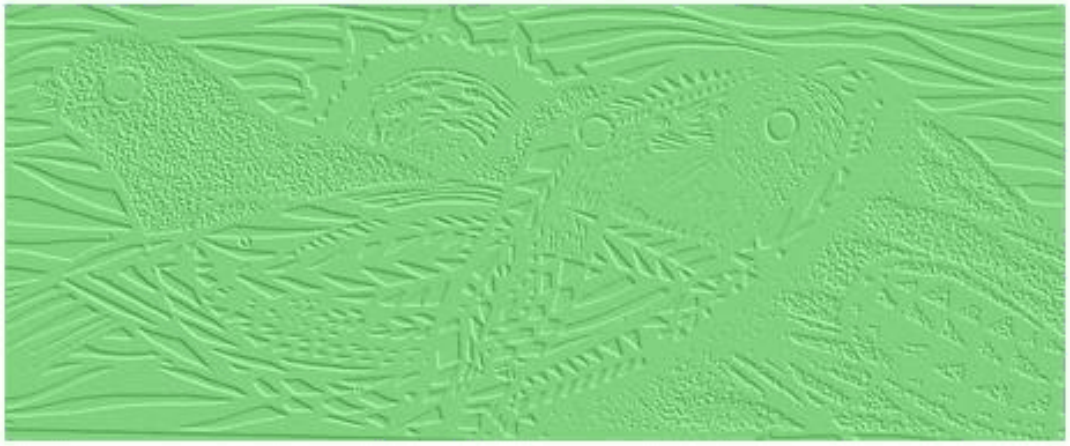

A COMPREHENSIVE STRATEGY for WILDLIFE CONSERVATION in AMERICAN SAMOA

Department of Marine & Wildlife Resources
American Samoa Government
September 2005
Revised November 2006

DEPARTMENT OF MARINE & WILDLIFE RESOURCES
American Samoa Government

A Message From The Director

There is much that we need to learn about wildlife in American Samoa. Yet, our knowledge of fruit bats, land birds, and wildlife habitats has advanced greatly with the help of the Wildlife Restoration program. These grants have supported scientific studies true to the priorities we identified for the Territory's wildlife.

Even today, native wildlife and their habitats remain a prominent feature of the American Samoan landscape. This compares favorably to many other developing countries, and has happened in spite of natural catastrophes and past unregulated exploitation. The recovery of the wildlife fauna from such impacts is evidence of the resiliency of the natural environment and a testament to the effectiveness of the conservation actions effected through the Wildlife Restoration program.

We as Samoans are also proud of what this shows about the attitude and cooperation of our people. The broad support of the Samoan people has enabled these programs to succeed, and speaks of the Samoan spirit to cherish that which it has inherited from past generations.

We can see, though, the demands that present and future growth in human population and development will place on our natural heritage. This is especially true on small islands such as ours. We face a great challenge to ensure that the native fauna and their habitats are not harmed by poor decisions on land and resource use.

A plan to meet this challenge can be seen in the following conservation strategy. It has grown out of our past experiences, and from consultations with the public, other local and federal agencies, as well as legal and scientific experts. *Ua fuifui fa'atasi ae sa vao ese'ese*. It focuses on our knowledge of the wildlife in American Samoa and on what we still need to know.

Our past progress makes me optimistic this plan will guide us toward even more successful research and management programs, and toward a healthy future for the wildlife of American Samoa.

Ufagafa Ray Tulafono
Director, DMWR
28 September 2005

LIST OF ACRONYMS

Several acronyms are used repeatedly in the text. To avoid repetitious explanation, their definitions are presented here:

ASAC	American Samoa Administrative Code
ASCA	American Samoa Code Annotated
ASCC	The American Samoa Community College
ASCMP	American Samoa Coastal Management Program
ASG	The American Samoa Government
ASIST	American Samoa Invasive Species Team
CRAG	American Samoa Coral Reef Advisory Group
CWCS	Comprehensive Wildlife Conservation Strategy
DMWR	The Department of Marine and Wildlife Resources of the American Samoa Government
DOA	Department of Agriculture
DOC	Department of Commerce
FBNMS	Fagatele Bay National Marine Sanctuary
NMFS	National Marine Fisheries Service
NOAA-NCCOS	National Oceanographic and Atmospheric Administration-National Centers for Coastal Ocean Science
NPAS	The National Park of American Samoa
SPREP	The Secretariat of the Pacific Regional Environment Programme
SWCDB	Soil and Water Conservation District Board
SWG	State Wildlife Grants

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Finally, our deepest *fa'afetai* and *fa'amalo* to E Kosaka and EF Curren, of the Hawaii Office of the FWS Federal Assistance (Region 1), for steering us through the SWG Planning process, and to DMWR Director Ufagafa Ray Tulafono for his support and active participation in all the consultative workshops throughout the development of this CWCS.

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1 EXECUTIVE SUMMARY

The wildlife resources of American Samoa are distributed among five volcanic islands (Aunu'u, Ofu, Olosega, Ta'u, and Tutuila) and two atolls (Swains and Rose). Land birds and fruit bats are the most conspicuous components of the native fauna and have been the focus of DMWR's wildlife investigations under the Wildlife Restoration Program. The State Wildlife Program provides DMWR with the opportunity to broaden the taxonomic coverage of its wildlife program to include those species that, for reasons of lack of funding, have been largely excluded in previous research and monitoring programs. Most of the taxonomic groups (vertebrates and invertebrates) are relatively depauperate with few to no species unique to American Samoa, with the exception of the gastropods. Land snails, in particular, are represented by numerous species, a high proportion of which are endemic to the Samoan archipelago.

The combination of small land mass, isolation from other faunal communities, occurrence of catastrophic natural forces, and a burgeoning human population render the islands' wildlife particularly vulnerable to the effects of shrinking habitat, novel and emergent diseases, minimal dispersal (movement of animals between islands), and drastic declines in abundances. For these reasons, it is imperative that resources for wildlife conservation be used for collecting the best scientific information for the timely institution of conservation and management tools to ensure the viability of: 1) its native wildlife populations for future enjoyment and for cultural uses; and 2) the biotic interactions that help sustain the islands' natural habitat.

The Comprehensive Wildlife Conservation Strategy presented here provides guidance for the allocation of resources and efforts to those species that for reasons of lack of information, low or declining abundances, highly localized or restricted distributions, and great vulnerability to threats are considered deserving priority conservation attention. Among these are select species of invertebrates (coconut crab, a *Papilio* butterfly, and endemic terrestrial snails) and vertebrates (Pacific boa, 2 species of skinks, green and hawksbill turtles, rare and poorly known species of land birds, ground-nesting sea birds, the sheath-tailed bat). The statuses of these species are described to the extent possible with available information, and priority conservation actions for each are defined (Section 5: SPECIES OF GREATEST CONSERVATION CONCERN). The expanding human population coupled with the lack of land use guidelines in the Territory make it imperative to develop and implement a wildlife habitat plan as a strategy necessary for the conservation of most species (Section 6: PROTECTION OF NATIVE HABITATS AS A STRATEGY FOR WILDLIFE CONSERVATION & Section 8: STATUTORY AND REGULATORY ASPECTS OF CONSERVATION). When implemented with local and regional partners, in full consideration of the traditional and cultural sensitivities of the local community (Section 7: WILDLIFE IN THE SAMOAN CULTURE: ANCHORING CONSERVATION TO TRADITIONS AS A STRATEGY), the strategies identified should improve information on the status of species, their ecological needs, vulnerability to threats, resiliency to disturbance, and prospects for maintaining viable populations through the future (Section 9: SUMMARY OF STRATEGIES AND MECHANISMS FOR IMPLEMENTATION).

2 INTRODUCTION

2.1 FOCUS AND SCOPE

Most species of the terrestrial fauna are covered to various degrees in this plan. Information on species or species groups for which sufficient data are available, and/or for which there is significant biodiversity or cultural interest are summarized. In general, the vertebrate taxa are better known, particularly the avifauna and mammals. The invertebrate taxa, on the other hand, remains poorly studied with the exception of a few groups or species, such as land snails.

With the exception of marine mammals and sea turtles, all other marine organisms are excluded from this plan. Several research and management initiatives are presently in place or under development for the conservation and management of the marine environment and the organisms therein. As of 2003, an Ocean Resource Management Process was established specifically to coordinate multiagency nearshore, harbor, offshore, and watershed management programs (Executive Order 004-2003). Marine protected areas in place include the Vaoto Territorial Marine Park (Ofu Is.: 0.5 km^2), the Fagatele Bay National Marine Sanctuary (Tutuila Is.: 0.7 km^2), marine protected areas under the National Park of American Samoa (primarily in Ofu Island), and the federally protected waters around Rose Atoll National Wildlife Refuge (Rose Atoll: 158.8 km^2). DMWR's Community-based Fisheries Management Program (a project funded by Sport Fish Restoration funds and SPREP) also provides for protective conservation of marine resources and areas within participating villages' jurisdiction (DMWR Sportfish Restoration Program 2001-2011). Plans are also under development to protect a mandated 20% of the marine areas surrounding the islands of American Samoa as "no take" zones (reference Gov. T. Sunia letter to the American Samoa Coral Reef Advisory Group, 02 August 2000; American Samoa's Marine Protected Area Strategy June 2005 draft, R. Oram, pers. comm.). This initiative constitutes compliance to Presidential Executive Order 13158 of May 26, 2000 on Marine Protected Areas (Federal Register Vol. 65, No. 105, May 31, 2000)

Monitoring of the habitat and nearshore resources are integral to these marine protection and management programs (e.g., DMWR's 3-year coral reef monitoring program under NOAA-NOS). Biological monitoring are also being undertaken in areas outside the protected and managed areas (DMWR Sport Fish Restoration Program: 2007-2011) and initial surveys have provided critical baseline information on effects of scale and benthic composition on marine resources (Sabater and Tofaeiono, *in press*). Extensive surveys and mapping of the benthic community have also been undertaken by NOAA (e.g., NOAA-NCCOS 2005).

The combined high level of research activity and on-going strategic planning on

protection and management programs should generate a volume of information in (at least) the next five years sufficient to conduct a better assessment of the state of the marine environment and organisms therein. Hence, the exclusion of marine organisms from this strategy at the present time in no way precludes their consideration in later revisions or updates of this Plan, should it be warranted.

Introductory accounts on taxonomic groups covered in this plan are presented in Section 3 (THE FAUNA). These accounts provide an overview of the diversity within groups and the general state of knowledge available on the taxa. Where information is inadequate for detailed treatment, or for taxonomic groups accorded lower conservation priority statuses, threats and recommended priority actions are incorporated in the general taxonomic accounts presented in Section 3. For example, a more detailed treatment of insects and other arthropods is precluded by the general lack of information of this group. Entomological studies in the Territory have focused largely on those species of economic importance as agricultural pests, pathogens, or beneficial symbiotic interactors (M. Schmaedick, pers. comm.). For this reason, with the exception of *Papilio godeffroyi*, the group has not been considered for detailed treatment in Section 5 (SPECIES OF GREATEST CONSERVATION CONCERN). However, some of the possible threats to the fauna are discussed in the overview (Section 3.1.1) as is a short list of identified conservation priorities. Other taxa similarly treated are crustaceans and the herpetofauna.

Taxa assessed as species or species groups of priority concern are described in greater detail in Section 5 (SPECIES OF GREATEST CONSERVATION CONCERN). The detailed accounts provide more specific information on abundance, distribution, habitat, and threats to the extent that data are available. Priority conservation actions specific to the species or species groups are provided. Included in these are terrestrial and sea birds, mammals (including marine species), terrestrial snails, marine turtles, and a few select species from other taxa.

It has long been recognized that adequate habitat (quality and quantity) are necessary for the health and stability of wildlife populations, particularly on small isolated islands. This plan brings into focus the status of the habitat (Section 4: AN OVERVIEW OF THE HABITAT) by illustrating in detail qualitative trajectories of projected landscape changes (Figure 3) and actual land cover trends for the islands of Tutuila and Manu'a (Figure 4). Threats to the habitat are elucidated in Section 6 (PROTECTION OF NATIVE HABITATS AS A STRATEGY FOR WILDLIFE CONSERVATION; see Section 6.2), priority actions deemed critical for addressing these threats are identified (see Section 6.3), and attendant regulatory and statutory measures in support of habitat conservation are discussed in Section 8 (STATUTORY AND REGULATORY ASPECTS OF CONSERVATION; see Sections 8.2.1 & 8.3.1, in particular).

2.2 DEVELOPING A COMPREHENSIVE STRATEGY: THE PROCESS

The Department of Marine and Wildlife Resources, as the Territorial agency vested with the mandate to "manage, protect, preserve and perpetuate the marine and wildlife resources in the Territory" (Section 24.0304 of Chapter 3 of the American Samoa Code Annotated), undertook the sole responsibility of developing the Comprehensive Wildlife Conservation Strategy (CWCS) for American Samoa. The blueprint for this planning had two components: 1) targeted TECHNICAL REVIEWS & CONSULTATIONS; and 2) interactive CONSULTATIVE DIALOGUES with various sectors of the government and the community (Figure 1).

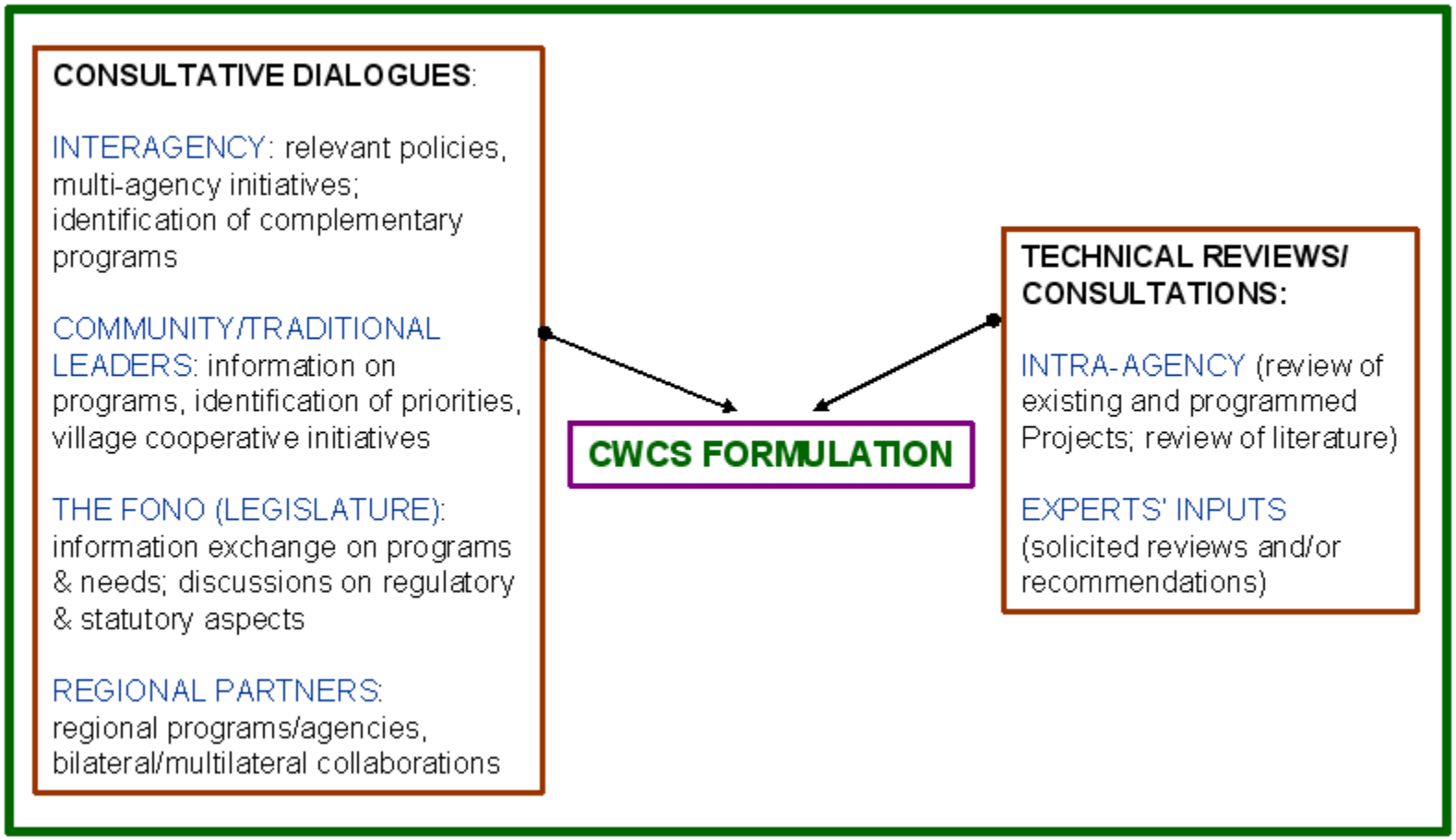
The reviews and expert consultations completed Phase I of the process, and produced a provisional list of conservation priorities based on the best scientific information available. Among the contributing agencies outside of DMWR were ASCC-Land Grant, the Department of Commerce/ASCMP, National Park of American Samoa (NPAS) and the Fagatele Bay National Marine Sanctuary (FBNMS). Expert consultations were sought on specific issues, among others on land snails (R. Cowie), freshwater snails (D. Vargo), arthropods (M. Schmaedick), marine mammals (L. Dolar), regional birds (D. Watling), vegetation (E. Webb, A. Whistler), invasive species (E. Hanson, T. Togia), and protective legislation (M. McCarthy).

