B27	mid Onenoa village	to Solo pt
B28	Solo pt	to Palau pt
B29	Palau pt	to Tapua stream mouth in Aoa
B30	Tapua stream mouth in Aoa	to Motusaga pt
B31	Motusaga pt	to Malo pt
B32	Malo pt	to Folau pt
B33	Folau pt	to Puputagi pt
B34	Puputagi pt	to Tiapea pt
B35	Tiapea pt	to stream mouth in cove
B36	stream mouth in cove	to stream mouth at end of bulge
B37	stream mouth at end of bulge	to mid Masefau village
B38	mid Masefau village	to Vainu'u mountain pt
B39	Vainu'u mountain pt	to east pt of Fagalua cove
B40	east pt of Fagalua cove	to Lepua pt
B41	Lepua pt	to Tapisi pt
B42	Tapisi pt	to stream mouth at Oa
B43	stream mouth at Oa	to Vainu'u pt
B44	Vainu'u pt	to Tulagamatu'u pt
B45	Tulagamatu'u pt	to 1/2 pt of westshore of afono bay
B46	1/2 pt of westshore of afono bay	to craggy pt

B47	craggy pt	to Amalau stream
B48	Amalau stream	to Samua ridge pt
B49	Samua ridge pt	to ne edge of Vatia bay
B50	ne edge of Vatia bay	to mid Vatia village
B51	mid Vatia village	to end of structures in Vatia
B52	end of structures in Vatia	to end of Polauta ridge
P53	se quarter of Pola islet	
P54	ne quarter of Pola islet	
P55	nw quarter of Pola islet	
P56	sw quarter of Pola islet	
C57	end of Polauta ridge	to midpoint west face Polauta ridge
C58	midpoint west face Polauta ridge	to east pt before va'aogeoge cove
C59	east pt before va'aogeoge cove	to west pt after va'aogeoge cove
C60	west pt after va'aogeoge cove	to east pt of Tafeu cove
C61	east pt of Tafeu cove	to Vaisa pt
C62	Vaisa pt	to Samitu'utu'u pt
C63	Samitu'utu'u pt	to Tialeogaumu ridge
C64	Tialeogaumu ridge	to Mulivaisigano pt
C65	Mulivaisigano pt	to Muliulu pt
C66	Muliulu pt	to Matautu pt
C67	Matautu pt	to Lalofutu pt
C68	Lalofutu pt	to Siufagatele pt
C69	Siufagatele pt	to Siufaga pt



C70	Siufaga pt	to 1/2 pt Fagasa bay
C71	1/2 pt Fagasa bay	to Sa'afelo pt
C72	Sa'afelo pt	to Fatuelo pt
C73	Fatuelo pt	to Agalua rock (all of Cape Larsen)
C74	Agalua rock (all of Cape Larsen)	to Faleoteine pt
C75	Faleoteine pt	to Ogegasa pt
C76	Ogegasa pt	to Fagatiele pt
C77	Fagatiele pt	to Leavenave stream
C78	Leavenave stream	to (next point of land)
C79	(next point of land)	to Siliaga pt
C80	Siliaga pt	to (next point of land)
C81	(next point of land)	to (next point of land)
C82	(next point of land)	to (next point of land)
C83	(next point of land)	to east edge of Aoloau bay
C84	east edge of Aoloau bay	to west edge of Aoloau bay
C85	west edge of Aoloau bay	to Mataututele pt
C86	Mataututele pt	to Greyhound pt
C87	Greyhound pt	to Tolotolooleoti pt
C88	Tolotolooleoti pt	to west side edge Nu'uomanu rocks
C89	west side edge Nu'uomanu rocks	to Squarehead
C90	Squarehead	to pt west of second cove
C91	pt west of second cove	to Fafaga pt
C92	Fafaga pt	to Leelee pt
C93	Leelee pt	to Vaoaga pt
C94	Vaoaga pt	to Niutulua pt

C95 Niutulua pt	to Tafola rocks
C96 Tafola rocks	to Faga pt
C97 Faga pt	to Faiaiulu pt
C98 Faiaiulu pt	to Fa'atafa rocks
C99 Fa'atafa rocks	to Poloa village
C100 Poloa village	to Utufotu rocks
C101 Utufotu rocks	to rocks at pt of Taputapu
D102 west end Taputapu islet	to west end Liuvaatoga rock
D103 west end Liuvaatoga rock	to Fagao'o pt
D104 Fagao'o pt	to Utusiva rock
D105 Utusiva rock	to rocky pt at east end of Amanave bay
D106 rocky pt at east end of Amanave bay	to Fa'alagiamu pt
D107 Fa'alagiamu pt	to Lepisi pt
D108 Lepisi pt	to Maugatele rock
D109 Maugatele rock	to east end of Nua village
D110 east end of Nua village	to Mu pt
D111 Mu pt	to Asili pt
D112 Asili pt	to Sinamano'o pt
D113 Sinamano'o pt	to Niuaveve rock
D114 Niuaveve rock	to Fagalele jr. high
D115 Fagalele jr. high	to Logologo pt
D116 Logologo pt	to east edge Pupuloa pt
D117 east edge Pupuloa pt	to Avaloa pt
D118 Avaloa pt	to Fagatele pt

D119 Fagatele pt	to to notch at halfway pt inside Fagatele bay
D120 to notch at halfway pt inside Fagatele bay	to east edge Fagatele bay
D121 east edge Fagatele bay	to Steps pt
D122 Steps pt	to third rock east of Matautuloa pt
D123 third rock east of Matautuloa pt	to pt east of two small rocks
D124 pt east of two small rocks	to pt east of Fagalua cove
D125 pt east of Fagalua cove	to Leti pt
D126 Leti pt	to Sail rock pt
D127 Sail rock pt	to Toa pt
D128 Toa pt	to start of dirt rd from vaitogi to Larsen's bay
D129 start of dirt rd from vaitogi to Larsen's bay	to Puafasi pt
D130 Puafasi pt	to Lepisi cove
D131 Lepisi cove	to Va'i cove at west end of airport runway
D132 Va'i cove at west end of airport runway	to Matautuotafuna pt
D133 Matautuotafuna pt	to east end of airport runway
D134 east end of airport runway	to east end of coconut pt
D135 east end of coconut pt	to Utulaina pt (Fatuuli Rock)
D136 Utulaina pt (Fatuuli Rock)	to Mata'ae pt
D137 Mata'ae pt	to Matautuloa pt
D138 Matautuloa pt	to Niuloa pt
D139 Niuloa pt	to wide pt east of Faga'alu bay
D140 wide pt east of Faga'alu bay	to Tulutulu pt
H141 Tulutulu pt	to Nu'ututai point
H142 Nu'ututai point	to customhouse

H143 customhouse	to main docks
H144 main docks	to head of harbor, townside
H145 head of harbor, townside	to mid pt of canneries
H146 mid pt of canneries	to bulkhead in Leloaloa
H147 bulkhead in Leloaloa	to Leasi pt
H148 Leasi pt	to Aua pt
H149 Aua pt	to tanks at Anasoposopo
H150 tanks at Anasoposopo	to Namumea'avaga point

## APPENDIX C

### Tahiti Petrel Voice Analysis

Vocalization analysis and auditory surveys are possible with recorded sounds. The parabola allowed us to record with greater range than before. The Stith website [[www.stithrecording.com](http://www.stithrecording.com)] reports:

“A parabolic reflector will allow you to pick up sounds much further away than a shotgun microphone. A parabolic microphone is equivalent to having a telephoto lens. It zooms in on the bird enabling you to pick up the bird at a further distance away, with much less surrounding noise. To get a sense of this difference, a parabola may pick up sounds 150' or more whereas a shotgun microphone may be able to only pick up sounds 30' to 75' away. This is all very dependent, though, on how loud the source is that you're trying to record, how much surrounding noise is present, and what microphone and recorder you are using. A parabola is also much more directional than a shotgun microphone... A disadvantage of using a parabola is its somewhat cumbersome size. If you'll be walking through thick brush, a shotgun microphone may be much easier to carry around and it's also easier to operate. A parabola may also not be the best choice if you're recording in high wind or rain.”

### Auditory Census

Tapes require further technical analysis to determine if counting the calls is a way to obtain a meaningful index of bird density per time of night and season. Sound analysis is a rapidly developing field. New programs like Canary 1.2.4 or Raven are available from Cornell University for about \$250.00. Personnel from the Cornell Library of Natural Sounds report "If you were recording with a single microphone, it is probably impossible to determine how many birds were recorded, unless there are very few calls and you have additional information available. For example, if you have some evidence that calls of individual birds are distinctively and reliably recognizable from each other based on their acoustic structure, you could perhaps infer numbers of birds from recording if there aren't too many. But this would be an unusual circumstance." Because only

one microphone was used, and many whistles sound familiar, it may not be possible to determine how many birds were calling. Further investigation is required. Copies of tapes of various calling birds will be archived at the Macaulay Library (formerly the Cornell Library of Natural Sounds). Greg Budney (gfb3@cornell.edu) is curator of the sound collection.

Preliminary analysis of the calls suggest the Tahiti Petrels have a rich vocal repertoire that is rare, if not unique, in the *Pterodroma* genus. Tahiti Petrels are classified as *Pseudobulweria*, close relatives to *Pterodroma* and their calls are much more complex than any species described by Warham (1992). The typical *Pterodroma* calls seem comprised of staccato notes repeated in a long sequence. Warham describes several types of calls including:

The typical "ti-ti" call, a series of short staccato notes produces a continuous chattering chorus, known from 21 species both large and small. Syllables plotted as inverted 'U's develop into longer ones. "With some species the harmonic structure results in a rather soft call with a liquid timbre" Warham (1992).

The 'Kuk-u-er' call and the 'Quor-wik' call are a low-pitched drawn out notes followed or preceded by one or more staccato 'ti' or 'wik' notes. The 'Moan' call is a distinctive low-pitched note held at constant frequency for several seconds. The 'Purr' call sounds like the 'churring' of Storm Petrels.

Tahiti Petrel vocalizations are idiosyncratic and we present several varieties on the basic ground-call. The calls of several individuals were made into sonagrams). Warham writes: "The acoustic structure and disposition of the harmonics, if any, vary from bird to bird and may also change in the course of a call." We found this to be true and were surprised by the amount of harmonics evident on the sonagram compared to the 'shreik' of the call itself. Figure 2 shows the complex harmonics in each call.

*Pseudobulweria rostrata* which has two main types of calls: the in-flight whistle and the on-ground "braying." The flight call constitutes a portion of the ground call: an up-slurred and extended whistle modified for flight. Tahiti Petrels occasionally issue a full

ground call in flight. As with the 'ti-ti' chorus described by Warham (1992), the whistles build upon each other and create a 'wall of sound'. Some whistles are attenuated, others are short and seems like ecolocators in a foggy, windy valley.

The ground-call consists of a drawn-out braying whistle comprised of five main parts: the hiccup, a pause, harmonics, whistle and the moan. Sexual dimorphism is suggested in the dueting calls where one call overlaps the end of the other. Figure 4 show two birds dueting. One birds nearing the end of its call is picked up by another during the 'hiccup' portion. The body of both dimorphic calls are fundamentally different. The fuzzy center may be a harsh rasp made a male and the narrow whistle-end may be a female. Each call starts with the hiccup note separated by a gap (inhalation?) then the variable center portion rich in harmonics. The last portion is drawn out whistle or moan. See Figure 5.

This theory was tested in this year by making tapes of known weight measured birds that might give another indication of gender, assuming females are smaller than males. We were able to obtain physical measurements and recordings from the same birds, based on weight and assuming males are heavier than females, we hoped to determine the gender. However, ambiguous results were obtained. In spite of a weight difference in 50 grams, the calls were superficially similar consisting of a moaning quality with differing silence gaps between the hiccup and the body of the call. In addition, the 2002 calls were different than the 2001 calls where overlap was detected. Figure 5 is the typical call made from the ground in 2002.

Looking at the other physical parameters, the culmen and tarsus are similar sized and suggest these are same-sexed birds. Just what that sex is still open to question. Sexual dimorphism is supposed by many workers but none has established this unequivocally on sexed birds. From direct observations of mating birds, Grant deduced in Bonin Petrels that the 'purr' and 'ti-ti' calls were males and the 'kuk-u-er' were females (cite in Warham 1992 ).

Tomkins and Milne (1991) recognized two series: 'sweet' calls where the moan was a pure tone and the 'ti-ti' with clear harmonics, and

the 'coarse' calls of similar pattern with few harmonic structures. They concluded that the sweet calls were used by males and coarse ones by females. Ristow and Wink (1980) found Cory's Shearwater (*Calonectris diomedea*) females had more rasping and lower pitched flight calls with much energy around 1 kHz. (cite in Warham 1992).

Other vocalizations are difficult to place in any onomatopoeic categories and this is the case with the Tahiti Petrels. Appendix 1 is a catalog of call types including flight calls, moans, duets, goose-like, idiosyncratic calls, etc. Also included is a sonagram of a call of the Audubon Shearwater from Ta'u (Appendix 1).

Vocalization work contacts:

Les McPherson  
McPherson Natural History Unit Sound Archive  
PO Box 21-083 Edgeware  
Christchurch, NZ  
64 (03) 942 3027  
fax: 64 (03) 365 3467  
[archivebirdsNZ@hotmail.com](mailto:archivebirdsNZ@hotmail.com)



## Appendix D

### Ectoparasites from Tahiti Petrels on Ta'u

Ectoparasites from a Tahiti Petrel specimen on Mt. Lata were collected by O'Connor and deposited with Dr. Ricardo Palma at Te Papa, National Museum of New Zealand, Wellington. Dr. Palma, in addition to identifying the specimens, provided background and their associations with Procellaridae. Dr. Palma would much appreciate any sample collected in the future (contact details below). Natural history and identification of the sampled lice as well as excerpted details from our correspondences follow:

The sample contained 14 lice (12 males, 1 female, 1 nymph) of the species *Halipeurus marquesanus* (Ferris, 1932).

It is unusual to have such a marked bias towards males, generally in lice and within *Halipeurus* in particular. Perhaps the fact that the host may be a chick might have some relevance. Later analysis of the specimen determined it was in fact a small adult bird.

Te Papa's collection includes samples of *Halipeurus marquesanus* (Ferris, 1932) from the following localities: Tahaa island (Society Is), Tavenni Island (Fiji Is), Marquesas Is, New Caledonia and New Zealand.

So far, the species *Halipeurus marquesanus* (Ferris, 1932) has been found on the Tahiti Petrel only. Two other species have been recorded from the Tahiti Petrel: one is *Ancistrona vagelli* (J.C. Fabricius, 1780), a species seldom collected, usually in very small numbers, but widespread on a great number of Petrel species. The other is a yet undetermined species of the genus *Saemundssonina*.

Potentially, the Tahiti Petrel may be host to lice belonging to other 3 - or even 4 - genera. Only further collecting will uncover what other louse species may be lurking in their plumage... Needless to say that you should not miss any future opportunity to delouse more of these very interesting birds.

The genus *Halipeurus* contains about 30 species all parasitic on Petrels of the genera *Pterodroma*, *Bulweria*, *Pseudobulweria*, *Puffinus*, *Calonectris*, *Pelecanoides*, *Pelagodroma*, *Oceanites*, *Halocyptena*, *Fregetta* and *Oceanodroma*.

Despite a request for additional parasite samples to be collected during processing of the Petrel specimen at the Smithsonian, and the importance these ectoparasites may offer for taxonomical clarity regarding Tahiti Petrels, these details were overlooked. Any future collections would be much appreciated by Dr. Palma, and could prove instrumental in determining the taxonomical status of Ta'u Petrel populations.

Few species of lice are known from this Petrel species (Tahiti), therefore any material is most welcome. Upon collection, preserve the specimens in ethanol or methanol but not in formalin. Send them in a strong vial, well cushioned inside a strong box to withstand the perils of the mail service. Address the parcel to Dr. Palma at the museum (see full address below) and declare them as "Dead insects for scientific studies". DON'T write the words "lice", "parasites", "ticks", "fleas" or anything which may make NZ agriculture officers (sometimes not well informed as to what these creatures are) weary and confiscate the specimens.

For any parasite, the host name is the most important piece of information. However, the locality & date of collection, the name of the collector and, in the case of internal parasites, the site within the body, are also important.

The locality - Ta'u Island, American Samoa - is perfect for a description...the locality of this sample is new for our collection. For louse ecological studies, it is good to have samples from a wide range of localities, especially if one is working with hosts covering a wide distribution”.