Phase 2 consisted of a combined process of consultation and public review. A series of three consultative dialogues were held, with the: 1) Fono (Legislature); 2) Executive Branch with all its various departments; and 3) Local Government (*pulenu'u*s [village mayors], *fa'alupega*s [county chiefs], district governors, and other traditional community leaders). Members of these three sectors were recognized as the critical leaders able to capture the sentiments and priorities of the community and, in turn, communicate to their constituents the various aspects of the proposed conservation program presented for review. The decision to combine consultations and the review process in a single exercise was predicated on the need to: 1) capture a more varied representation from the community than could have been achieved if the plan was simply left out for review at the public's leisure; 2) target sectors and agencies whose cooperation and support are, in effect, requisites to the effective coupling of proposed actions with the community; and, 3) achieve an atmosphere of interactive dialogue facilitated by Samoan staff of DMWR (Wildlife Division assistants, Director U.R. Tulafono, and Administrative Supervisor F.A. Tuaumu) able to a) provide instantaneous translations of technical material, b) solicit responses in a language that participants would be most comfortable with (Samoan), and, most importantly, c) ensure that the proper cultural and traditional protocols for discourse were observed.

Given the shared responsibility for conservation of shared wildlife, dialogues with counterpart agencies (such as the Ministry of Natural Resources, Environment, & Meteorology [MNREM] of the Government of Samoa, SPREP, and natural and

environmental agencies in New Caledonia) as well as collaborating partners (such as scientists at the University of South Pacific, Suva, Fiji) in the region were held. Two positive developments from these discussions form staging points for concrete regional actions. These were: 1) the signing of an MOU for scientific collaboration (information exchange, technical assistance, joint investigations) between DMWR and Samoa/MNREM; and 2) organization and sponsorship (by DMWR, under SWG Planning) of a regional workshop on wildlife monitoring techniques as a means of stimulating region-wide population monitoring and estimation of abundances particularly of those species shared among countries and territories.

FIGURE 1. PROCEDURAL BLUEPRINT FOR THE DEVELOPMENT OF AMERICAN SAMOA'S CWCS



2.3 DEFINING SPECIES OF GREATEST CONSERVATION NEED

Assignment of priority ratings to species, at the very least, should take into consideration information on taxonomic status (is the species endemic or unique to the area), abundance (are local populations in decline, increasing, or stable), distribution (how geographically widespread is the species, how restricted are distributions within sites of occurrences), and threats (what are the types and how severe). These types of information may not be available, or may only be partially available, for a number of species found in American Samoa. Thus, the rankings assigned to species examined were reached to the extent possible with available data, published and unpublished (including those from on-going projects). The significance of species to the local culture was also considered in the evaluations.

Following these guidelines, five levels or classes of conservation rankings were developed. **Class I** species are those for which insufficient data are available. Such data include the minimum required to make informed decisions on spatial patterns or trends in abundance, and the extent of distributional restrictions or among-population movements. **Class II** species are those for which baseline data exists to at least tentatively identify threats or guide focused research on variables of concern. These data might suggest a direct threat to survival (e.g., from introduced predators or disease), an indirect threat through destruction of critical habitat, or possible genetic bottlenecks due to very restricted population sizes. Species near range boundaries are predicted to be more sensitive to habitat loss, and species with broad diets and habitat breadth less so (Swihart et al. 2003). **Class III** species are those of conservation interest due to rarity, uniqueness, or cultural importance, but for which there are already ongoing monitoring and research programs. **Class IV** species are indigenous species of interest as components of natural communities, but which are known to be abundant. **Class V** species are exotics or invasives, and for which population control or reduction would be encouraged where feasible. Results of the rankings are presented in Section 3.

2.4 AMERICAN SAMOA: GEOGRAPHIC AND SOCIO-CULTURAL BACKDROP

2.4.1 GEOGRAPHY

American Samoa is an unincorporated, unorganized territory of the United States, and is located approximately between 167 º to 172 º W (latitude) and 11º to 15 º S (longitude) in the southwestern Pacific (Figure 2). Five of the seven islands comprising the Territory are volcanic in origin – Tutuila, Ta'u, Ofu, Olosega, and Aunu'u. Ta'u, Ofu, and Olosega islands are collectively referred to as Manu'a. The other two

islands, Swains and Rose, are coral atolls set off remotely from the five volcanic islands.

Tutuila, the largest of the seven islands and with Mt. Matafao as its highest point, accounts for approximately 72% of the Territory's total land area (Table 1). With the exception of the two atolls, the islands are topographically steep and rugged, particularly along the northern shores. Flat plains and areas less than 30 ^{o} in slope that are suitable for agriculture, settlement, and development are limited.

TABLE 1. ISLAND SIZE AND MAXIMUM ELEVATION OF THE FOUR PRINCIPAL VOLCANIC ISLANDS (from Whistler, 2002)[1]

ISLAND	AREA (km^2)	ELEVATION (m ASL)	HIGHEST POINT
Tutuila	124	650	Mt. Matafao
Ta'u	39	930	Mt. Lata
Ofu	5	495	Mt. Tumu
Olosega	4	640	Mt. Piumafua

[1] The other 3 islands measure less than 2 km^2 in area.

2.4.2 SOCIO-CULTURAL PROFILE

As of the April 2002 census, the population in the Territory was estimated at slightly less than 60,000, 97% of whom reside in Tutuila (Department of Commerce Statistics Division 2005). With an average annual growth rate of 2.0% (between 1990-2000), the population is estimated to have exceeded 60,000 by the end of 2005. Approximately 48% of this population are less than 40 years of age, and the median age of 21 is at least 10 years younger than that of the continental US.

The highest recorded rates of growth in population is in western side of Tutuila Island, particularly in the Tualauta county. The Manu'a islands exhibited negative growth rates (-2.2%), perhaps, as a result of immigration from the islands from lack of opportunities for employment and economic development (Department of Commerce 2003).

Although American Samoa, undeniably, has the trappings of western developed countries, tradition and religion continue to permeate the fiber of the society. The "aiga," or extended family is the core structure of the society and all matters of

family life (from administration of communal lands to handling of weddings and funerals) are typically run by the senior matai (chief) and subordinate matais. The running of customary village affairs generally resides in the traditional leaders, such as the village council of chiefs. Although the Governor, Lt. Governor, and representatives to the lower house of the legislature, or Fono, are duly elected by qualified residents, members of the Senate are selected by councils from among the titled traditional leaders. The understanding of this integration of traditional and western modes of governances and life styles are considered crucial for successful implementation of any program in the Territory. Indeed, the traditional heirarchical structure of the society acts as a pre-existing network by which outreach and public participation may be pursued.

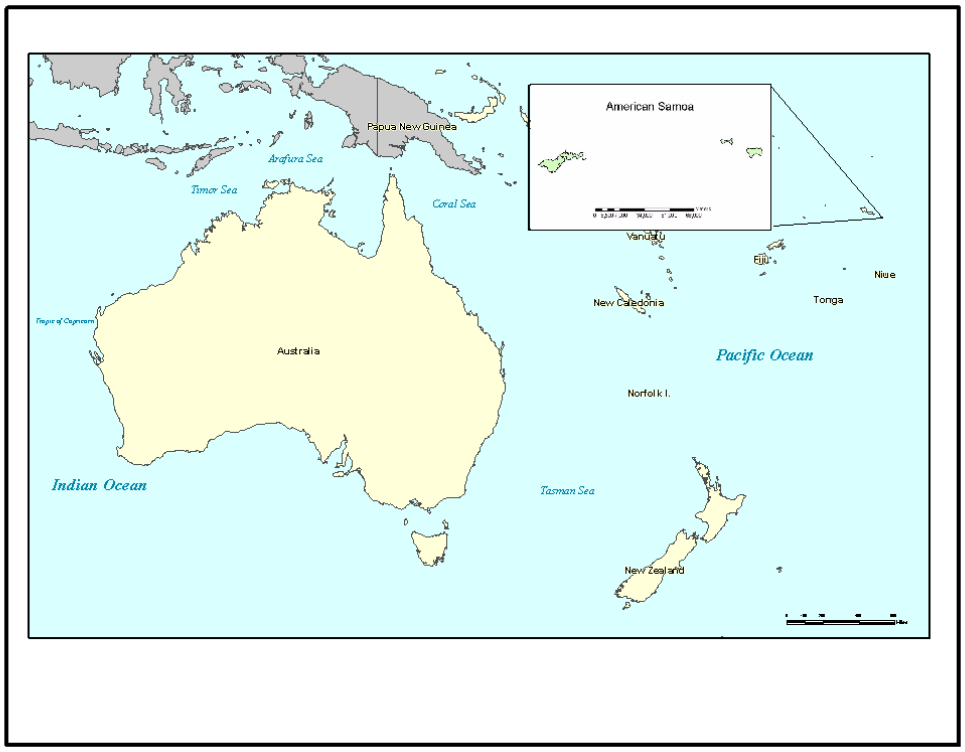


FIGURE 2. REGIONAL MAP SHOWING LOCATION OF AMERICAN SAMOA ISLANDS (area with Tutuila and Manu'a enlarged in the inset).

3 THE FAUNA: A general review of diversity, distribution, and threats

The results of rankings based on guidelines expounded on in Section 2.3 for vertebrate species are summarized in Table 2 (see pages 20-23). Classes I, II, and III are three main classes of species that warrant particular concern. Very few invertebrate species have sufficient data for ranking. Hence, although some are identified as high priority species (see subsections 3.1, 5.1, 5.2, & 5.3) their few numbers did not warrant inclusion in the Table. Herein are overviews on all the taxonomic groups considered in this plan.

3.1 INVERTEBRATES

3.1.1 INSECTS AND SIMILAR ARTHROPODS

There have been significant collections of insects in American Samoa, most of which have been summarized in Kami & Miller (1998). They found records of over 2500 species in the Samoan archipelago, of which a large subset occur in American Samoa, but of course these numbers almost certainly underestimate total diversity. For example, even limited trapping on Tutuila can result in the capture of at least one heretofore undescribed species (M. Schmaedick, ASCC Land Grant, *pers. comm*.). The level of diversity and endemism in American Samoa is depauperate by insect standards (Wilson & Taylor 1967, Adler & Dudley 1994, Bickel 1996, de Boer & Duffels 1996, Miller 1996, Morrison 1997). Nonetheless it is a daunting task to ascertain detailed habitat requirement, abundance or distribution data on a single species, let alone a substantial subset of the fauna (*cf.* Holloway [1996] for a summary of habitat association studies from a different island ecosystem, and Levings & Windsor [1982] for an example of seasonal and temporal fluctuations in populations). Recent work in American Samoa has focused on collections on Swains island and Rose Atoll (DMWR *unpub. data*) and on soil communities (Vargo 2000).

Perhaps because of their conspicuousness, Lepidoptera have been one of the better-studied groups in the territory, including data on habitat requirements and ecology (Swezey 1921, Hopkins 1927, Swezey 1942, Comstock 1966). There are also numerous endemic but somewhat cryptic moth species (Munroe 1996). Although most of the butterfly fauna in American Samoa consists of widespread species (Dudley & Adler 1996, Munroe 1996), there are several known endemic species, including the conspicuous (but seemingly not abundant, M. Schmaedick *pers. obs.*) *Papilio godeffroyi*. It is important not to neglect rare species, since they often have unique

intrinsic characteristics that may affect their responses to conservation measures (Kunin & Gaston 1993).

3.1.1.1 Threats to insects and similar arthropods

Although there is no direct evidence on the current status of most insect species in American Samoa, there are several reasons to be cautiously optimistic. First, there remain significant areas of native habitats in the territory, so habitat specialists are unlikely to be threatened strictly due to habitat loss (*cf.* Raghu et al. 2000). Second, although there is local application of insecticides on agricultural crops, the areas devoted to this land use are still relatively limited, and there is active monitoring of pesticide usage by the American Samoa Environmental Protection Agency. Third, there is no timber industry, so there has been no recent broad-scale or aerial applications of pesticides. Fourth, many of the species on a remote archipelago such as American Samoa are expected to be generalists, which are in turn expected to represent the most abundant component of the insect fauna (Kitihara & Fujii 1994).

However, there are at least three significant threats to subsets of the insect fauna. The first are introduced and invasive ant species, which are well known as important drivers of ecosystem change (Madeiros et al 1986, Jourdan 1997). It is possible other invasive insects may also have deleterious effects on the native insect fauna, although introduced insects do not necessarily cause declines even in closely related native species (Roubik & Wolda 2001). The second is the possible impact of the introduced toad *Bufo marinus* on ground arthropod species. This amphibian is currently widespread and very abundant on Tutuila, less abundant or absent from the other islands. However, since the current terrestrial arthropod fauna has already been subject to waves of invasive ant species, it may already consist primarily of a robust generalist fauna (Vargo 2000). Third, there is the threat of unintended consequences of insect species introduced as biological controls (Howarth 1991, Louda et al. 2003), a number of which have been introduced on various islands in American Samoa to control invasive plants or insects.There is particular reason to be concerned about the impact of such agents on butterfly species (Nafus 1992).

3.1.1.2 Conservation Priorities for Insects and similar arthropods

Given their conspicuousness and endemic status we classify *Papilio godeffroyi* as a high priority species and feature it in greater detail in subsection 5.1. Recommended actions for arthropods as a group are:

1. *Review and develop a list of research priorities* on diversity,

distributions, and conservation status assessments in collaboration with ASCC-Land Grant and the Department of Agriculture for consideration in subsequent revisions of this Strategy.

2. *Document the distribution of invasive ant species* in the territory, in part to locate potential refugia from these highly adaptible species (Tsutsui & Suarez 2003).

3. *Conduct insect surveys in endangered habitats*, to ascertain the presence of potential habitat specialists that might also be imperiled by reductions in these habitats, and which might be expected to be rarer even within preferred habitats (Kitihara & Fujii 1994), and to generate predictive maps to guide further efforts to locate rare species (Wang et al. 2003).

3.1.2 CRUSTACEANS

Terrestrial and freshwater stream crustaceans are a conspicuous part of the fauna of oceanic islands such as American Samoa (Burggren & McMahon 1988, Cook 2004). Land crabs in particular may be key components of tropical terrestrial ecosystems (O'Dowd & Lake 1991, Green et al. 1997, Sherman 2002). On other islands land crabs have been the focus of intensive research (Hicks 1985, Lee 1985, Louda & Zedler 1985, O'Dowd & Lake 1990, Jimenez et al. 1994, Green 1997), but we were able to locate no published studies that had been conducted on this fauna in American Samoa (Knudsen et al. 1992).

3.1.2.1 Threats to terrestrial and freshwater crustaceans

Biological information of terrestrial and freshwater crustaceans is very limited. For this reason, it is impossible to pinpoint threats to the species other than those associated with human activities. The potential for overharvesting is high in those species that are edible and conspicuous, such as the coconut crab (*Birgus latro*). Pollution from waste water from piggeries and sewer systems, toxic (pesticide) runoff from farms, and improperly disposed solid waste compromise water quality and, therefore, the habitat of native freshwater fauna (such as crayfish). Recently discussed ideas for fresh-water shrimp farming in the Territory may also pose a threat to the native fauna if a) new (exotic) species are introduced, b) streams are modified for irrigation of pens or farms, and/or c) vegetative modification of streams are undertaken to increase food material for aquaculture.

3.1.2.2 Conservation priorities for terrestrial and freshwater crustaceans

Because of its large size (Burggren & McMahon 1988), potential ecological impact (Sherman 2002), cultural importance, history of overexploitation in other parts of its range (Chauvet & Kadiri-Jan 1999), commercial potential (priced at ~$25 each in local markets), and apparent rarity in American Samoa, we initially focus our conservation priorities on the coconut crab, *Birgus latro* (see subsection 5.2). With this exception, the following actions are recommended to address the preliminary conservation needs of crustaceans as a group:

1. *Develop research priorities* in collaboration with pertinent agencies and experts (such as ASCC-Land Grant) to facilitate development of a conservation plan for the taxonomic group. At the minimum, a thorough inventory of stream fauna (thus, also covering other faunal groups inhabiting streams such as freshwater fishes, eels, and snails), in the context of their basic ecology (e.g., physico-chemical parameters, zonation) must be conducted; and

2. *Rigorously review any proposal to set-up aquaculture projects* for its possible impact on native fauna and the quality of the environment they inhabit.

Additionally, DMWR should continue to provide technical advice and cooperative support to agencies tasked with minimizing pollution of freshwater bodies in the Territory, such as ASEPA and the NRCS/SWCDB.

3.1.3 GASTROPODS

In spite of its small land area, American Samoa has a diverse gastropod fauna in both freshwater streams and terrestrial habitats (Haynes 1990, Miller 1993, Cowie 1998). The land snail fauna includes a significant number of species endemic to the Samoan Archipelago (~42 of ~58 total species), several of which were newly discovered in American Samoa (Cowie 2001a). The diversity in freshwater gastropods is lower (at least 13 species known from Tutuila), none of which are unique to American Samoa (Haynes 1990).

A comparative analysis of information from various surveys spanning from the 1920s to the late 1990s show an alarming declining trend in populations of native species in contrast with generally increasing trends in populations of exotic species of land snails (Cowie 2001a). Several of the identified threats to the species are present in American Samoa, including the predatory snail, *Euglandina rosea*, and commensal rats; a predatory flatworm, *Platydemus manokwari*, has recently been introduced to Samoa and may find its way into American Samoa through (among

NOTE: R. Cowie (pers. comm) was uncertain as to the source of recent information that *P. manokwari* is already in Aemrican Samoa (see Cowie 2005). However, P. Craig (*pers. comm*) reported personally finding flatworms identified as *P. manokwari* in Tutuila Island (see also Cowie 2005). It is clear that additional confirmatory information or documentation is needed.

others) imported agricultural products (but see footnote). If these, and other threats, are not addressed, the potential loss in diversity will be great. Hence, endemic land snails (including arboreal species) are among the taxa of priority conservation concern (see subsection 5.3).

3.2 VERTEBRATES

3.2.1 HERPETOFAUNA: AMPHIBIANS, LIZARDS, AND SNAKES

The herpetofauna of American Samoa is relatively depauperate and consists largely of widespread and introduced or commensal species (Table 2; Allison 1996). It includes one introduced amphibian species, at least 13 species of terrestrial reptiles, and breeding populations of two marine turtle species. There are also pelagic records of at least two other marine turtle species: the leatherback (*Dermochelys coriacea*) and the Olive ridley (*Lepidochelys olivacea*) (Grant 1994; Utzurrum 2002). Amphibians, lizards, and snakes are profiled in the succeeding sections. The paucity of information on terrestrial species precludes a more specific description of status and threats to the three species of high conservation concern (see Table 1) in Section 5 (SPECIES OF GREATEST CONSERVATION CONCERN). In lieu of this, priority actions recommended for their conservation are incorporated in this section (see 3.2.1.5 below). The two breeding species of marine turtles are discussed in greater detail in Section 5.4 as species of priority concern: *Chelonia mydas* (green turtle) and *Eretmochelys imbricata* (hawksbill turtle) are listed as Threatened and Endangered, respectively, under the US Endangered Species program.

3.2.1.1 Amphibians

There are no native amphibians in American Samoa. The introduced toad *Bufo marinus* is widespread and abundant on Tutuila, including on high ridges covered in native forest, but is absent or as yet uncommon in Manu'a, and absent from the two atolls. Although studies of the diet of this species in the territory suggest a significant arthropod component in the diet (Grant 1996; ASCC Land Grant, *unpub. data*), there is no data from American Samoa on the possible impact of this predation on the net abundances of the native arthropod fauna.

3.2.1.2 Snakes

Only one species of native snake occurs in American Samoa, the Pacific

Boa *Candoia bibroni*. Although widespread and occasionally common elsewhere in the region (e.g., Fiji, *pers. obs*), in American Samoa this species is very infrequently encountered, is apparently rare, and is currently known only from Ta'u island (Amerson et al. 1982b). Although there are no recently developing threats to the species on Ta'u, which is still almost entirely covered in native vegetation, the restricted distribution and lack of detailed data on its distribution and abundance on Ta'u argue for further study of this species. There is the possibility that the Ta'u form represents a distinct subspecies, since all individuals collected have been extremely melanistic (Amerson et al. 1982b); genetic studies may be warranted in the future to explore this possibility. The soil snake *Ramphotyphlops brahminus* is a recent introduction to the territory, and is currently common and (based on anecdotal evidence) expanding its range on Tutuila.

3.2.1.3 Lizards

The most recent and exhaustive distributional surveys of geckos and skinks was conducted in American Samoa by Amerson et al. (1982a, 1982b). Schwaner (1980) determined life history information for several species, and a recent summary of the relationship between the fauna in American Samoa and elsewhere in Oceania is found in Allison (1996). Species present include five geckos, all of which are widespread in the region: *Gehyra mutilata*, *G. oceanica*, *Hemidactylus frenatus*, *Lepidodactylus lugubris*, and *Nactus pelagicus*. The skink fauna includes *Cryptoblepharus poeciloplurus*, *Emoia adspersa*, *E. cyanura*, *E. lawesi*, *E. nigra*, *E. samoense*, and *Lipinia noctua*. The only endemic species is *E. samoense*, a common and widespread species on Ta'u and Tutuila (Amerson et al. 1982b). The species with the most restricted distribution within the territory appear to be *E. adspersa*, which is apparently confined to Swains island, and *C. poeciloplurus*, which is known from very few specimens. Both of these species occur elsewhere in the region, and it is possible their distributions may be constrained by competition with other lizard species (Case & Bolger 1991).

3.2.1.4 Threats to the herpetofauna

The greatest threat to the native herpetofauna of the territory is likely to be loss of habitat. Although there remains a substantial area of native lowland forest in the territory, coastal forests, particularly those on Tutuila, are under significant pressure from human activities and habitat modification. Although most of the species found in American Samoa are good dispersers and can presumably recover from local habitat loss, even these generalist species can be constrained in their ability to rapidly colonize

new areas (e.g., Cook et al. 2001). A number of the skink species are restricted to or prefer coastal habitats, including *C. poeciloplurus* and *E. lawesi,* making them susceptible to hurricanes and potentially less well-adapted to their local surroundings (Calsbeek & Smith 2004). Introduced predators are also a potential threat, but both cats and rats have been present in most of the territory for a significant time, and their impacts on the herpetofauna are unlikely to significantly increase. The exception is Swains island, where cats have been introduced to control rats (W. Jennings, *pers. comm.*) since the surveys conducted by Amerson et al (1982a).

3.2.1.5 General Conservation Priorities

The lack of known, imminent threats on most islands downgrades the overall priority level of herpetofaunal studies. There are, however, three species that warrant priority attention, and the following actions are recommended to facilitate future conservation planning for this group:

1. *Update the status of the three high priority species*: *Candoia bibroni* (Pacific Boa), *Cryptoblepharus poeciloplurus* (Snake-eyed Skink), and *Emoia adspersa* (Micronesian Skink)

The recent severe damage to the forest habitat in Ta'u brought on by Hurricane Olaf (February 2005) may have had an impact on the Pacific Boa. Both species of skinks were noted as rare and/or of restricted distribution during previous surveys (Amerson et al 1982a).

2. *Re-assess the status of the Swains island herpetofauna*

Swains Island represents the last known habitat for rare and/or coastal species of skinks (Amerson et al 1982a). The introduction of cats to the island since the last previous surveys may have had adverse effects on the herpetofauna of the island.

3. *Prevent spread of introduced species, or new introductions*

Strict quarantine measures must be applied to prevent the spread of *Bufo marinus* to the Manua islands, and the introduction of the Brown Tree Snake (*Boiga irregularis*) to the Territory.

3.2.2 THE AVIFAUNA

Avifaunal diversity in American Samoa is depauperate by tropical standards (Diamond 1984, Keast 1996), but includes potentially endemic land bird (sub)species, a number of species found nowhere else in the territories of the USA, and potentially important breeding areas for certain widespread seabird species (Table 1). There are also a small number of migratory species that occur in the territory, including

some shorebirds, seabirds and *Eudynamys taitensis*. Due to low numbers observed, strictly pelagic occurrence patterns, and/or the limited habitats available for these species in American Samoa, they are omitted from priority consideration. For consistency, where possible all taxonomic affiliations follow those used in Handbooks of the Birds of the World: del Hoyo et al. (1992), Gochfeld & Berger (1996), Taylor (1996), Baptista et al. (1997), Collar (1997), Chantler (1999), Bruce (1999) and Woodall (2001).

A number of studies and surveys have been conducted on the resident avifauna of American Samoa. Results of early collecting trips by the Whitney South Sea Expedition and others are summarized in Banks (1984). Baseline distributional and abundance information is presented in Amerson et al (1982a, 1982b), Engbring & Ramsey (1989), Pyle et al. (1990), and Trail et al. (1992). More recent survey results can be found in Freifeld (1999), Utzurrum & Seamon (2001), O'Connor & Rauzon (2003), and Freifeld et al. (2004). Regional distribution data were determined from species accounts in Harrison (1983), Pratt et al. (1987), Stattersfield et al (1998), Watling (2001), and US Fish & Wildlife Service (2005).

There are numerous ongoing studies of the American Samoan avifauna, particularly on land bird species. Distributions and abundance estimates have been obtained in several ways. DMWR has been conducting DISTANCE-based VCP transects for forest bird species for more than 10 years - these data provide a reliable baseline for detecting any long-term or climate-related trends in abundances of the Passerine species in the territory (Freifeld et al. 2004). There are also ongoing DISTANCE-based point surveys extending over the same time period, designed to survey Columbiform and other highly mobile frugivorous species. Recent mark-recapture studies have greatly enhanced our knowledge of the distributions and abundances of the Manu'a forest avifauna, particularly *C. vitiensis*, *G. stairii*, and *V. australis*, as well as documenting long-term survival patterns on Tutuila (*unpub. DMWR data*). These methods may also provide a basis for detecting possible shifts in habitat associations over time (O'Connor 1986), a not unexpected pattern when major changes in bird abundance are caused by catastrophic disturbances such as hurricanes.

The threat posed to the indigenous avifauna by vector-borne diseases has also been the focus of much recent research (Jarvi et al. 2003, Atkinson et al. *In Press*). Genetic studies are now under way to ascertain relationships of land bird populations among the various islands in the territory (DMWR Wildlife Investigations: W-1-R), and to assess the possibility of deleterious losses of genetic diversity in selected species (Bates 2002). Proposed but not yet undertaken studies include the use of stable isotopes to investigate the resource bases and possible niche-partitioning of forest bird species, as well as to test invasive rats for evidence of seabird consumption (*sensu* Bearhop et al. 2002, Lott et al. 2003, Mauffrey & Catzeflis 2003).

A number of the bird species that occur in American Samoa are widely distributed or have congeners throughout the Pacific region. In many cases, data obtained elsewhere or on closely related taxa may well be generalizable to American Samoan populations. Examples of such recent studies include those on foraging ecology (Surman & Wooller 2003), movements (Day et al. 2003), abundances (Bull et al. 2002), physiology (Schleucher & Withers 2002), habitat use (Craig & Beal 2001) and distributions within archipelagos (Freifeld et al. 2001).

3.2.3 MAMMALS

3.2.3.1 Terrestrial mammals

Discounting domestic animals, there are eight species of terrestrial mammals present in islands of American Samoa. Of these, three are indigenous bats, four are exotic murids (*Mus musculus*, *Rattus exulans*, *R. norvegicus*, and *R. rattus*), and one is a feral pig (*Sus scrofa*) that is considered to be a Polynesian introduction.

The three native mammals are all members of the Order Chiroptera: *Emballonura semicaudata semicaudata* (Family Emballonuridae), and *Pteropus samoensis* and *P. tonganus* (Family Pteropodidae). All three species are considered of conservation concern, with *E. semicaudata* possibly extinct in the Territory and deserving the highest priority action.

The introduced species, on the other hand, are of concern due to their potential impact on native species or the habitat. Introduced rats may prey on most ground nesting birds, and recent work have documented their presence in high elevation areas where native species-of-concern (sea birds and the spotless crake) are known to occur and/or nest. The impact of feral pigs on forest regeneration and seedling survivorship in native habitats, added to the possibility that they may facilitate dispersal of invasive plants, has led the NPAS to conduct regular removal trapping in Park areas in the past (R. Cook, *pers. comm.*). The degree of threat or impact of these introduced species should be determined so that appropriate control or mitigation may be established.

3.2.3.2 Marine mammals

The dearth in scientific information on species and abundances of marine mammal species occurring in American Samoa in the face of: a) global concerns for the status of marine mammals; b) efforts to establish regional conservation and protection programs particularly for migratory species (SPREP, 2005); and c) a local initiative

declaring Territorial waters as marine mammal and turtle sanctuaries (American Samoa Government Executive Order No. 005-2003) has elevated this group into the American Samoa's list of Species of Conservation Concern (see Subsection 5.10). Following is an overview of the diversity in the region, in general, and in waters surrounding American Samoa, in particular, as excerpted from the Dolar (2005) report commissioned by DMWR:

"To date, 33 marine mammal species have been reported to occur in the tropical South Pacific either as resident, seasonal migrant or occasional visitor. The list ... includes 30 species of cetaceans, one sirenian and two species of pinnipeds (Reeves et al., 1999). Most populations of the commercially important large whales have been greatly reduced by whaling, and hunting of medium-sized and small cetaceans still occurs in some areas in the South Pacific Ocean (*e.g*. the Solomon Islands) Reeves, et al. 1999, Dawbin, 1984; Kahn, 2004).