There is no problem whatsoever if the lice have been frozen... most of the lice I have here (over 100,000 of them) have originated from birds which were frozen prior to louse collection.

Most Petrels are parasitized by 4 or 5 louse species ALL co-inhabiting the same individual bird. The only difference is that some species are mainly found on the wings while others on the head and others on the belly, or back, etc.

Tahiti Petrels have *Halipeurus* on their wings, *Ancistrona* on the body and *Saemundssonina* on the head and neck, but there is still the possibility for other species of other genera to occur.

For future collections, follow above instructions from Dr. Palma, and send to: Ricardo L. Palma, Curator of insects, Museum of New Zealand Te Papa Tongarewa, P.O. Box 467, 169 Tory Street  
WELLINGTON NEW ZEALAND

Phone + 64 4 381 7361

Fax + 64 4 381 7310

E-mail: [ricardop@tepapa.govt.nz](mailto:ricardop@tepapa.govt.nz)

[http://www.tepapa.govt.nz/our\\_resources/Bugs/collection\\_bugs.html](http://www.tepapa.govt.nz/our_resources/Bugs/collection_bugs.html)

## APPENDIX E

### Radar Survey Techniques Employed at Channel Islands National Park for Seabirds Nesting in Remote and Challenging Habitats

Ornithological surveillance radar techniques have been recently applied to successfully monitor and study aspects of the biology of other seabirds nesting in inaccessible habitats in old-growth forests (e.g., Marbled Murrelets *Brachyramphus marmoratus*), at offshore islands (e.g. Cassin's Auklets *Ptychoramphus aleuticus*, Xantus's Murrelets at Anacapa Island), and in high mountains (e.g., Newell's Shearwaters *Puffinus puffinus newelli*). In these studies, the radar was either mounted on boats for offshore work or mounted on a camper unit and 4-wheel drive truck for terrestrial work. Radar monitoring techniques have provided a new opportunity to measure changes in abundance and distribution of several types of radar have been effective tools in ornithological research for more than four decades (Eastwood 1967). Marine radar is probably the easiest and least expensive to operate, and has additional benefits of high resolution, small minimal sampling range, high availability, and high portability (Cooper et al. 1991, Hamer et al. 1995). Radar surveys have a distinct advantage over many types of surveys because they are able to detect flying birds: regardless of light levels and in complete darkness and fog; regardless of whether or not they are vocalizing; and small birds can be tracked out to a 1.2 km radius, much farther than by eye during daylight (Hamer et al. 1995). Radar also provides valuable information on bird flight speed, flight direction, behavior, and use areas (Hamer and Schuster. 2003).

#### Equipment

Radar surveys were conducted using a Furuno model FCR-1411, 10-kW, X-band radar unit, with a flexible 2-m long slotted wave-guide array antenna. Pulse length could be set at .08, 0.6, or 1.0  $\mu$  sec, depending on range setting. The radar beam had a vertical span of 25 degrees and a horizontal beam width of 2 degrees. We mounted the radar equipment on and conducted radar surveys from the CINMS vessel Balleña in 2000 and the CINP vessel Pacific Ranger in 2001-02. In 2000 we mounted the radar apparatus on the roof of the main wheelhouse of the Balleña, while in 2001-02 the radar was

mounted on a specially fabricated steel tripod 2 m above the wheelhouse of the Pacific Ranger. In 2001-02, we installed a Furuno model PG-1000 flux-gate compass to the radar which fixed the shoreline image on the radar monitor regardless of the shifting position of the vessel. In 2002, CINP skippers also developed a functioning stern anchoring system which greatly reduced boat movement due to anchor swing and anchor drag. The stern anchoring system kept the boat with the bow pointed toward the island such that the clarity of murrelet echoes near island-cliff nesting habitats were not affected by radar backscatter.

In 2002, we also refined our radar-tilting protocol to minimize the variation in murrelet detection rates during periods of poor weather. The angle of the radar antenna could be raised (in 5° increments) off the water to minimize wave clutter. However, echo sizes of targets near the surface of the ocean became smaller with each increment. Through several 2002 trials under different weather conditions, a tilt of < 10° was found to reduce wave clutter without reducing the overall detection rate or increasing the difficulty of identifying murrelets. In addition, working under high SW winds in particular tended to clutter-out portions of the water within 100 m of the shoreline in the “cliff zone” (see later). Radar counts typically show a reduction with higher winds (producing wave clutter on the radar screen) and radar tilt positions >10°. In 2002, we determined that ≥ 50% of the shoreline must be free of clutter to complete an adequate survey.

All data in 2000-02 were collected under relatively calm sea conditions with a radar tilt of 0-10° and, if increasing wave clutter prevented a complete four-hour survey of the cliff zone from 23:00-03:00, the survey was cancelled and the data was not used in the analyses. These various improvements served to increase the numbers of nights of data collection per year (by allowing data collection during marginal conditions) and improved data quality (by facilitating interpretation of echo trails) but we believe that data were still comparable between years. Due to the difficulty of detecting a small murrelet-type target at great distances with the radar, we found the 0.5 nm setting (1.1 km radius) was the most appropriate scale for monitoring. The radar completed one scan

every 2.5 sec with a plotting function set to 30 sec. Therefore, each radar target would leave an echo trail with each echo retained for 30 sec. The echo trail could be subsequently plotted and measured, allowing us to estimate flight speeds by using a hand-held scale and measuring the distance between three or more echoes.

### Data Collection

A biologist experienced in interpretation of radar echoes monitored the screen and recorded murrelet detections on a data sheet. Echoes on the radar screen were also recorded for the duration of each survey using a Sony 8mm video camera to enable biologists to review survey sessions at a later date. In 2000-2002, sites were monitored during the main incubation period in April and May, based on average timing at the SBI colony (Murray et al. 1983, Drost and Lewis 1995). In 2000, radar surveys were conducted throughout the night from 20:00 to 05:00 (PDT) (Hamer and Meekins 2000). This monitoring schedule allowed us to document activity patterns of murrelets throughout each night. In 2001-02, radar surveys were conducted at night during a four hour period from 23:00 to 03:00 (PDT). In 2000, these sampling hours had the smallest coefficient of variation in radar counts (Hamer and Meekins 2000).

For each radar detection we recorded: identification number, time, flight zone, flight behavior, distance between echoes on the radar screen (mm), flight speed (mph), and the number of radar echoes. In 2000, we segregated all murrelet detections into three zones of activity: a) cliff zone - murrelet targets detected within 100 m of the coastline; b) middle zone - murrelet targets detected seaward but within 101-400 m of the coastline; and c) sea zone - murrelet targets detected seaward > 400 m from the coastline. In 2001-02, we just recorded detections in the cliff zone since these counts had the lowest coefficient of variation in 2000 and murrelets detected flying into or out of steep slopes and cliffs at a distance of < 100 m from shoreline were more likely to be directly arriving at or departing from the monitoring area, reducing possible doublecounting (Hamer and Meekins 2000). In 2000-2001, large samples of flight paths in the cliff zone were plotted on U.S. Geological Survey 7.5' topographic maps, when time allowed. In 2002, we standardized this procedure and mapped the first detection observed at the beginning of every five minute interval. Within the cliff zone, we recorded four

categories of flight behaviors: a) inbound - targets flying towards the island within + 45 degrees of the coastline axis; b) outbound - targets flying away from the island within + 45 degrees of the coastline axis; c) circling - targets detected circling with a minimum of a 1/4 arc and; d) unknown - targets flying parallel to coastline or at angles >45 degrees of the coastline axis or targets that had no initial or final bearing from the shoreline.

In 2000-01, we recorded weather conditions at the beginning and end of each survey period. In 2002, we increased the frequency of weather data collection with weather and sea state information recorded at the beginning of each survey hour, including: percent cloud cover, horizontal visibility (good, fair, poor), wind speed (mph), wind direction, precipitation, air temperature (C°), sea surface temperature (C°), cloud ceiling height (m), and moon phase (quarterly). In 2002, we also collected data on light intensity (lumens/sqf) using a stow-a-way® data logger attached to the roof of the main wheelhouse. To minimize the effect of the anchor light (which is required on each vessel by law) on the data logger, the light was turned off at the beginning of each hour for 15 minutes while the logger retrieved information."