Of the 33 species of marine mammals recorded present in the region, only eleven have been confirmed from the waters surrounding the islands of American Samoa. Two of these are mysticetes: minke whale (*Balaenoptera acutorostrata or B. bonaerensis*), and the humpback whale (*Megaptera novaeangliae*)*;* the remaining nine are odontocetes: sperm whale (*Physeter macrocephalus*), short-finned pilot whale (*Globicephala macrorhynchus*), killer whale (*Orcinus orca*), common bottlenose dolphin (*Tursiops truncatus),* pantropical spotted dolphin (*Stenella attenuata*), spinner dolphin (*Stenella longirostris)* (Reeves et al., 1999), rough-toothed dolphin (*Steno bredanensis*), Cuvier's beaked whale (*Ziphius cavirostris)* (Utzurrum pers, comm.; Craig, 2005) and false killer whale (*Pseudorca crassidens*) (Craig, 2005)."

Table 2. Vertebrate species known or thought to have had resident breeding populations in the territory of American Samoa. Species highlighted in bold are priority species for new studies.

Species	Common Name	Taxonomic Status	Abundance	Distribution	Threat	Conservation Class	Data
HERPETOFAUNA							
Geckos:							
Gehyra mutilata	Stump-toed Gecko	I	M	M	L	IV	L
Gehyra oceanica	Polynesian Gecko	I	A	G	L	IV	M
Hemidactylus frenatus	House Gecko	C	A	G	L	IV	M
Lepidodactylus lugubris	Mourning Gecko	C	A	G	L	IV	M
Nactus pelagicus	Pelagic Gecko	I	M	M	H	IV	L
Skinks:							
Cryptoblepharus poeciloplurus	Snake-eyed Skink	I	R	V	H,S	II	L
Emoia adspersa	Micronesian Skink	I	M	R	P	II	L
Emoia cyanura	Azure-tailed Skink	I	A	G	L	IV	M
Emoia lawesi	Lawes Skink	I	U	M	H	IV	L
Emoia nigra	Black Skink	I	A	G	L	IV	M
Emoia samoensis	Samoan Skink	E	M	G	L	IV	M
Lipinia noctua	Moth Skink	I	M	G	L	IV	L
Snakes:							
Candoia bibroni	Pacific Boa	I	R	V	P,S	I	L
Ramphotyphlops brahminus	Soil Snake	C	M	R	-	V	M
Marine Turtles:							
Chelonia mydas	Green turtle	I	U	R	H,P,S	II	M
Erytmochelys imbricata	Hawksbill	I	U	R	H,P,S	II	M

AVIFAUNA

Sea birds:

Anous m. minutus	Black Noddy	I	M	M	L	IV	H
Anous stolidus pileatus	Brown Noddy	I	A	G	L	IV	M
Gygis a. alba	White Tern	I	A	G	L	IV	H
Nesofregetta fuliginosa	Polynesian Storm-petrel	I	?	?	P	I	L
Fregata a. ariel	Lesser Frigatebird	I	M	G	L	IV	M
Fregata minor palmerstoni	Great Frigatebird	I	M	G	L	IV	M
Sterna anaethaetus	Bridled Tern	I	U	R	L	I	L
Sterna fuscata oahuensis	Sooty Tern	I	M	R	L	IV	H
Sterna lunata	Grey-backed Tern	I	U	R	L	IV	H
Sula dactylatra personata	Masked Booby	I	U	R	L	IV	H
Sula leucogaster plotus	Brown Booby	I	M	G	L	IV	M
Sula sula rubripes	Red-footed Booby	I	M	G	L	IV	H
Phaethon lepturus	White-tailed Tropicbird	I	A	G	L	IV	M
Phaethon rubricauda	Red-tailed Tropicbird	I	M	R	L	IV	H
Procelsterna cerulea nebouxi	Blue-grey Noddy	I	U	W	L	IV	M
Pseudobulweria rostrata	Tahiti Petrel	U	M	M	P	II	M
Pterodroma arminjoniana heraldica	Herald Petrel	U	U	R	P	I	M
Pterodroma leucoptera brevipes	Collared Petrel	I	?	?	P	I	L
Puffinus lherminieri dichrous	Audobon's Shearwater	I	U	M	P	II	M
Puffinus nativitatus	Christmas Shearwater	I	?	?	P	I	L
Puffinus pacificus	Wedge-tailed Shearwater	I	?	R	P	I	L

Land birds:

Acridotheres fuscus	Common Myna	C	A	R	-	V	H
Acridotheres tristis	Jungle Myna	C	A	R	-	V	H
Aerodramus s. spodiopygius	White-rumped Swiftlet	I	A	G	H	IV	H

Anas superciliosa pelewensis	Pacific black Duck	I	R	R	H,P	I	L
Aplonis atrifusca	Samoan Starling	E	A	G	D,I	III	H
Aplonis tabuensis manuae/tutuilae	Polynesian Starling	E	U	G	I,S	III	H
Clytorhynchus vitiensis powelli	Lesser Shrikebill	E	U	M	H,S	III	H
Ducula p. pacifica	Pacific Imperial-pigeon	U	M	G	P	III	H
Foulehaio c. carunculata	Wattled Honeyeater	U	A	G	D	IV	H
Gallicolumba s. stairi	Shy Ground-dove	U	R	R	H,S	III	H
Gallirallus philippensis goodsoni	Banded Rail	I	A	G	P	IV	H
Egretta s. sacra	Pacific Reef Egret	I	M	G	L	IV	M
Myzomela cardinalis	Cardinal Honeyeater	U	M	R	D	IV	H
Porphyrio porphyrio samoensis	Purple Swamphen	I	U	M	P	I	L
Porzana t. tabuensis	Spotless Crake	I	V	V	H,P,S	II	M
Ptilinopus p. perousii	Many-colored Fruit-dove	U	R	M	C,H,S	III	H
Ptilinopus porphyraceus fasciatus	Purple-capped Fruit-dove	U	M	G	C	IV	H
Pycnonotus cafer	Red-vented Bulbul	C	A	R	-	V	H
Todiramphus chloris manuae/pealei	Collared Kingfisher	I	M	G	H,I	IV	H
Tyto alba delicatula	Common Barn-owl	I	M	G	H	IV	M
Vini australis	Blue-crowned Lory	U	U	R	I,P	III	H

MAMMALS

Terrestrial mammals:

Emballonura semicaudata	Sheath-tailed bat	I	V	G	C,S	I	H
Mus musculus	House mouse	C	?	?	-	V	L
Pteropus s. samoensis	Samoan flying fox	E	U	M	C,D,H,P	II	H
Pteropus t. tonganus	Insular or Tongan flying fox	U	A	G	C,P	III	H
Rattus exulans	Polynesian Rat	C	A	G	-	V	H
Rattus norvegicus	Norway rat	C	A	G	-	V	H
Rattus rattus	Roof rat	C	?	G	-	V	L

Sus scrofa	Domestic Pig	C	M	G	-	V	M
Marine mammals: (many of these species unlikely breed in Territorial waters but may migrate through the area with calves enroute to feeding grounds following the breeding season)							
Mysticetes (2 species)	Baleen whales	W	?	G	P, S	I	L
Odontecetes (9 species)	Toothed whales/dolphins	W	?	G	P	I	L

Taxonomic Status: **U** - Unique to American Samoa in the USA, **E** - species or subspecies globally endemic to the Samoan islands, **I** - indigenous but occurs elsewhere in the USA, **C** - commensal with man, exotic or introduced, **W** - geographically widespread, some migratory

Abundance (known or inferred abundance *in the territory* where the species occurs, and scaled for expected values for the species): **V** - very rare, **R** - rare, **U** - uncommon, **M** - moderately common, **A** - abundant, **?** - data deficient

Distribution (known or inferred spatial distribution *in the territory*): **V** - very restricted, occurs on a single island and is not widespread thereon, **R** - restricted to a single island, or to rare habitats on several islands, **M** - restricted to specific habitats that are not rare on more than one island, or to a subset of islands, **G** - occurs in many habitats, or on most or all islands, **?** - data deficient

Threat (known or inferred existing threats based on best available information): **C** - potential susceptibility to Catastrophes such as hurricanes, **D** - high prevalence of Disease in the species, **H** - associated with a threatened or restricted Habitat type, **I** - high likelihood of competition with Introduced species, **L** - presumed Low or no current threats identified, **P** - susceptible to Predation by humans or introduced species, **S** - susceptible to declines due to Small population sizes.

Conservation Class (conservation study priority class): **I** - High priority: insufficient data available to make informed assessment of conservation status, **II** - High Priority: available data permits identification of threats or known low population sizes, **III** - Priority: ongoing studies or conservation and management efforts, **IV** - Moderate Priority: high abundance, widespread distribution, or lack of known imminent threats, but monitor for emerging threats, **V** - Low Priority: species for which local extinction would be satisfactory.

Data (reliability or recency of sources of data used in Abundance, Distribution, and Threat columns): **H** - High reliability, based on recent publications or current/ongoing but as yet unpublished survey data, **M** - Moderate reliability, based on irregular surveys, incidental captures, or repeated anecdotal evidence and personal observations, **L** - Low reliability, based on possibly dated literature reports or infrequent anecdotal or personal observations.

4 AN OVERVIEW OF THE HABITAT

4.1 VEGETATION TYPES

Whistler (2002) recognized six main categories of plant communities, of which five can be found on the high volcanic islands in American Samoa: littoral, wetland, upland scrub, disturbed, and rainforest vegetation. Although American Samoa is subject to relatively frequent hurricanes, vegetation patterns suggest these disturbances do not typically affect large areas of forest (Mueller-Dombois & Fosberg 1998, but *cf.* Webb & Fa'aumu 1999). The most extensive natural terrestrial habitat in American Samoa is lowland tropical rainforest (Whistler 1992). Due to the presence of few permanent streams and lakes, wetland habitats are the least extensive. There is significant heterogeneity within these broad habitat categories, which can be differentiated into a large number of habitat subtypes (Whistler 1980; also see Mueller-Dombois & Fosberg for a discussion on habitat subtypes). However, the flora of American Samoa has very low rates of endemism (van Balgooy et al. 1996). The two atolls in the territory are dominated by agroforest with remnants of littoral species (Swains Island; Whistler 1983) or by natural littoral communities (Rose Atoll; Whistler 2002).

4.2 STATUS AND PROGNOSIS

Available aerial and satellite imagery for the American Samoa islands are highly inadequate for delineation of the extent of the vegetation categories defined by Whistler (2002). In fact, in a recent effort to generate a land cover map by the Pacific Northwest Research Station Forest Inventory and Analysis (FIA) Program, portions of disturbed vegetation (*sensu* Whistler 2002) characterized as managed lands (agroforest and coconut plantations) were lumped together with other forest types (undisturbed, disturbed secondary, etc) as part of the "forest" coverage (Donnegan et al. 2004). For this reason, our assessment of the status and prognosis of habitats across the 7 islands of American Samoa is limited by the available information, and focuses largely on wetlands and rainforests (collectively lowland, montane, cloud forests [including upland scrub]; undisturbed and disturbed).

The current extent of native habitats in American Samoa compares favorably with the situation found in most tropical countries. However, there is increasing pressure on forest habitats, especially on Tutuila. The pattern of conversion of habitats into types less suited for wildlife is best modeled in Figure 3, and actual documented changes are illustrated in Figures 4a and b. **The general net trend is towards**

decreasing habitat quality. Except in parts of the Tafuna Plain, much of the land converted was previously classed as an agroforest type (Cole et al. 1988). Human population growth and economic development are important drivers in the pattern of land use conversion (American Samoa Government 2002; Department of Commerce 2003), as is the resurgent production of highly profitable, blight-resistant taro (*Colocasia esculenta*) and various leafy vegetables such as *Brassica rapa*.

Although recent estimates of overall rainforest cover for the Territory are unavailable, a comparison of satellite and aerial images over the last decade indicate that rainforest areas remain largely in tact (Figure 4). Given that approximately 40% of the land area are characterized by slopes 30° or greater, a significant portion of the islands remains forested and is projected to remain forested through the foreseeable future. Under a 50-year lease agreement between local villages and the federal government, a combined total of approximately 3,240 ha. of select forested tracts on Tutuila and Ta'u were established as the National Park of American Samoa. A significant portion of areas with slopes less than 30° consist of tracts of agriculture intermixed with forest patches or tree species (Department of Commerce 2003) and remain suitable habitat for a wide array of vertebrate and invertebrate species. In Manu'a (particularly Ta'u Island), areas of previously cultivated land have been left to fallow and are reverting to natural vegetation (Figure 4b).

Wetland and riparian habitats have experienced the most severe declines in coverage. It is estimated that at least 48% of the original wetlands has been degraded, and that approximately 450 acres of wetland habitat remains, largely in the Nu'uuli Pala, Leone Pala, and in Aunu'u (Department of Commerce 2003). Of these tracts, the Nu'uuli Pala and Leone wetlands are declared Special Management Areas and as such are afforded protection under the Territorial Coastal Zone Management Plan.

Littoral vegetation remains largely in stable and good condition in most islands other than Tutuila. On Tutuila, recent development in Fogagogo and Vaitogi have resulted in removal of significant areas of *Pandanus*, *Barringtonia*, and *Callophyllum* (pers. obs.). Still, a significant portion of remaining littoral vegetation on Tutuila are along steep coastal slopes, and it is unlikely that development and urban growth in the near future will result affect these areas (although see Section 5.4.4 regarding threats to beaches).

Current administrative provisions aimed at slowing down decline in habitat quality, or outright loss of native vegetation cover are inadequate (see subsections 8.2.1 & 8.2.2 for a thorough discussion). Yet it is recognized that the protection and conservation of the Territory's natural vegetation landscape is integral to the conservation of its wildlife populations (see subsection 4.3 below). For this reason, this plan highlights the protection of native habitats, through research & outreach (subsection 6.3), and through legal means(subsection 8.3), as a critical strategy for

wildlife conservation. In particular, four critical habitat types are defined and designated priority conservation areas fitting these habitat types are indicated in Figure 4.

4.3 HABITAT AND WILDLIFE: INTERDEPENDENT SYSTEMS

For many vertebrate species in American Samoa, agricultural crops can be an important resource. Cultivation of traditional plants such as coconut (*Cocos nucifera*), breadfruit (*Artocarpus altilis*), papaya (*Carica papaya*), nonu (*Morinda citrifolia*) and banana (*Musa spp.*) may potentially have increased some wildlife populations, especially bats, nectarivorous birds, and *Aplonis atrifusca* (Utzurrum & Seamon 2001). Clearing for plantations has traditionally occurred in a shifting or rotational scheme, primarily in secondary or disturbed forests (Nunn 2001, Myllyntaus et al. 2002). After initial intensive production, areas cleared for agriculture become fallow and regenerate into heterogeneous forests initially characterized by colonizing species such as *Macaranga harveyana* and *Pipturus argenteus*.

Taro and vegetable cultivation, in contrast, is often monocultural and may create areas that are both of little use to wildlife and prone to erosion (*pers. obs.*). Although even extensively cleared areas will regenerate (e.g., Elmqvist et al. 2001), the absence of other species (such as coconut or remnant native trees) in taro plantations presumably reduces visits by disperser species, slowing regeneration. Likewise, although residential areas can in theory provide valuable resources for many birds and bats (Rudd et al. 2002, Ricketts & Imhoff 2003), many of the trees planted near dwellings are exotic species of little use to wildlife (*unpub. DMWR data*).

However, in spite of the utility of agricultural areas to some wildlife species, there can be no substitute for maintaining extensive areas of native forests. This is particularly true for those species with somewhat narrow niches (Swihart et al. 2003). Even generalist species, such as many of American Samoa's native birds, are significantly more abundant in undisturbed native forests (Freifeld 1999), and the extent of deforestation has been shown to be crucial in predicting overall species richness (Steadman et al. 1999). Fruiting and flowering episodes in native species may also cause temporal shifts in animal movements (Webb et al. 1999).

Conversely, wildlife are equally important to native habitats and plant species. For example, Rainey et al. (1995) found that interactions among pollinators and plants may structure plant pollination and seed dispersal systems. Although the interactions between plants and animals have been the subject of numerous studies (e.g., see Howe & Westley 1988, Hunter et al. 1992, Fenner 2000 and Levey et al. 2001 for numerous examples from various ecosystems), there may be salient differences in plant-animal interactions between island systems such as American Samoa and more continental systems (Rainey et al. 1995).

For example, more than half of the native flora of Samoa are species dispersed by birds (Carlquist 1996). Many of the frugivores in American Samoa are generalist consumers of native fruits (e.g., Trail 1994, Webb et al. 1999), and elsewhere birds and bats have been shown to be instrumental in colonizing new islands (Shanahan et al. 2001). The conservation of this native fauna was predicted by Webb & Fa'aumu (1999) to be "essential in retaining the potential for regeneration of native forest after large-scale disturbance." Recent studies have indeed shown the crucial importance of wildlife in facilitating regeneration from the catastrophic disturbances that characterize this ecosystem (Elmqvist et al. 2001, Hjerpe et al. 2001).

These crucial interdependencies between plants and animals must therefore guide our approach to conservation in the territory. In most cases, we have attempted a two-tiered approach to conservation, focusing both on characteristics of the species of interest, and on its habitat associations. Only by obtaining adequate information on both aspects of a species ecology can we make truly informed management decisions.

FIGURE 3. PROJECTED LANDSCAPE CHANGES BASED ON OBSERVED PATTERNS OF LAND USE (Green arrow projects a positive reversal to higher quality habitat; brown arrow represents a loss in habitat quality. Difference in line thickness reflect differential rates of conversion between types of habitat with rates proportional to thickness.)

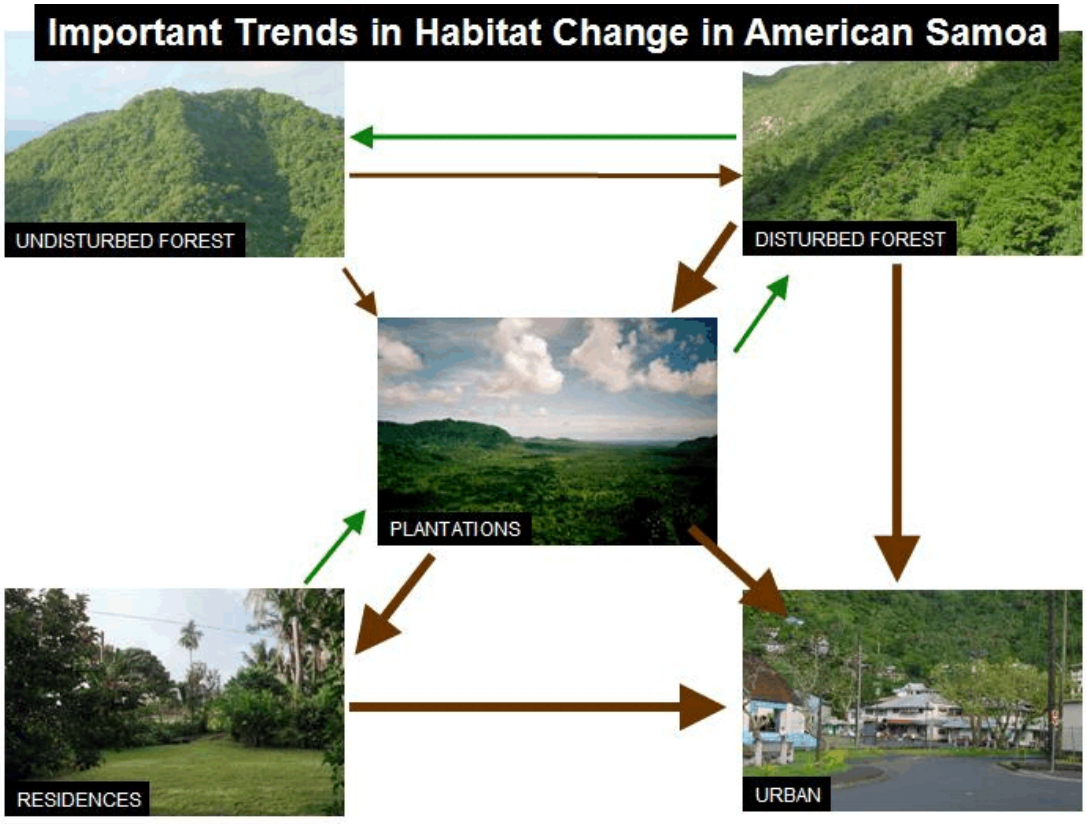
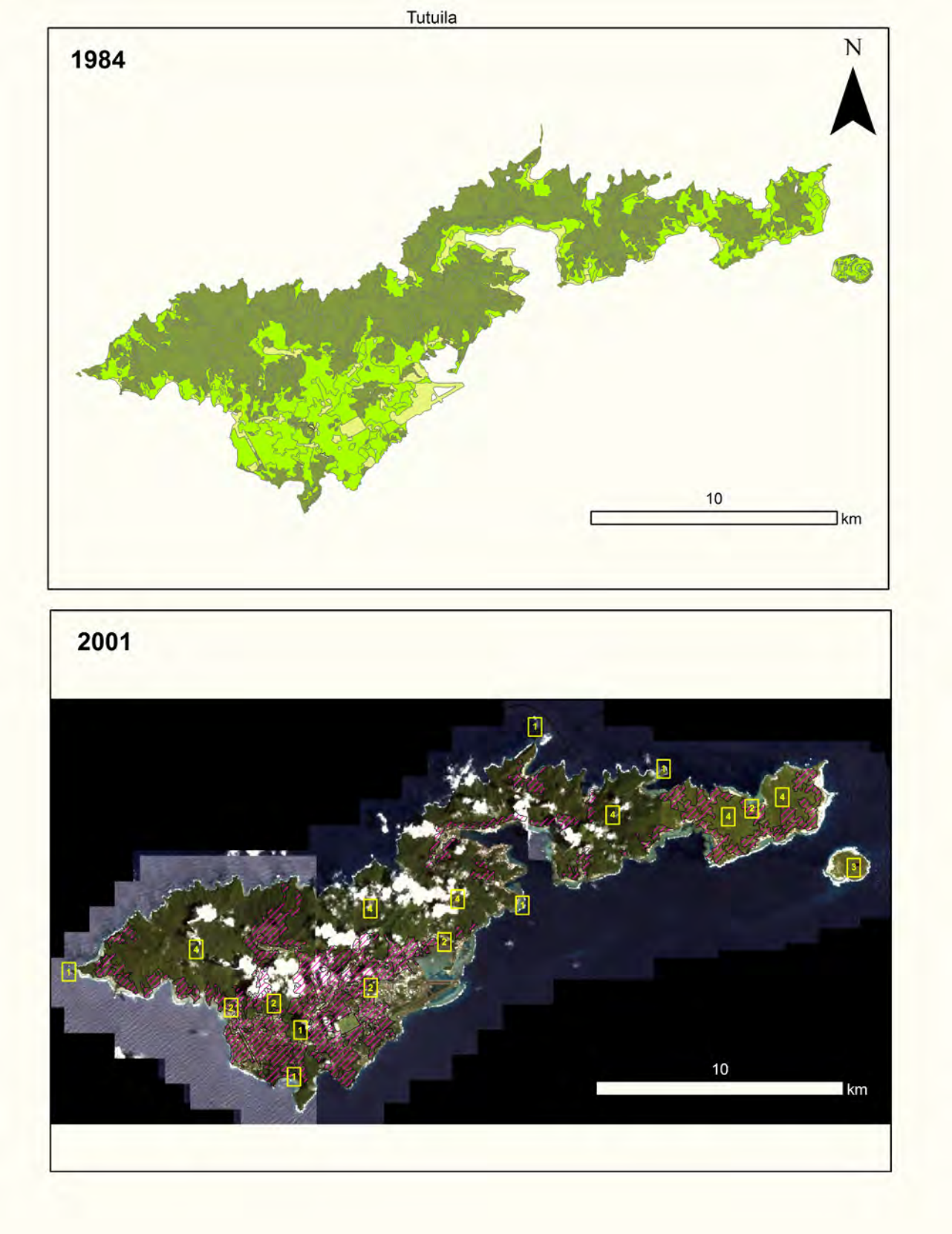


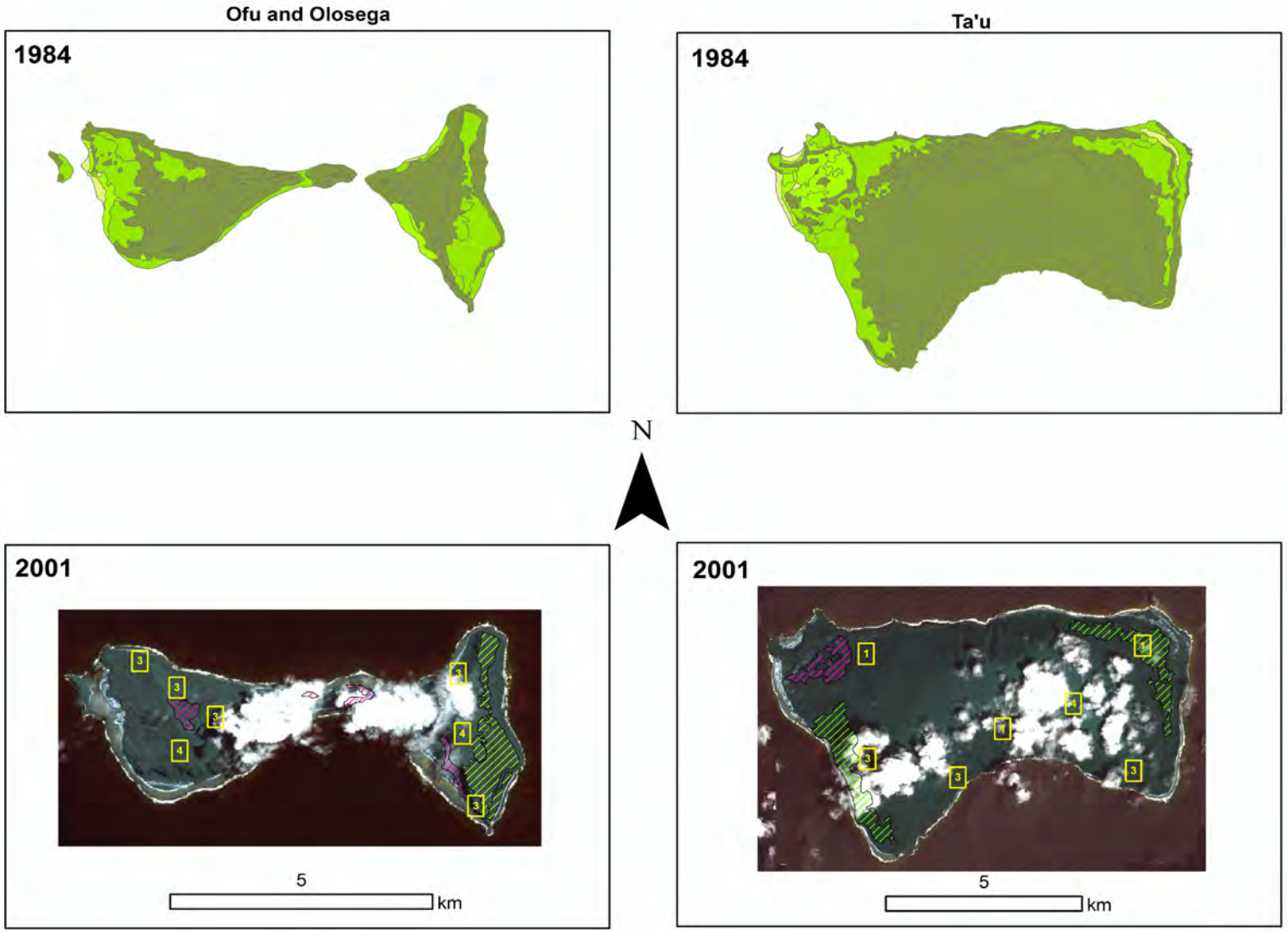
Figure 4. Maps of Tutuila (a) and Manu'a (b) showing actual land cover trends in American Samoa over the past two decades. The upper map in each figure shows land cover classes in 1984 as mapped by Cole et al. (1988). The dark green areas represent native vegetation types, the lighter green areas are disturbed and agroforest areas, while the beige areas are built up or urbanized habitats. The lower map in each figure shows an Ikonos (Space Imaging Systems LLC) satellite image from 2001, partially obscured by scattered clouds. The green cross-hatched areas indicate Cole et al. (1988) habitat classes that have experienced a significant reversion toward native types. The pink cross-hatching indicates approximate areas of habitat classes that experienced significant decrease in suitability or quality for wildlife. These changes are not specific to any one habitat type. For example, native habitat can experience a decrease in suitability by being converted to agroforest, while agroforest can become less suitable by being converted to more residential areas (see Figure 3). Numbers refer to Priority Habitat Preservation Areas in the following Table:

NUMBER	TYPE	DESCRIPTION/EXAMPLES (Species Benefitted)
1	Refugia	Known refuges from hurricanes, introduced predators, human disturbance, e.g., volcanic craters (*P. tonganus*), offshore islets (*P. tonganus*, land snails)
2	Critically threatened habitats	Habitats with very limited distributions, high uniqueness, rare plants, or high rates of loss, e.g., Tava-mamala (Tafuna Lowland) rainforest (native birds, bats), mangrove/estuarine areas (Pacific black duck)
3	Habitat for rare wildlife	Areas determined to have significant remnants of rare or declining wildlife, e.g., Manu'a wooded talus slopes (Shy ground-dove), Mt. Lata montane scrub forest (Spotless crakes and ground-nesting seabirds)
4	Contiguous expanses of habitat	Large remaining areas of native habitat, e.g., Mt. Leaeno & Mt. Leele (snails, insects, Pacific imperial-pigeon)

4.a



4.b



5 SPECIES OF GREATEST CONSERVATION CONCERN

Native species 1) whose conservation status are unknown (Conservation Class I), 2) known to the extent that they are considered to be of concern by virtue of threat and/or small population sizes (Conservation Class II), or 3) considered high priority in the past and are currently the focus of on-going research, conservation, & management efforts (Conservation Class III) include several invertebrates (a butterfly, a land crab, and endemic terrestrial snails), five reptiles (2 marine turtles, a snake, and 2 skinks), nine birds, and a variety of mammals (3 bats, and cetaceans) (see Table 2 for a listing). With the exception of a few that are largely unknown, these species or species groups are presented in this Section in greater detail. Abundances, distribution, and threats to each are provided to the extent that data are available. Priority actions deemed essential for the conservation or future conservation planning are enumerated at the end of each descriptive subsection. The conservation needs of those poorly known species excluded from this Section but deserving priority attention have been outlined in the overviews presented in Section 3.

Laboratory-hatched *P. godeffroyi*
(M. Schmaedick, ASCC/Land Grant)

5.1 *Papilio godeffroyi*

Local common name: Unknown
Distribution: endemic to Samoan Archipelago
Abundance: deemed rare
Status: not federally listed

The butterfly, *Papilio godeffroyi*, is a rare endemic. Despite its conspicuous appearance, the butterfly has remained largely unnoticed in the Territory. Larvae were recently found on *Micromelum minutum* (N. Gurr, *pers. comm.*), a relatively common plant species in forest edges and disturbed habitats. It is possible that other species in the Rutaceae and Araliaceae families are important food plants for the larvae (M. Schmaedick, *pers. comm.*).