## APPENDIX F

Establishing a Water Collection System and Base Camp on Mt. Lata  
See <http://www.wildlifewaterguzzler.com/> for a 200 gallon light fiberglass tank (4'X2'X4')

### Efforts to date

O'Connor conducted extensive negotiations by phone and written correspondence through 2000-2001 with the US Coast Guard office in Honolulu, inquiring about the use of a helicopter often present on Coast Guard cutters that visit the Samoan islands out of Honolulu on an annual/biannual basis. The commander in Honolulu felt it was too great a risk to conduct operations in a remote location like Ta'u, where pilots have little flying experience at high elevation. At the time, the choppers on the long-liners in Pago Harbor were considered too light-weight to handle load lifting and high elevation / inclement weather flying.

Timing may have been key in this decision, as the CG has recently lost a chopper in Antarctic operations and may have grown shy on the idea of assisting. According to the Park Superintendent at the time, there are certain provisions in the federal government for agencies to enter into interagency agreements, and this was the option we were pursuing. If the cooperative agreement framework still exists, it may be worth a try to revisit the issue.

A helicopter would be useful to bring supplies and possibly a water collection system similar to the ones in use in the Kipahulu Valley at Haleakala NP on Maui. However, definitive decisions must be made, and permissions requested from the people of Ta'u before a semi-permanent structure is to be set in place. While human presence certainly contributes to the decline of the summit environment, something must be done to get a handle on the rat situation and possibly effect some type of control measure. Otherwise the significant seabird colonies of Mt. Lata may be ultimately surrendered to introduced mammalian predators.



## APPENDIX G

Status of the Spotless Crake in American Samoa.

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### ABSTRACT.

During July 2001, during seabird surveys in dense montane rainforest at the summit of Ta'u, we documented the occurrence of the Spotless Crake (*Porzana tabuensis*) in American Samoa for the first time in 17 years. The last sightings were made during 1985-1986 in lowland agricultural areas, semiwetland and secondary forests. Norway Rats (*Rattus norvegicus*) also were discovered in the montane forests and pose a threat to the continued survival of the crake at its only colony in the Samoan archipelago. Received 4 June 2003, accepted 15 August 2003.

The Spotless Crake (*Porzana tabuensis*), also known as the Sooty Rail, is present over much of South Pacific, including Australia, New Zealand, New Guinea, Philippines, and many oceanic islands as far east as the Marquesas Islands and Pitcairn Islands (Pratt et al. 1987). Although widely scattered in small vulnerable populations, the Spotless Crake (*P. t. tabuensis*) exists in virtually every major island group in the South Pacific. In Western Polynesia, it is extirpated from Futuna but occurs on three islands in Tonga, and on six islands in Fiji (Watling 2001). It is known from Samoa only on the island of Ta'u, the easternmost high island of the Samoan archipelago. This population was discovered in 1923 when biologists with the Whitney South Seas Expedition found the birds in marshy coastal habitat on the northwest side of the island (Murphy 1924, Banks 1984). Others were not able to find the secretive species during 1975-1976 (Amerson et al. 1982). The population was thought to be extirpated since it had not been seen since 1923 (Muse and Muse 1984), but was rediscovered during 1985, when a road-killed specimen was found. Subsequent searches found one individual, and

heard several more 1 km east of Ta'u village (Engbring and Engilis 1988). Since so much time had passed between the initial discovery and rediscovery, and these sightings were in lowland, agricultural forests in the northwest area where they were discovered, Engbring and Engilis (1988) speculated that the population was small and decreasing as wetland habitat diminished with a reduction in subsistence agriculture. The discovery of crakes at the summit of Ta'u suggests the population may have been larger than originally thought and that crakes could be present on other island summits in Samoa.

## STUDY AREA AND METHODS

Ta'u (14° 14' S, 169° 267'W) is the largest of the Manu'a Islands located approximately 100 km. east of Tutuila in the U.S. Territory of American Samoa. The National Park of American Samoa was established in 1993, and approximately half of the island of Ta'u was leased to the U.S. Park Service (Craig 2002). The Ta'u Island Unit encompasses 2,160 ha of coastal, upland and high elevation scrub forests rising from the eastern and southern coastlines to the highest point in the territory at the summit of Mt. Lata (966 m). Habitat at the summit is composed of dense montane rainforest characterized by the 'ie'ie vines *Freycinetia storkii* and *F. reinecki*, tree ferns (*Cyrtandra* spp.), native *Melastomes* and the invasive alien melastome (*Clidemia hirta*). Rainfall at the summit can exceed 750 cm per year and misty conditions characterize the daily weather. Hurricanes episodically modify the forest environment and the most recent (Hurricane Val in 1991), destroyed much of the tree canopy on the summit.

During seabird surveys in at the summit on 19 July 2001, at 08:00 h (Samoa standard time), we heard calls we thought were Tahiti Petrel (*Pseudobulweria rostrata*) or Audubon's Shearwater (*Puffinus lherminieri*) chicks in burrows, but the sounds apparently moved. The location was marked, and after dark we attempted to locate the adults arriving to feed the chicks at the burrow. Since no sightings were made, we placed a voice-activated tape recorder in the undergrowth at the site, but no vocalizations were captured on tape. When calls were heard again at 16:00, we tried to locate the bird by crawling through the tangled undergrowth of ferns and vines to the

base of several tree ferns, where the sound was last heard. Although some digging had occurred under the ferns, we found but no burrow or other nest. Later, we heard sounds from this area at about 07:30 on 21 July, and again attempted to find the calling bird in the dense vegetation. The sound moved away rapidly, suggesting a bird other than a seabird chick, which would have been unable to move so quickly in the dense undergrowth.

## RESULTS AND DISCUSSION

Our search through the tangles elicited bird movements and a rattle-like alarm call preceding the emergence of a Spotless Crake from the vegetation. Its conspicuous red eye, pink legs, and dark gray body were diagnostic. Crakes were heard again making a "bup-bup-bup-bup-bup" call from this site in December 2001 and December 2002. A "churring" call that was repeated at sunrise, and sunset near our camp, about 0.5 km from the previous site may have been this species. Another crake was heard and glimpsed in December 2002 in similar habitat about 1.6 km distant. Spotless Crakes are considered monogamous and territorial, possibly throughout the year (Taylor 1996). Our observations in the same area on our different visits suggest crakes are territorial year round and widely scattered through the montane forest area of Ta'u, estimated to be about 20 km<sup>2</sup>. Spotless Crakes have been recorded elsewhere at high elevations. They occur from sea level up to 3,300 m in New Guinea (Taylor 1996). Throughout its range, they are found in rank vegetation in almost any habitat, in fern-covered hillsides, heathy flats and coastal scrub, usually near water (Taylor 1996). On some islands, Spotless Crakes occupy low-stature forests and also rocky habitats without standing water. They also readily occupy artificial wetlands, farmlands, and seabird islands where they have been reported to eat a wide range of prey including insects on a cow carcass, seeds, shoots and invertebrates and eggs of shearwaters, petrels and terns (Taylor 1996). In the Kermadec Islands, New Zealand, they have been reported foraging in trees that hold Black Noddy (*Anous minutus*) nests (Taylor 1996). On Ta'u, Tahiti Petrels are relatively common nesters in the areas where crakes were encountered and it is possible that the crakes prey on Petrel eggs.

In July 2001, we also found that Norway Rats (*Rattus norvegicus*) were present in moderate densities on the summit of Ta'u. Throughout the Pacific Islands, Spotless Crakes have suffered reductions and local extinctions where humans and commensals are present (Taylor 1996). Overall, the status of the crake in Western Polynesia is alarming due to declining populations as a result of introduced dogs, cats, mongooses and rats (Watling 2001). Spotless Crakes survive in New Zealand rat-infested areas by inhabiting the wettest part of the marsh, where rats are least likely to go (C. R. Veitch, pers. comm.). Likewise, crakes may persist on Fiji, despite the presence of the mongoose, by inhabiting isolated swamps (Watling 2001). As a result of rat predation, Spotless Crakes have become rare on Norfolk Island, and the species is extinct on Raoul Island in the Kermadec Island group. Spotless Crakes persist in the Pitcairn Islands where rats have been eradicated from Oeno Island and should increase as a result (B. Bell, pers. comm.). On Poor Knights Island, New Zealand, Spotless Crakes increased after human occupation ceased and pigs were removed (Taylor 1996). Norway Rats have been present at low elevations on Ta'u for many years and may have contributed to the extirpation of the Spotless Crake from these areas. Pacific Rats (*R. exulans*) are common in the forest area on Ta'u, but evidently only Norway Rats are established in the upper rainforest. Norway Rat predation on crakes, on their invertebrate foods and on seabirds is likely to be a significant threat to their survival. The climate, terrain, fiscal and legal constraints makes rat control on Ta'u summit very unlikely in the near future. Current rodenticide registration in U.S. Pacific territories does not allow usage in nonagricultural areas. An exemption from the U.S. Environmental Protection Agency (EPA) to the Federal Insecticide, Fungicide, and Rodenticide Act is being sought. The EPA and USFWS are pursuing national registrations for rodenticides (brodifacoum and diphacinone) for conservation purposes, to be used in all U.S. territories and possessions, and should be available within several years. Even with such a registration, significant fiscal and physical barriers must be overcome to insure that the Spotless Crake, a candidate for listing under the Endangered Species Act, continues to survive in the Samoa Archipelago.