5.1.1 THREATS

Specific threats are difficult to identify owing to the lack of information on the butterfly's biology in the Territory. It is unlikely that food is a limiting factor given the

abundance of potential food plants. The most immediate threat would be overcollecting for the lucrative price the butterfly may fetch in the collectors' market.

5.1.2 CONSERVATION PRIORITIES

The dearth of information on the species requires that priorities be set to:

1) *document distribution* among and within islands of the Territory, including any information on habitat-specificity;

2) *determine abundance and how the abundance may be distributed among habitats* (i.e., overall measures of abundance, patchiness or lack thereof in ocurrence);

3) *identify critical food plant species* for larvae; and

4) *assess natural threats*, such as predators and disease agents (e.g., parasites).

When sufficient baseline information on numbers, distribution, and basic biological needs and threats shall have been collected, a species-specific conservation plan should be developed given the potential commercial interest in the species.

Coconus crab for sale at the Fagatogo market (Photo by DF Nyhagen)

5.2 THE COCONUT CRAB, *Birgus latro*

Local common name: u'u

Distribution: widespread in Oceania & within American Samoa

Abundance: common (immature) to uncommon (adults)

Status: not federally listed; locally protected

The coconut crab, *Birgus latro*, has been a particularly frequent subject of study elsewhere in Oceania (Fletcher et al. 1990, Kadiri-Jan & Chauvet 1998, Chauvet & Kadiri-Jan 1999, Brown & Fielder 1991). It is found on all the islands of American Samoa (except Rose atoll), but is abundant primarily on Swains island (*pers. obs.*). Despite its cultural importance as a food resource, there have been no studies conducted on the local species, and estimates of their numbers and information on the extent of their distributional (habitat) range in the Territory are lacking.

5.2.1 THREATS

Specific threats to the long-term health and viability of populations of coconut crabs in the Territory are unknown due to the lack of studies on the species. The most logical threats to the species are unregulated harvesting and loss of habitat, and these factors should be investigated. Subsistence and low-level commercial harvest pose a threat to the species, particularly when harvest is biased towards reproductive adults. Although existing regulations limit the harvest of crabs by size and reproductive condition (American Samoa Administrative Code Title 24, Chapter 09), it is suspected that a substantial amount of crabs harvested for subsistence and informal sale may violate restrictions.

Anecdotal information from locals who habitually hunt consistently report rocky coastal areas as likely areas for finding coconut crabs. In Tutuila, rocky coastal plains, particularly in the Tafuna area, are increasingly being bulldozed for housing and other developments. If, in fact, this type of substrate is important habitat for the species, then continuing developments may have a significant impact on the species, or a developmental stage of the species.

5.2.2 CONSERVATION PRIORITIES

Based on the minimum information available on the status of and threats to the species, the following priority actions are recommended to enable better conservation planning for species:

1) *assessment of the population and distributional status* in American Samoa

Measures are in place to regulate the take of *B. latro* throughout the Territory, including a prohibition against the take of gravid females. However, we have insufficient evidence to determine if these regulations are adequate to maintain a healthy population of crabs, or to determine trajectories in abundances through time. Once initial estimates of population abundance and distributional data become available, it will be possible to derive specific hypotheses pertinent to management decisions. For example, it might be important to determine which possible causative factors predict heterogeneity in spatial patterns of *B. latro* abundance;

2) *research the reproductive ecology of the species*, and

3) *conduct a feasibility study on subsistence and commercial farming* of cococut crabs

Information on the species' ecological requirements, particularly for successful reproduction is vital for management of the species. Given the cultural interest in the species as a food item, farming of the crabs (whether for subsistence or commercial use) may alleviate pressure on populations in the wild.

As supporting information, it will be beneficial to *systematically compile harvest information* in cooperation with villages. The information can be used to develop a profile on levels of take, sizes taken, and areas of collection. Information on methods used for harvest could also be useful when developing a management plan.

Eua sp. and *Trochomorpha apia* (Photo used with permission from R. Cowie)

5.3 ENDEMIC TERRESTRIAL SNAILS

Local common name: sisi
Distribution: endemic to Samoan Archipelago
Abundance: deemed rare
Status: ESA list candidates or species of concern

Two species of terrestrial gastropods are currently candidates for listing under the US Endangered Species Act: *Eua zebrina* and *Ostodes strigatus*. Six others are categorized as species of concern: *Diastole matafaoi*, *D. schmeltziana*, *Samoana abbreviata, S. conica*, *S. thurstoni* and *Trochomorpha apia*.

The snail fauna of the Pacific has been well-studied (Cowie 1996 and references therein), but primarily with a view to documenting distributions and diversity from given islands or archipelagos, rather than providing a basis for monitoring and conservation (e.g., Cowie & Cook 1998, Cowie & Rundell 2002, Cowie et al. 2002). However, these data have been sufficient to detect significant long-term declines in many species (Cowie 2001a, Cowie & Cook 2001).

5.3.1 THREATS

By far the most significant threat to native snail faunas is posed by introduced species of snails (Cowie 2001b). Although the efficacy of predatory species for the biocontrol of previously introduced deleterious species such as the African snail *(Achatina fullica*) was largely undocumented, several species have been introduced to the Samoan Archipelago precisely for this reason (see Lydeard et al. 2004). The most significant introduced predatory snail may be *Euglandina rosea*, but there are at least 25 other introduced species that may be important predators or competitors (Cowie 2001b). The predatory flatworm *Platydemus manokwari* could also be disastrous for native species (Cowie & Robinson 2002). The flatworm was introduced to Samoa to control introduced predatory snails, but itself has become a threat to the native snails. It is reported that this flatworm is now common on Tutuila, although it has not been reported from other American Samoa islands (Cowie 2005; P. Craig pers. comm.). Finally, for snail species with critically restricted distributions (e.g., *S. abbreviata*, Cowie & Cook 2001), even small-scale habitat loss is a potential problem.

5.3.2 CONSERVATION PRIORITIES

Due to the many threats faced by the remaining native snails in the territory, our immediate priorities are:

1) *exhaustively document the within-island distributions* of the snails within and among habitats;

2) *identify critical ecological linkages between species and habitat factors* (e.g., microclimate; substrate, plant species); and

3) *develop and implement a monitoring program* to determine population performance and trends through time.

Accurate distribution maps would allow focused conservation efforts within small but critically important areas, perhaps by the exclusion of introduced species. It would also determine the presence of any refugia within which some or all invasives are absent. Again, measures could then be taken to reduce the chance of immigration in to these refugi by known invasives. The monitoring program should be designed within an ecological framework. This would enable identification of factors that may be impacting the species, or factors critical for

The second major priority is to **improve quarantine methods**, both between American Samoa and Samoa to its west, and within American Samoa between Tutuila and the more pristine Manu'a islands to the east. It is imperative that *P. manokwari* not be introduced from Samoa, and the frequent shipment of root crops such as taro greatly increases the risk of such an accidental introduction. If indeed P. manokwari is already in Tutuila, it is imperative that quarantine measures are observed to precent its spread to other islands. Likewise, it is critically important that *E. rosea* not be introduced into Manu'a.

These priorities echo a few of the conservation actions outlined in Cowie (2004), and should set the stage for more in-depth treatment in subsequent updates of this strategy.

Female green turtle (top) and a hawksbill hatchling
(Photo by KS Saili)

5.4 MARINE TURTLES

Local common name: laumei
Distribution: throughout the Pacific
Abundance: uncommon in American Samoa
Status: *E. imbricata* - Endangered (ESA list);
C. mydas - Threatened (ESA list)

Two species of marine turtles regularly occur in the territory of Amerian Samoa, the hawksbill sea turtle (*Eretmochelys imbricata*) and the green sea turtle (*Chelonia mydas*) (Tuato'o-Bartley et al. 1993). Territorial beaches are known nesting areas for both of these species (Utzurrum 2002). Juveniles of both species are frequently observed in coastal waters where they are likely foraging (Grant et al. 1997a). Because little is known about the federally endangered hawksbill sea turtle in American Samoa, it deserves immediate priority attention (Craig 2002). Although slightly more information is available on the federally threatened green sea turtle in the territory (i.e., migration routes as per Craig et al. 2004), this species requires equal priority attention due to serious declines in its Pacific population (Craig 2002). The protection of sea turtles and their habitats (i.e., nesting beaches and foraging areas) is critical to not only preserve populations inhabiting the territory, but also aid in forestalling the global extinction of these two species.

5.4.1 ABUNDANCE

Abundance estimates of American Samoa's sea turtle populations are difficult to make due to a dearth of data for the territory. Based on interviews of villagers, Tuato'o-Bartley et al. (1993) speculated that there were only 120 breeding females (greens and hawksbills combined) in the territory in 1993. This data can only be taken as a rough estimate as it relied on several untested assumptions. Additionally, although Grant et al. (1997a) discussed relative abundances of juveniles in the territory, they did not attempt to make population estimates for juvenile size classes. Tuato'o-Bartley et al. (1993) conceded that multiple years of data collection would be required to provide

accurate population estimates for the territory. Although opportunistic flipper tagging of turtles has been conducted in the territory since 1971 (Grant et al. 1997a), recapture rates are relatively low, providing insufficient data to make accurate population estimates at this time. The need for aggressive data collection aimed at determining local population size is supported by the fact that territorial sea turtle populations, albeit only roughly quantified, are clearly decreasing (Tuato'o-Bartley et al. 1993).

5.4.2 DISTRIBUTION

Sea turtles have been reported in coastal waters and on beaches of every island in American Samoa, with most reports coming from Tutuila, the island on which most people in the territory live (Utzurrum 2002). On Tutuila, the majority of sea turtle sightings occur in Pala Lagoon (Lion's Park), Faga'alu Park, and Gataivai (in Pago Harbor) (DMWR data). These sightings are consistent with recovery data suggesting that Pala Lagoon and Pago Harbor have high concentrations of sea turtles (Utzurrum 2002). Figure 5 shows the locations at which turtle sightings were reported during the first eight months of 2005.

Beaches with nesting potential (i.e., sandy areas not inundated by high tide) occur on all aspects of Tutuila and on at least one beach of every island in the territory. Most of the 11 beaches on Tutuila for which nesting activity has been reported are located on the eastern half of the island (DMWR data) (Figure 5). All of these beaches are believed to be hawksbill nesting areas. Although nesting has been reported on the Manu'a islands (Tuato'o-Bartley et al. 1993, P. Craig pers. comm.), it is not known how frequently nesting occurs there or which sea turtle species is using the beaches.[1] Rose Island is a confirmed green turtle nesting site with relatively high nesting activity (Craig et al. 2004).

5.4.3 KEY HABITATS

Key habitat for sea turtles includes both potential foraging areas and known and potential nesting beaches. In addition to the known hawksbill nesting beaches on Tutuila, several potential nesting beaches on which extensive sandy areas not inundated by high tide waters are available (DMWR data). Although it appears that the selection of nesting beaches may have a geographical basis (i.e., areas at the eastern side of Tutuila) in the territory, further research is needed to determine which beach

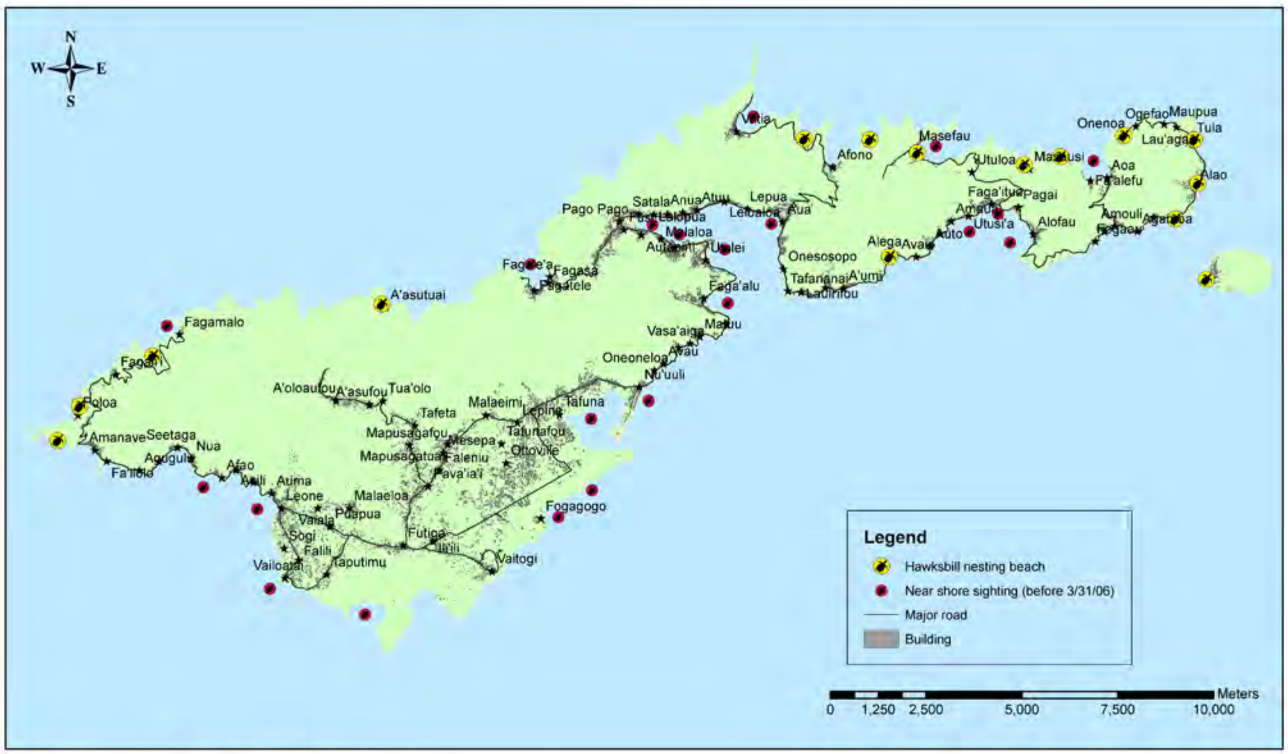
[1] Hawksbill hatchlings and tracks and diggings possibly from a nesting turtle were reported recently (2006) from Ta'u Island (V. Vaivai and R. Hart pers. comm.).

characteristics affect nesting beach selection. Given that the availability of dry sand and possibly geographic location may not be the only factors influencing nesting beach selection, the limited availability of known and potential nesting beaches on Tutuila necessitates protecting them all as nesting habitat until the contrary can be proven through regular beach monitoring efforts.

Based on dietary habits, nearshore areas with coral and seaweed covers are the most probable foraging grounds for hawksbill and green turtles. Limited data from in-water surveys and incidental sightings, however, indicate that hawksbills are present throughout the surrounding waters of Tutuila Is. (Figure 5). Additional rigorous surveys are needed to determine whether certain areas are preferred over others (as may be indicated by density or abundance), and enable designation of select sectors for management are critical foraging areas.

FIGURE 5

Sea Turtle Habitat on Tutuila, American Samoa



K. Schletz Saili
Dept. of Marine & Wildlife Resources
Pago Pago, American Samoa
9 July 2006

Created in ArcGIS 9 using ArcMap
WGS 1984 Zone 2S

5.4.4 THREATS

The construction of seawalls for protection of coastal roads and village infrastructure is a recent and increasing threat to potential nesting beaches. Majority of these structures were installed following extensive damages to coastal roads in the aftermath of Hurricanes Ofa and Val in 1991 and 1992, respectively. Additional construction followed hurricanes in 2004 and 2005. The areas under increasing threat are confined to portions of the islands were villages and coastal infrastructures are found in Tutuila and Manu'a. In Tutuila, any future road development and shoreline revetment (such as a seawall) particularly along the southeastern sector of the island must be reviewed closely as these are areas of known nesting beaches.