#### ACKNOWLEDGEMENTS

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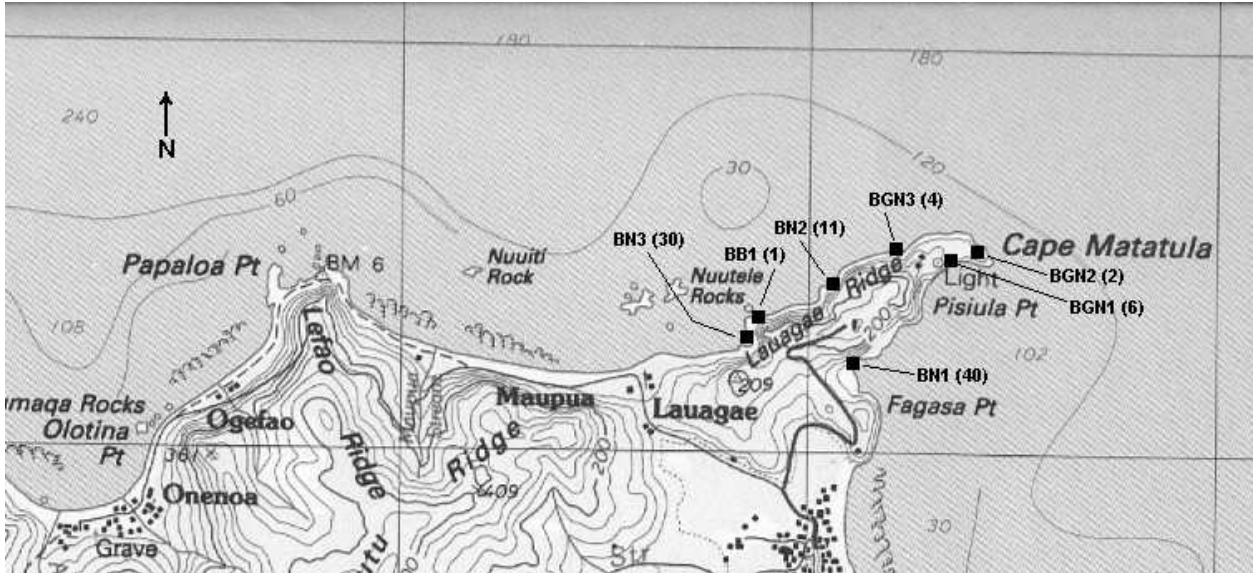
## Appendix H

### Coastal Seabird Colonies

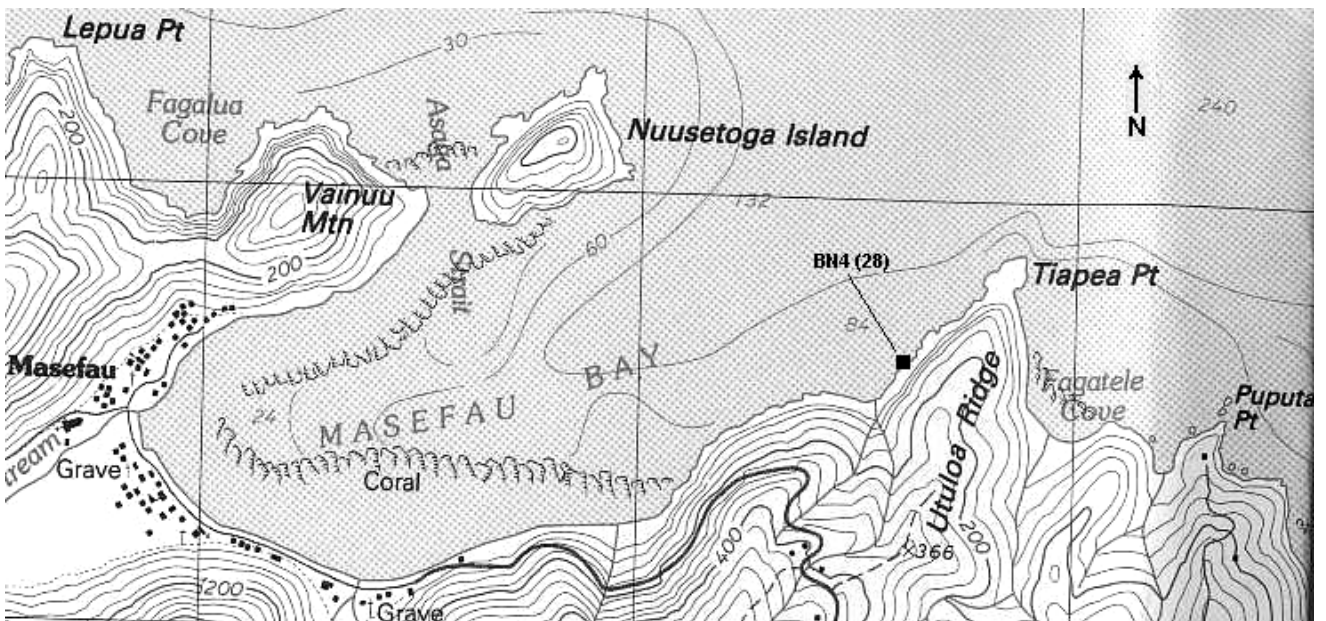
Now that their locations are established, these colonies should be visited annually. Number of adult birds, and number of active nests should be noted (see Appendix B for colony survey suggestions). Regular assessment of these colonies is important because these coastal colony nesters can frequently change the locations of their colonies between breeding years (Bibby et al. 1992)(Not in Lit Cit). No time of year is recommended over another at this point for colony surveys. Some coastal colony nesting seabird species in American Samoa appeared to breed year-round (e.g. Red-footed Boobies). Other species (e.g. Brown and Black Noddies), did not have young present at the time of any visit during this project (except on Rose Atoll), although adult birds were observed using colonies on Tutuila year-round as single individuals and in pairs. Several years of colony visits may be needed before preferred breeding seasons can be pinpointed. Meanwhile once-a-year visits to these colonies will suffice.

By conducting short-term, regular surveys of known breeding sites the Park can follow changes in the location and size of seabird colonies and use this information in its natural and cultural resource management strategies. The Park will better understand its role in protecting seabirds as indicators of healthy onshore and offshore ecosystems. Simply tracking the location of seabird breeding colonies and the numbers of birds at each on an annual basis will prove to be a simple and robust first step for continued seabird monitoring in American Samoa.

### Tutuila Coastal Colonies Location Maps

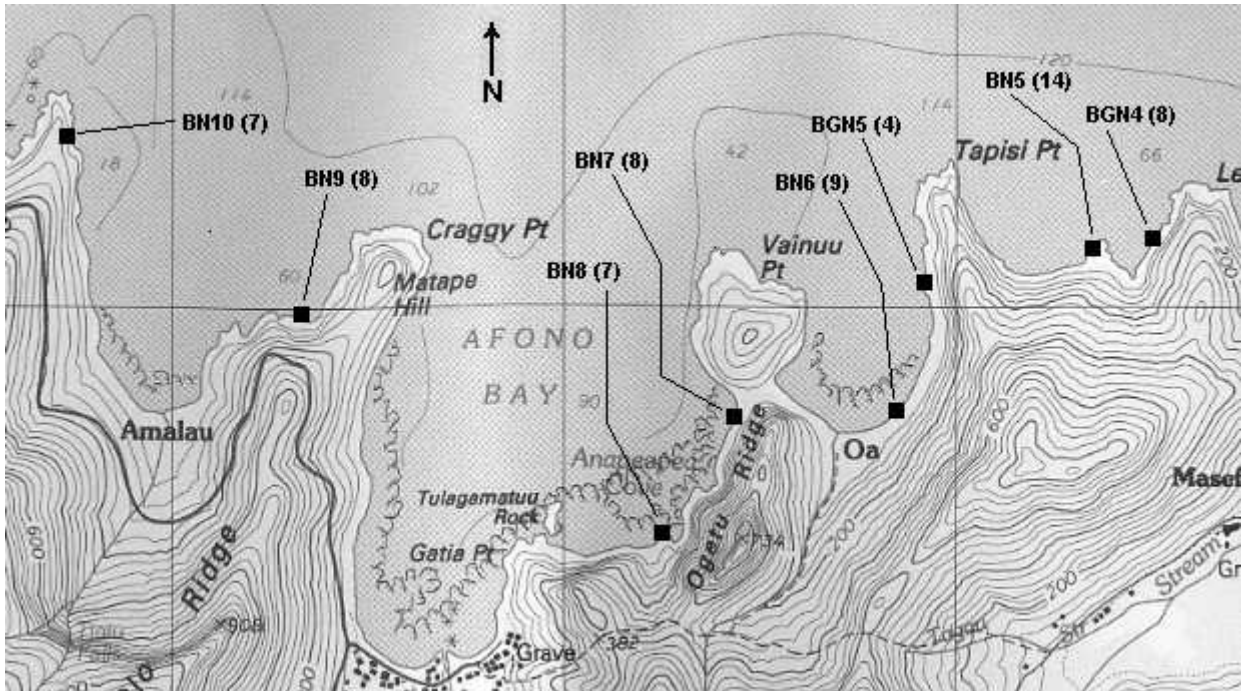


Cape Matatula (east end), and nearby north shore colonies

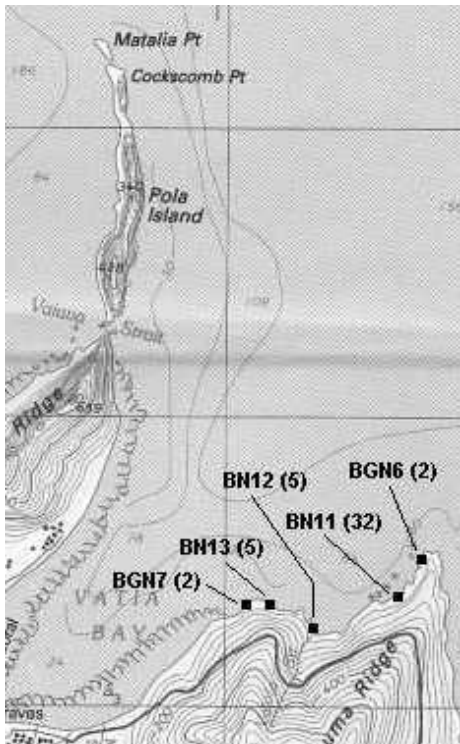


Masefau Bay (north east quadrant), Brown Noddy colony # 4

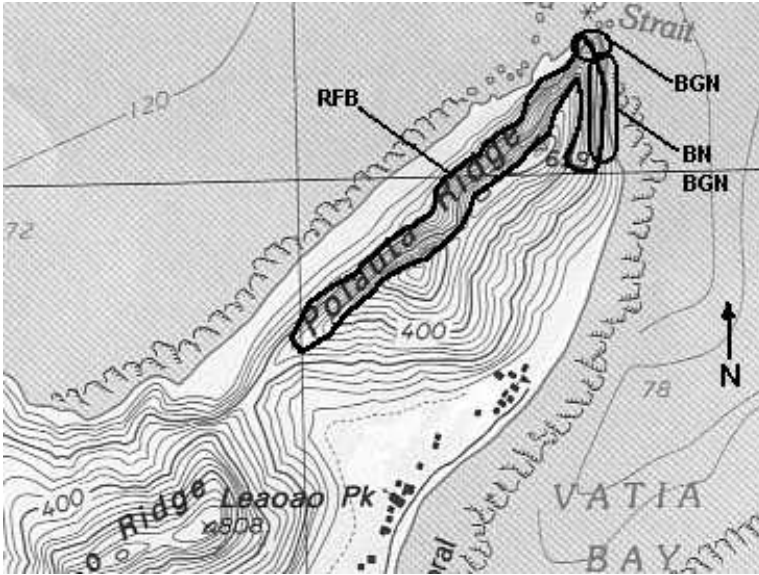




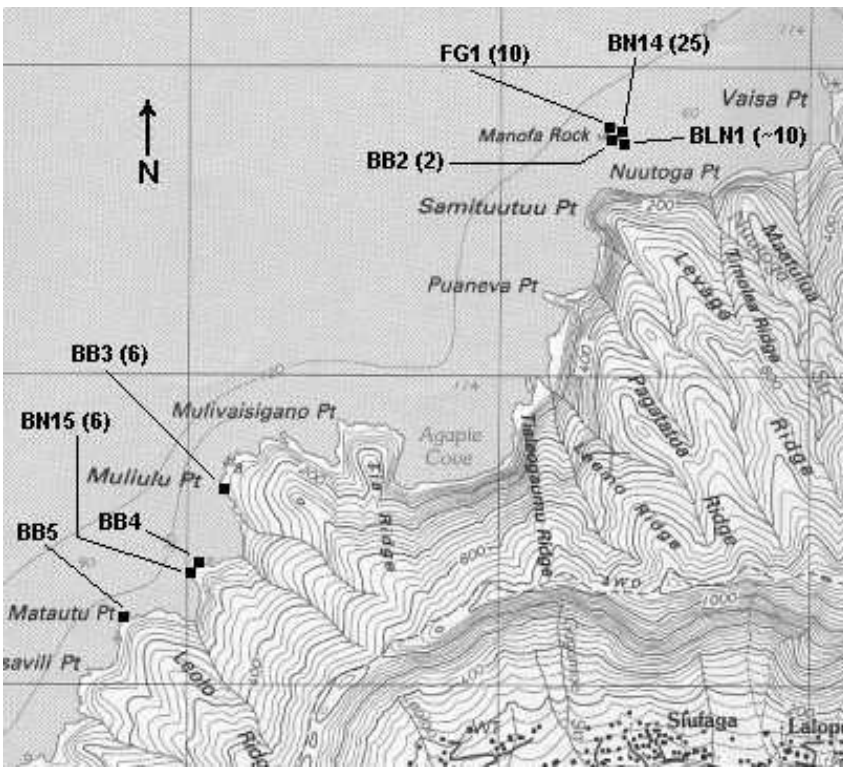
Afono Bay and surrounding coast, north shore



East edge of Vatia Bay, Amalau Lookout areas



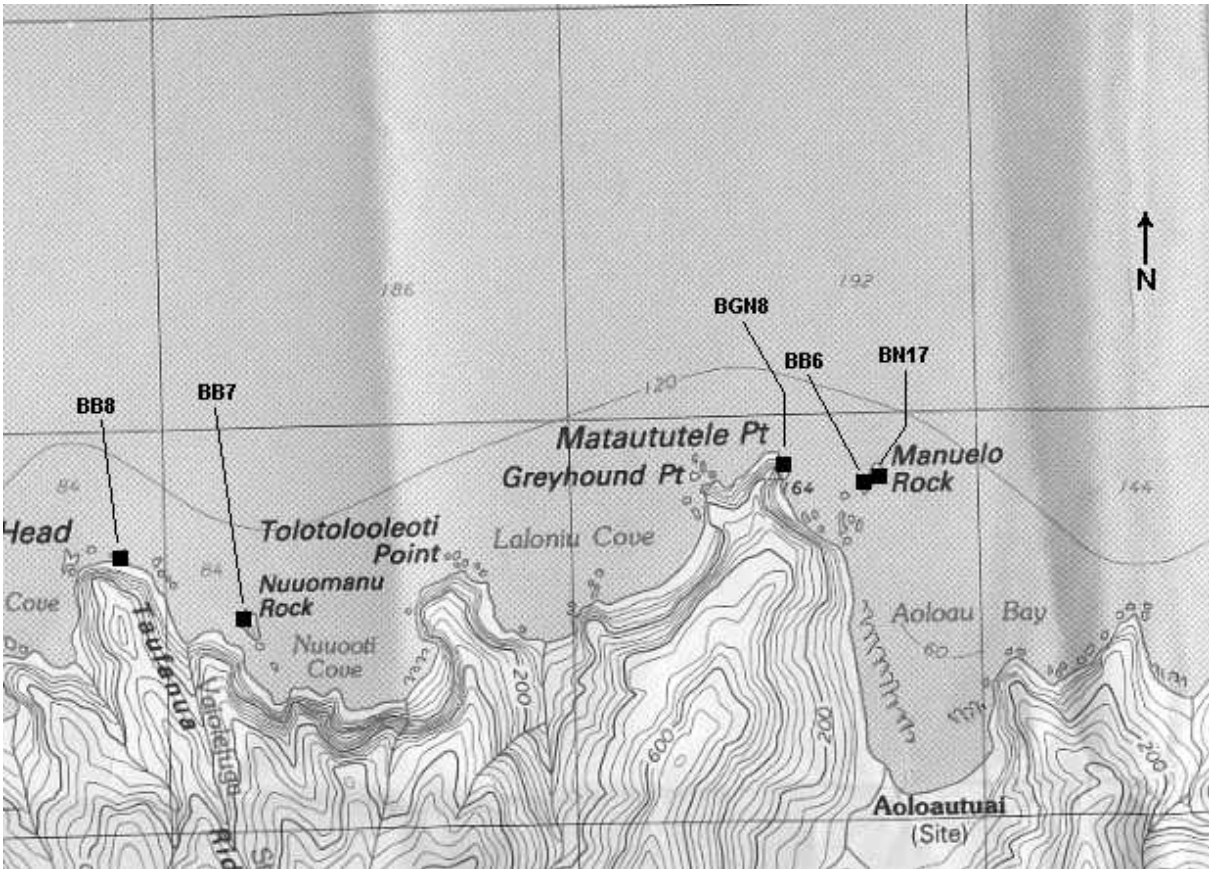
West side of Vatia Bay, Polauta Ridge areas