Other, more insidious threats to the habitat itself include sand-mining and associated construction projects, inundation with freshwater runoff during floods, and pollution (Witherington 1999). Shoreline activities may also degrade foraging habitats by indirectly altering the seafloor composition and available food items at those sites (Gibson & Smith 1999).

Direct threats to nesting turtles and hatchlings include light pollution, traffic on roads accessible to turtles, predation, and poaching of eggs and adults (Boulon 1999). Turtles frequenting territorial waters (both coastal and pelagic) are at greatest risk from poachers and incidental catch in longline fisheries (Craig 2002). Although the harvest of eggs and turtles are illegal under Territorial and federal laws occasional reports of poaching are not uncommon (DMWR Enforcement/Conservation logs).

Satellite tracking of green turtles nesting in Rose Atoll demonstrate that these threats are not limited to American Samoa (Craig et al. 2003). The migratory habit of these organisms expose them to predation by humans in other countries where regulations and restrictions on takes are not as stringent as in American Samoa. Indeed, the transnational habits of sea turtles necessitate the immediate implementation of a regional recovery plan (Craig 2002).

5.4.5 CONSERVATION PRIORITIES

A territorial sea turtle recovery plan was drafted in 1999 (AS Sea Turtle Recovery Team 1999) followed by an executive order from American Samoa's governor establishing the territorial waters as sanctuary for sea turtles and marine mammals in 2003 (American Samoa Government 2003: Executive Order 005-2003). These documents in addition to the USFWS recovery plans for Pacific populations of both green sea turtles and hawksbill sea turtles (NMFS 1998) outline American Samoa's sea turtle research needs. DMWR along with other local recovery team members has

initiated a sea turtle research program aimed at implementing the needs identified in the draft recovery plan.

Among the identified conservation needs being acted upon are: 1) *mapping local distributions*; 2) *physical characterization of documented and potential nesting beaches* to be used in the mitigation of threats to nesting sea turtles, nests, and hatchlings; 3) *determination of genetic stocks* to aid in transboundary management; 4) *documentation of migration routes* (with focus on the hawksbill sea turtle); 5) *identification of key foraging areas*; and 6) *increasing public awareness on conservation issues* affecting local populations of sea turtles (NOAA Unallied Management Grants to DMWR: 2004 to present).

Future research will be needed to establish reliable estimates of population size and long-term data sets from which population trends can be determined. Also, the American Samoa Sea Turtle Recovery Team need to revisit the draft conservation strategy for the territory, assess what objectives have been accomplished, and identify pragmatic means by which unaccomplished priority objectives can be accomplished. Although a regional conservation strategy has apparently been drafted (Craig 2002; SPREP Marine Turtle Conservation Action Plan 2002-2007), its implementation appears to be behind schedule. Communication networks must be re-established in order to implement a regional conservation plan. The celebration of the Year of the Sea Turtle in 2006 provides an excellent impetus to reestablish communication lines among nations and readdress the implementation of a regional conservation strategy.

Pacific boa being re-released to the wild, Fiji (Photo by RCB Utzurrum)

5.5 TERRESTRIAL REPTILES OF CONCERN

Candoia bibroni (Pacific Boa)
Local common name: gata
Distribution: throughout the region; restricted in American Samoa
Abundance: rare
Status: unknown, but maybe in decline; locally protected

Cryptoblepharus poeciloplurus and *Emoia lawesi* (Snake-eyed and Lawes skinks)
Local common name: pili and pili oua'
Distribution: restricted in American Samoa
Abundance: presumed rare
Status: unknown; locally protected

Three species of reptiles are deserving attention and very little is known of their current status in American Samoa except that they are rare and of restricted distribution. These are the Pacific boa (*Candoia bibroni*) and two species of skinks (*Cryptoblepharus poeciloplurus* and *Emoia lawesi*). The Pacific Boa is currently known only in Ta'u, although there is fossil evidence of its occurrence in Tutuila in the past (Steadman and Pregill 2004).
A brief summary of threats to these species, and of baseline actions that can enable a preliminary assessment of their statuses are presented in this section.

5.5.1 THREATS

Major threats to the Pacific boa and the two skinks (Snake-eyed and Lawes) are likely to be loss of habitat and predation. The Pacific boa is presently known only from the island of Ta'u. Ta'u remains largely covered with forest and a substantial area of which is protected under the National Park lease agreement with the local villages. Yet, the last confirmed sighting of the boa was in 1996 despite repeated visits to the area of last sighting. Two separate sightings of a snake resembling the boa were reported in 2006 from Ta'u village and Faga (on Ta'u) lacked confirmatory evidence. If still extant, the population may be reduced to critically low numbers requiring active intervention aimed at increasing numbers.

The Snake-eyed Skink (*C. poeciloplurus*) and Lawes Skink (*E. lawesi*) are restricted to or known to prefer coastal habitats, thus making them susceptible to hurricanes, and susceptible to introduced predators. Both cats and rats have been present in most of the territory for a significant time, and their impacts on the

herpetofauna are unlikely to significantly increase. The exception is Swains island, where cats have been introduced to control rats (W. Jennings, *pers. comm.*) since the surveys conducted by Amerson et al. (1982a).

5.5.2 CONSERVATION PRIORITIES

Although the lack of known, imminent threats on most islands downgrades the overall priority level of herpetofaunal studies, there are at least three areas that warrant attention:

1. *Update the status of the Pacific Boa in Ta'u*, due both to the recent severe hurricane damage to Ta'u and the paucity of distributional records from the island. Two recent (2006) descriptions of snake sightings from utility workers and local villagers in Ta'u indicate continued presence of the Pacific boa in the island. However, the lack of confirmatory evidence precludes definitive determination of the species. Still, the reports serve to stress the importance of status assessment surveys.
2. *Update the status of the Swains island herpetofauna*, given previous records of uncommon species from the island and the introduction of cats (to the island) since the previous surveys.
3. *Update the status of the Snake-eyed skink*, since this species was noted as rare during previous surveys.

5.6 NATIVE LAND BIRDS

A number of land birds are of conservation concern by virtue of their status, distribution, abundance, susceptibility to threats, and/or cultural importance (Table 1). Several of these species are restricted to the Western Polynesian region, while others are more geographically widespread. Only one species is endemic to the Samoan Archipelago, the Samoan Starling (*Aplonis atrifusca*). Following are brief descriptions of threats to the species. Information on distribution and abundances, and general assessment of status are summarized in Table 1 and cited in Subsection 3.2.2. Gaps in information and priority actions pertinent to their conservation are identified in the accounts.

5.6.1 HABITAT, DISTRIBUTION, ABUNDANCE & THREATS

Among land birds, a baseline information gap exists for *Anas superciliosa* (Pacific Black [Grey] Duck), *Porphyrio porphyrio* (Purple Swamphen), and *Porzana tabuensis* (Spotless Crake). Monitoring programs and ecological studies have been conducted to various degrees for at least a decade on most other species of interest. Nine species are featured below as deserving priority attention.

(Photo by RCB Utzurrum)

5.6.1.1 Purple Swamphen
Local common name: manuali'i

Porphyrio porphyrio, or the Purple Swamphen, is widespread but apparently never abundant in agroforests and wetland areas. In American Samoa, it occurs on all islands except Rose Atoll (Amerson et al. 1982a). This is a species of cultural importance, known in Samoan as the *manuali'i*, or bird of kings. It is also, however, perceived as a threat to crops such as banana (*Musa spp.*), and is occasionally killed by farmers. Its populations may be inherently vulnerable due to the limited extent of wetland areas in American Samoa. It may also be vulnerable to the conversion of agricultural lands from mixed, traditional methods to modern intensive methods, which have been shown to affect other species associated with human agricultural systems (e.g., Hole et al. 2002). Its diet elsewhere in its range is omnivorous, and thus it may be beneficial in agricultural settings if it also consumes snails or other pests of agricultural

crops. It is therefore important to accurately determine the abundance and distribution of this species, and to determine its actual dietary preferences and habits. Such distribution data could allow the construction of detailed maps to predict the most suitable habitats for *P. porphyrio*, a method successfully used in other study systems (e.g., Li et al. 2002).

5.6.1.2 The Spotless Crake
Local commmon name: unknown
Status: ESA candidate species

Porzana tabuensis, or the Spotless Crake, is a high priority species due to its extreme rarity, as well as the possible threat posed by introduced *Rattus* species. The well-documented propensity for flightlessness of insular rails in this genus (Slikas et al. 2002) makes them particularly susceptible to within-island threats. *P. tabuensis* is restricted to Ta'u island, and although formerly reported from lowland wetlands thereon, recent records are exclusively from dense montane scrub habitats near the summit of Mt. Lata (~1000 m elevation). There remain, however, large areas of Ta'u that have not been systematically explored for this species, and its cryptic habits may mean it has been overlooked. It is known to be associated with ephemeral upland stream habitats in Western Samoa (*pers. obs.*), so systematic surveys are clearly needed to determine the status and vulnerability of this species on Ta'u. Recent rat trapping in Ta'u has documented the presence of *Rattus norvegicus* in both lowland agroforest and summit montane scrub habitats, while *R. exulans* occupies forested habitats on the north side of the island (O'Connor & Rauzon 2003, DMWR *unpub. data*). However, rat abundances were low on the south side of the island, suggesting the possibility of a refuge for *P. tabuensis* in the Laufuti and Liu areas.

5.6.1.3 Samoan and Polynesian Starlings
Local common name: fuia and miti vao (respectively)

There are six Class III bird species listed in Table 2. One is the Samoan endemic *Aplonis atrifusca* (Samoan Starling). Survey data suggest reasonably abundant populations of this species on all the high islands of American Samoa. It is a habitat generalist, and is not subject to significant human predation. It is listed as a priority species due to its endemism, its significantly high loads of endoparasites (Atkinson et al. *in press*), and because its cavity nesting habit creates a possible vulnerability to the burgeoning Tutuila populations of introduced *Acridotheres* species. Its congener, *A. tabuensis* (Polynesian Starling), is also listed as a priority species. The

Manu'a form of this species is a known endemic subspecies. *A. tabuensis* occurs on all the high islands, but in much lower abundances than *A. atrifusca*.

Lesser shrikebill from Laufuti, Ta'u (Photo by RCB Utzurrum)

5.6.1.4 Lesser Shrikebill
Local common name: unknown

Clytorhynchus vitiensis (Lesser Shrikebill) populations in American Samoa are a known endemic subspecies, and are restricted to the Manu'a island group. Recent data suggests this species is more abundant and more widespread than previously thought, but even where it has its largest population, on the small island of Ofu, it can only be considered uncommon. It apparently strongly prefers a restricted subset of forested habitats, and thus is likely to suffer from catastrophic alterations of canopy cover caused by hurricanes. Since there have recently been two significant hurricanes in American Samoa (Heta in January 2004, Olaf in February 2005), continued monitoring of this species remains a high priority.

5.6.1.5 Pacific Imperial-pigeon
Local common name: lupe

Ducula pacifica (Pacific Imperial Pigeon) is a culturally significant species, the subject of both abundant lore, elaborate hunting traditions, and more recent exploitative hunting using modern methods (Craig et al. 1994). Populations on Tutuila apparently reached moderately stable levels approximately 7 years after the major hurricanes of 1991 and 1992 (Hurricanes Ofa and Val) (Utzurrum & Seamon 2001), although the numbers observed are a fraction of those reported in earlier studies (e.g., Amerson et al. 1982b). In spite of an ongoing hunting ban, poaching of this species remains a serious problem.

(Photo by C Atkinson)

5.6.1.6 Shy (Friendly) Ground-dove
Local common name: tuaimeo
Status: ESA candidate species

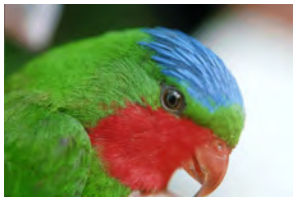
Gallicolumba stairi (Shy Ground-dove) is the rarest Columbiform in American Samoa. It is known only from Ofu and Olosega islands, where it appears to occupy low to mid-elevation forest. Recent data suggests its low population sizes are probably a natural phenomenon, since it apparently prefers steep but forested slopes in close proximity to

exposed or talus substrates. The largest population previously occurred on Olosega, particularly in areas that were ravaged by Hurricane Heta [2004]. Although presumably able to recover from such natural disturbances, there is clearly an inherent vulnerability in the small populations of the species.

Male *P. perousii* (Photo by R Utzurrum)

5.6.1.7 Many-colored Fruit-dove
Local common name: manuma

Ptilinopus perousii (Many-colored Fruit Dove) is endemic to the western Polynesian region. It is an uncommon and local dove that occurs on all the high islands of American Samoa, but has more specialized feeding preferences than its more abundant congener, *P. porphyraceus* (Purple-capped Fruit Dove). The male many colored-fruit dove is a visually striking bird, and are more frequently noted in fruiting native banyan than the drabber females. This species is of conservation concern due to both the difficulty of estimating its minimum habitat requirements and to its frequent movements, which make reliable population estimates difficult to obtain. For these reasons, radiotelemetry studies are a high priority for this species.



(Photo by RCB Utzurrum)

5.6.1.8 Blue-crowned Lory
Local common name: segaula

Vini australis (Blue-crowned Lory) is another culturally important species, with its bright feathers used in traditional headgear and as decorations in woven mats. It is restricted to Manu'a, with the largest population occurring on Ta'u, although post-hurricane records exist from Tutuila. Although the populations appear to be stable, they are known from elsewhere in their range to be vulnerable to both introduced rats and introduced cavity nesting birds, such as the common myna. Detailed life-history studies, as well as studies of seasonal shifts in resource usage, are priorities for this species.

(Photo by RCB Utzurrum)

5.6.1.9 Pacific Black [Gray] Duck
Local common name: toloa

Anas superciliosa has been rarely reported in a number of wetlands on Tutuila, but is regularly found only from the tiny nearshore island of Aunu'u. Even there abundances appear to be low, with maximum recorded counts of 8-12 individuals (DMWR unpubl. data). Periodic

counts of the Aunu'u population indicate numbers are low and stable at best (i.e., there are no indications that numbers are increasing). The species is culturally significant, appearing in many Samoan proverbs, and there is significant potential for poaching due to its isolation from regular enforcement activities. Demographic and ecological studies are clearly needed to better understand the status of the species, and determine what management actions may be instituted to increase its numbers.

5.6.2 SUMMARY OF THREATS TO THE AVIFAUNA

Threats to birds vary from species to species (see above) but fall into five general classes. The first is the threat of **predation**, typically from introduced rats but also from cats or humans. This applies not only to ground nesting species, but also to cavity nesters such as *V. australis*. The second is **loss of habitat**, whether of particular plant species such as *Ficus prolixa* or of entire habitat types such as wetlands. The third is **catastrophic declines**, especially in species with very small populations, due to natural occurrences such as hurricanes. The fourth threat is that of **disease**. Although most indigenous diseases do not appear to be major threats, new or emergent diseases such as West Nile Virus are a significant concern. The fifth threat is that from **introduced species**, including introduced birds already present in the territory.

5.6.3 CONSERVATION STRATEGIES

The data suggest several broad strategies are required to meet the conservation needs of the avifauna of the territory.

1. *Protect the Manu'a islands from introduced species* and *prevent the entry of new threats* (such as the brown tree snake) into the Territory.

Enhance quarantine procedures, as well as post-introduction emergency eradication efforts, since there is frequent shipping between Tutuila and Manu'a. The Manu'a islands contain 16 of the 17 species of conservation concern. A number of these are known to be vulnerable to introduced species, particularly *Rattus rattus*.