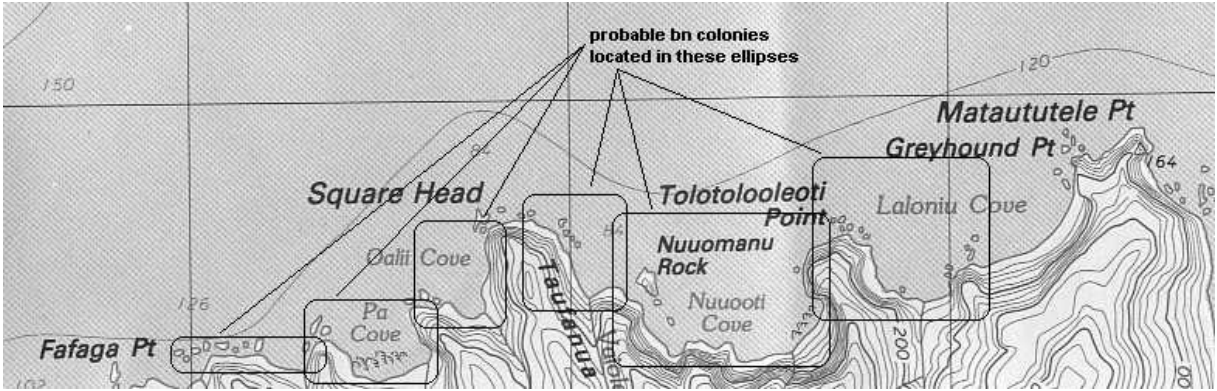
Vaisa Pt., surrounding north shore National Park coast



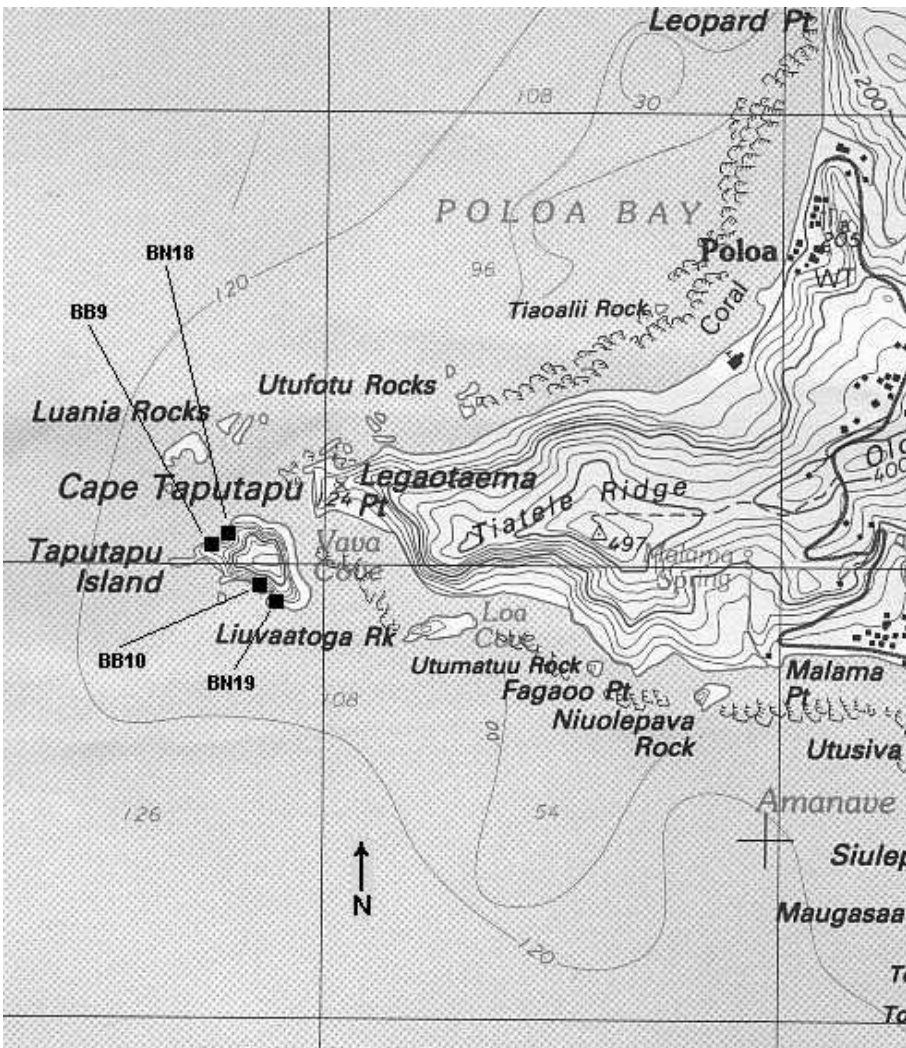
Fagafue Bay, west of Fagasa on north shore



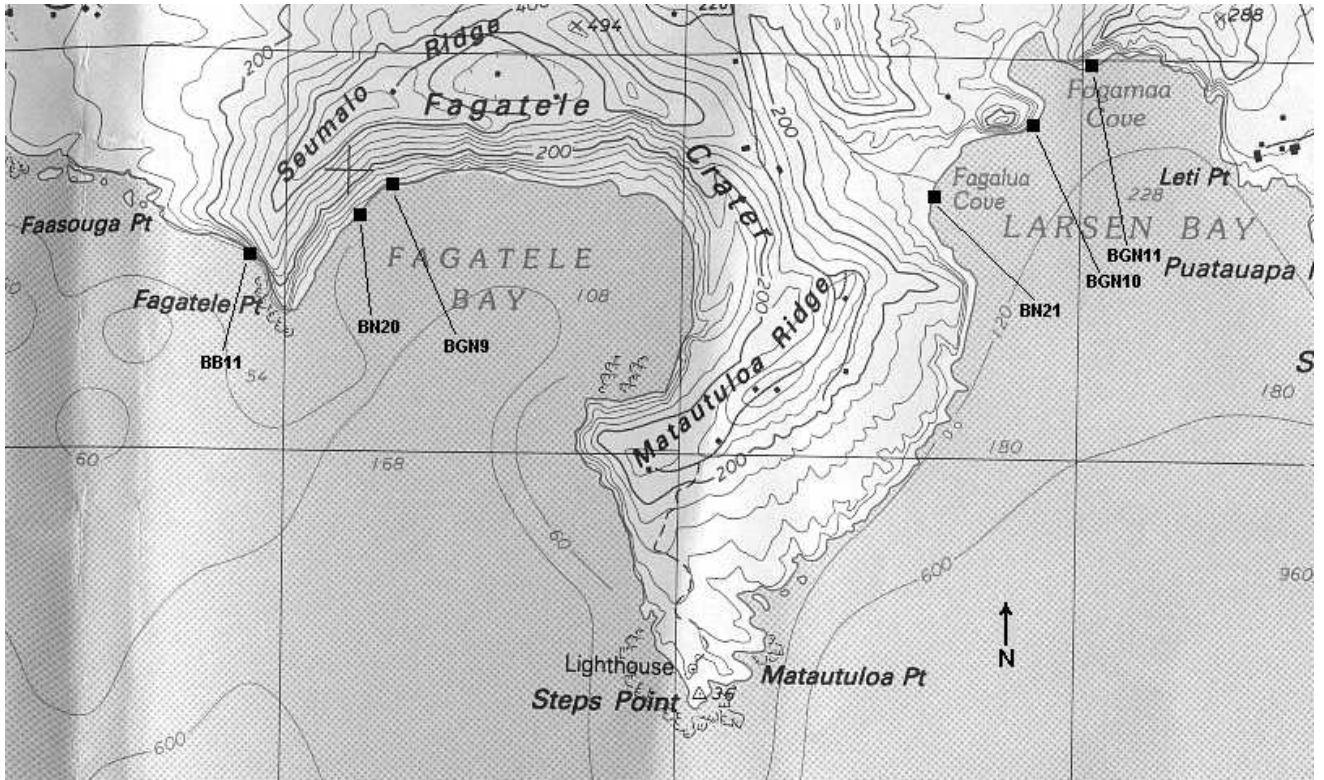
Manuelo Rock to Squarehead, north shore west of Aoloau Bay



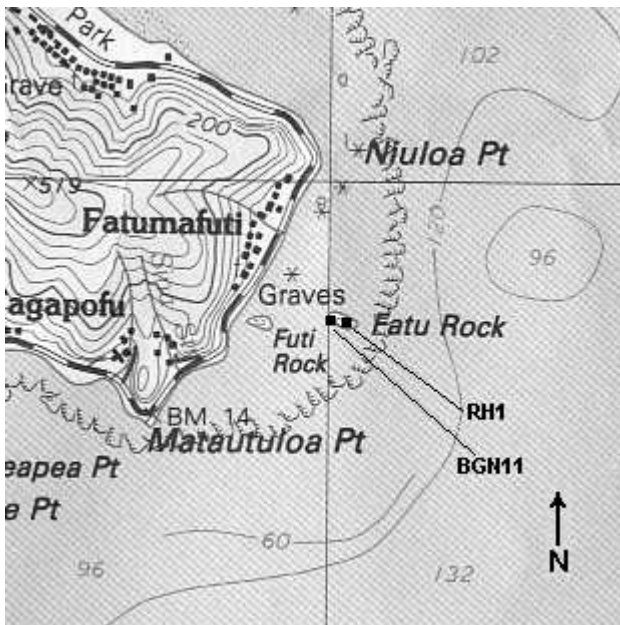
Probable BRNO colonies in vicinity of Square Head Pt.



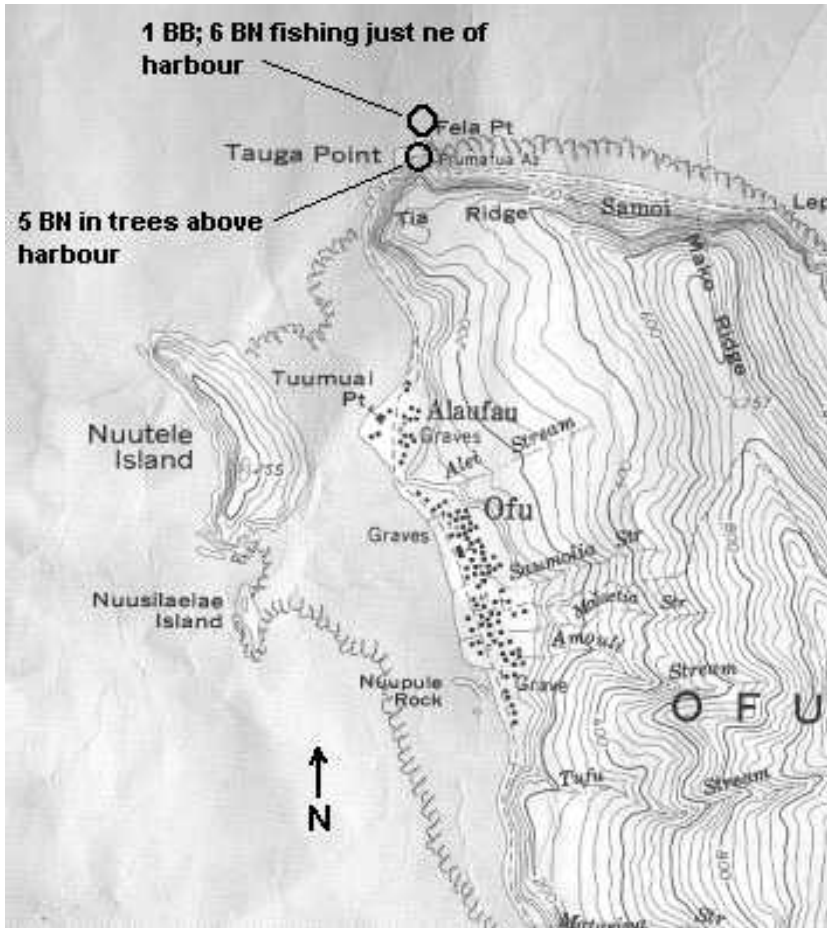
Cape Taputapu (west end of Tutuila)



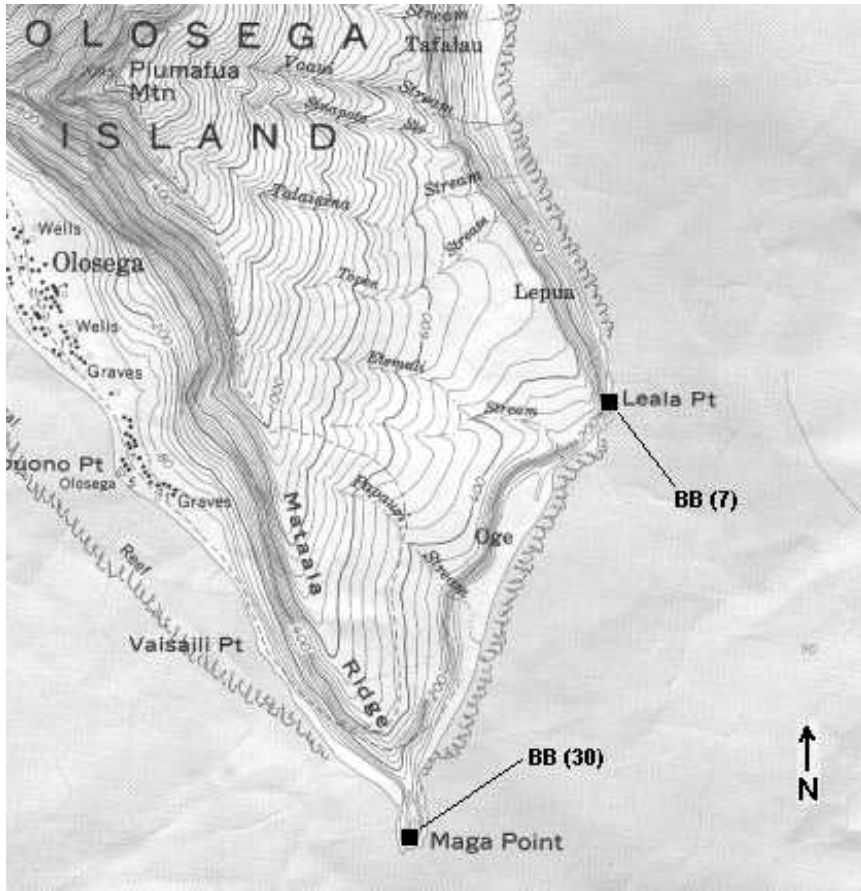
Fagatele and Larsen Bays, south west shore of Tutuila



Fatu Rock, between Coconut Pt. & Pago Pago Harbor  
Ofu Coastal Colonies Location Map



Olosega Coastal Colonies Location Map



Ta'u Colonies Location Map





## Appendix I

Brief Video Clips from Mt. Lata (Paul O'Connor, 2001)

[Samoa01.MPG](#)

[Samoa02.MPG](#)