2. Initiate extensive surveys to *determine distributions and habitat requirements of poorly known species.* Among the priority species are *A. superciliosa, C. vitiensis, G. stairi, P. porphyrio*, and *P. tabuensis*.

3. Employ well-designed surveys to *derive robust population estimates, and monitor at intervals sufficient to allow detection of multi-annual trends in abundances*.

4. *Determine detailed demographic data for species of concern*, since even reliable abundance estimates are often insufficient to determine factors responsible for dynamics of populations.

5. *Create a territorial habitat management plan*.

6. *Develop mechanisms for emergency response to threats of emergent infections*, such as West Nile Virus.

5.7 SEA BIRDS

Tahiti Petrel (*Pseudobulweria rostrata*) (Photo by RCB Utzurrum)

Six sea bird species (*Nesofregetta fuliginosa*, *Sterna anaethaetus*, *Pterodroma leucoptera brevipes*, *P. arminjoniana heraldica, Puffinus nativitatus*, and *P. pacificus*) are grouped as Class I simply due to lack of information on the extent, if any, of current breeding populations in American Samoa (Table 2). All but *S. anaethaetus* are expected to be found in remote and difficult to access locations, primarily the montane scrub summits of mountains. This has inhibited the collection of incidental data on these species during the course of previous studies. Putative *S. anaethaetus* have been seen (on at least 6 occasions in the past 5 years) in the vicinity of Tutuila island (*unpub. DMWR data*), but surveys have not been systematic enough to derive robust estimates of their abundance.

Two other seabird species (*Pseudobulweria rostrata* and *Puffinus lherminieri*) are listed as Class II species (Table 2). Their breeding sites are well documented, and their presence has been repeatedly confirmed, but abundance estimates are not robust and they are potentially threatened by a known population of *Rattus norvegicus* in the most important breeding area at the summit of Mt. Lata, Ta'u.

5.7.1 THREATS

Threats are largely unknown. However, predation by introduced rats is the most likely threat to ground-nesting species. Since most nesting areas are either in isolated islets, inaccessible cliffs on north-facing slopes of the islands, and/or remote montane to mossy tops of mountains disturbance by humans and potential for habitat loss are not seen as imminent threats to the species.

5.7.2 CONSERVATION STRATEGIES

1. *Obtain updated estimates of abundances and distributions of priority species*

Systematic surveys encompassing the range of possible breeding periods would alleviate the information gap on most species. A survey of *S. anaethaetus* would also improve the accuracy of population estimates available for other diurnal species.

2. *Determine if and to what degree rat predation is a threat* to ground-nesting species

E. semicaudata from Fiji
(Photo by J. Palmeirim)

5.8 SHEATH-TAILED BAT

Local common name: pe'ape'a vai
Distribution: throughout Oceania
Abundance: unknown
Status: possibly extinct in American Samoa;
ESA candidate species

5.8.1 DISTRIBUTION

Emballonura semicaudata semicaudata is a regional subspecies of an insectivorous bat geographically widespread throughout Oceania (Hutson et al. 2001). Its historical distribution includes Fiji, the Samoan Archipelago, Tonga, and Vanuatu. Three other recognized subspecies occur north of the equator in Chuuk and Pohnpei (*E. s. sulcata*), the Mariana Islands (*E. s. rotensis*), and Palau (*E. s. palauensis*) (Flannery 1995; Koopman 1997).

In American Samoa, historical records confirm their occurrence in all the main islands, except Rose Atoll and Swains (Amerson, et al., 1982). Voucher specimens have been collected from Ta'u (Sanborn 1931: AMNH) and Tutuila (Amerson et al. 1982b & Pacific Ocean Biological Survey Program in 1966: USMNH) (in Amerson et al. 1982b).

5.8.2 ABUNDANCE

Previously estimated in the 10,000s, no more than 2 individuals of this species were last sighted in 1998, in the same shallow coastal cave in Afono (Tutuila Is.) where the largest colonies were reported from in the mid-1970s (Amerson et al. 1982b, R. Utzurrum unpubl. DMWR data). An estimated 100-200 individuals were reported from this Afono cave by Knowles (1988) and subsequent visits in 1990, 1992, and 1993 yielded similar results, i.e., bats were either absent or were present in very low numbers of 2-3 individuals (Grant et al. 1994). On-going systematic acoustic (for free-ranging bats) and cave surveys (for roosting individuals) in the four main islands of Tutuila and Manu'a have failed to detect the presence of the species (DMWR WCRP R-1-R-0 *E. semicaudata* assessment project: 2002-present).

Aggregations in the 10,000s are highly uncharacteristic of the genus *Emballonura*, and estimated aggregates of 15-20 or up to 100 individuals may be more typical of the species (Nowak 1994, Flannery 1995, Wiles et al. 1997). With this in mind, the sporadic surveys conducted between 1975 and the present strongly indicate that *E. semicaudata* may be near extinct (if not already extinct) in American Samoa. Reports from Fiji and Samoa indicate that populations of *E. s. semicaudata* are in decline or have been extirpated elsewhere in the region (FIJI: Hutson et al. 2001, C. Morley [University of the South Pacific, Suva] pers. comm.; SAMOA: Lovegrove et al. 1992, Park et al. 1992, Tarburton 2002, R.C.B. Utzurrum unpub. data on random acoustic surveys in 2004 in Upolu and Savai'i islands). There is very little known of the status of populations in Tonga and Vanuatu, but the bats are thought to be rare in Tonga (Koopman and Steadman 1995).

Although populations of the subspecies *E. s. rotensis* appear to be healthy in Aguiguan, it is now absent from four other Mariana islands they previously were recorded from (Esselstyn et al. 2004). The subspecies *E. s. sulcata* and *E. s. palauensis* persist within their historical range and populations are reportedly stable (Hutson et al. 2001).

5.8.3 HABITAT

E. semicaudata typically roost in caves, although they may possibly use rockfalls on cliff faces or hollows of large trees (such as banyans), and even man-made structures such as under bridges (Lemke 1986, Grant 1993, Grant et al. 1994, Hutson et al. 2001, Esselstyn et al. 2004). The bats were often found to co-habit the caves with swiftlets (in American Samoa, *Aerodramus spodiopygius*). There are no systematic studies on the types of habitats free-ranging and foraging individuals frequent. Estimates of densities provided by Amerson et al. (1982a: Table 29) indicate their presence in a range of natural and disturbed habitats, from littoral and mangove forests to ridge forest, and in plantations and villages. A recent study of sheath-tailed bats in Aguiguan, Mariana Islands indicate that the species prefer forest over non-forest areas (Esselstyn et al. 2004).

5.8.4 THREATS

Direct threats are largely unknown but it is assumed that the lack of suitable safe roosting habitats contributed to the vulnerability of the species, or their possible decline or extirpation from American Samoa islands. In American Samoa, most caves are small, shallow, and along coastal areas (Amerson et al. 1982, unpubl.

DMWR records). Tidal surges and strong winds would easily inundate these caves during hurricanes, as evidenced by the appearance of the Afono cave following Hurricane Ofa in 1990 (Grant et al. 1994). Inland caves are largely unknown but they may represent the last holdout of these species in American Samoa.

While use of pesticides have been implicated in the decline of insectivorous bats worldwide, and of *E. semicaudata* in the Mariana Islands, in particular (Rainey 1998), the level of chemical use in the Territory is minimal due to a relatively low intensity agricultural production requiring its application. Moreover, widespread aerial spraying for mosquitoes and other pests is not practiced. Destruction and disturbance of caves have been also been implicated in the decline and extirpation of the species from islands in the Mariana chain (Rainey 1998). Again, these impacts were not associated with decline of the populations in American Samoa (Grant et al. 1994), and, indeed, white-rumped swiftlets (*Aerodramus spodiopygius*) persist in relatively large numbers in the same caves once co-habited by the bats (R. Utzurrum pers. obs).

Steadman and Pregill (2004) found numerous *E. semicaudata* bones in prehistoric material from a cave in Tutuila, indicating that the species have been present in the islands for centuries before the arrival of Polynesians. Hence, it cannot be inferred that their possible extinction represents a case of an unsuccessful colonization by a recent arrival. Indeed it was suggested that predation by the barn owl (*Tyto alba*) may account for most of the vertebrate bones in the cave deposits (Steadman and Pregill 2004). Whether such predation can satisfactorily account for the severe decline or extinction of the species may be addressed through a more thorough archaelogical analysis of deposits in other caves in the Territory.

5.8.5 CONSERVATION PRIORITIES

Subspecies *E. s. semicaudata* is possibly locally extinct in American Samoa and is in decline elsewhere in the region. It is a candidate for listing in the US Endangered Species list. The priority actions recommended in this strategy are intended to reach a final determination of its status and, if warranted, trigger development and implementation of a recovery plan.

1) *Assessment of local status*

Complete systematic visual and acoustic surveys in Aunu'u, Manu'a, and Tutuila in American Samoa, with simultaneous collection of ecological variables from areas surveyed.

Conduct a thorough palaeontological analysis of substrate in all known caves, where suitable, to recover any historical evidence of presence of the bats. This

particular measure should be undertaken in collaboration with the American Samoa Historic Preservation Office.

2) *Assessment of regional status*

Develop cooperative studies with regional partners to document changes in numbers and conduct ecological and toxicological studies that may help determine causes of population declines. This may be achieved through cooperative efforts under the Memorandum of Understanding between DMWR and the Ministry of Natural Resources and Environment (Government of Samoa) signed in 2004, and in collaboration with colleagues at the University of the South Pacific in Suva, Fiji (C. Morley and M. Tuiwawa).

3) *Species restoration*

If found to be extant, development and implementation of a Species Recovery Plan (possibly involving captive breeding and reintroduction) should be a priority under SWG. Regardless of the status of the populations in American Samoa, a regional species recovery plan should also be developed in collaboration with partner agencies to stave off any further declines in populations elsewhere in the South Pacific.

P. samoensis (top) and *P. tonganus*
(Photo by RCB Utzurrum)

5.9 THE FLYING FOXES

Pteropus samoensis
Local common name: pe'a vao
Distribution: restricted to Samoan Archipelago and Fiji
Abundance: moderately uncommon
Status: populations locally stable; locally protected

Pteropus tonganus
Local common name: pe'a fanua
Distribution: widespread in the South Pacific
Abundance: common
Status: populations relatively stable; locally protected

The two species of flying foxes are by far among the best known wildlife in the Territory. In addition to general accounts on the species (*P. samoensis*: Banack 2001; *P. tonganus*: Miller and Wilson 1997), numerous studies on various aspects of the biology of both species have been published, with in-depth investigations on a number of these aspects continuing on. These include estimates of abundances (Amerson et al. 1982a, 1982b, Wilson and Engbring 1992, Brooke 1997, 2001, Utzurrum and Seamon 2001, Utzurrum et al. 2003), assessments of impacts of hurricanes and hunting (Daschbach 1990, Craig and Syron 1992, Craig et al. 1994a, 1994b, Morrell and Craig 1995, Grant et al. 1997b, Pierson et al. 1996), and studies on feeding ecology and physiology (Cox et al. 1992, Elmqvist et al. 1992, Banack 1996, 1998, Nelson et al. 2000a, 2000b, Nelson 2003), habitat use (Banack and Grant 2003b, Richmond et al. 1998, Brooke 2001, Nelson 2003), pollination and seed dispersal ecology (Cox et al. 1991, Rainey et al. 1995), patterns of activity and behavior (Cox 1983, Banack 1996, Thomson et al. 1998, Brooke et al. 2000, Norberg et al. 2000, Brooke 2001), and reproduction (Grant and Banack 1999, Banack and Grant 2003a). In addition to these, recent projects focused on genetics of populations (both inter- and intra-population patterns) and diseases are in progress (DMWR Wildlife Investigations: W-1-R Program). Findings from these and other studies support the continued placement of the flying foxes among the species of conservation concern particularly because of their vulnerability to anthropogenic activities.

5.9.1 DISTRIBUTION

Pteropus samoensis is extant only in the islands of Fiji and the Samoan Archipelago. Fossil bones found in a cave in ‘Eua were the last indications that the species may have occurred once in Tonga (Koopman and Steadman 1995). Populations in the Fiji Archipelago are recognized as the subspecies *P. s. naiwensis*, while those occurring the Samoan islands are designated as *P.s. samoensis* (Wodzicki and Felten 1975).

Pteropus tonganus, on the other hand, is the most geographically widespread species in the genus (Mickleburgh et al. 1992, Koopman and Steadman 1995). Three subspecies are recognized: *P. t. basiliscus* is found in small islands northeast of Papua New Guinea to the Solomons; *P. t. geddiei* occurs in Vanuatu and New Caledonia; and *P. t. tonganus* range from Fiji east to the Cook Islands (Wodzicki and Felten 1975, Hill and Beckon 1978, Koopman 1979, Wodzicki and Felten 1981, Koopman 1993).

In American Samoa, both species are confirmed from Aunu’u, Manu’a, and Tutuila (Amerson et al. 1982a, 1982b, Wilson and Engbring 1992), where the largest and most stable populations occur.

5.9.2 ABUNDANCE

Populations of both species have been surveyed since the late 1980's in Tutuila (Craig and Syron 1992, Wilson and Engbring 1992, Craig et al. 1994, Brooke 2001, Utzurrum and Seamon 2001, Utzurrum et al. 2003). The highest reliable estimate of *P. tonganus* in Tutuila was 12,000, with the current estimates of approximately 7,000-8,000 individuals. Estimates of *P. samoensis* are more difficult to obtain due to its largely solitary nature. However, daytime visual counts of the species estimate numbers in Tutuila at 1,000 - 1,500 individuals (Craig et al. 1994, Brooke 1997, 2001, Utzurrum et al. 2003). The sizes of the populations in Manu’a are less known due to logistical challenges of conducting regular systematic surveys in the islands. While linear surveys conducted by Amerson et al. (1982) found higher abundances of fruit bats (lumped as a single species) in each of the Manu’a islands compared with Tutuila, data from periodic surveys since 1995 clearly show that in recent years populations of both species are considerably lower in those islands than on Tutuila (Brooke 1997, DMWR unpubl. data from 1997-2004).

Trends show that the species are impacted by hunting (Craig and Syron 1992, Craig et al. 1994a, 1994b), even when hunting was regulated and conducted only on a seasonal basis (Utzurrum and Seamon 2001). When populations suffered substantial reductions of up to 80% in the aftermath of two successive hurricanes in the early 1990s, an executive order for a total ban on the hunting of the fruit bats was

called in 1992 and subsequently encoded in 1995 (American Samoa Administrative Code Title 24 Chapter 8). Since then populations have rebounded (Brooke 1997, 2001, Utzurrum and Seamon 2001, Utzurrum et al. 2003). However, recent hurricanes (2004 and 2005) may have set back the populations, albeit at levels less drastic than seen in 1990 and 1991 (DMWR, unpub. data from on-going surveys).

5.9.3 HABITAT

Both species prefer forest habitats, particularly low elevation forests, but, *P. tonganus*, in particular, may be seen foraging close to habitations where agricultural fruits (such as breadfruit and mango) and flowers (banana flowers) are available (Banack 1996, Richmond et al. 1998, Brooke 2001, Banack and Grant 2003b, Nelson 2003).

Roosting groups of *P. tonganus* (a colonial species) and individuals of *P. samoensis* (generally a solitary species) are largely confined to forested areas, in locations that often are removed from houses (Brooke et al. 2000). However, atypical transient roosts of *P. tonganus*, in trees within people's backyards, do appear following hurricanes (DMWR unpubl. data from on-going studies).

5.9.4 THREATS

Flying foxes are without any significant natural predators in American Samoa, although predation by barn owls have been reported in the past (Amerson et al. 1982, Engbring and Ramsey 1989, Grant and Banack 1995). **Hunting** (currently banned, although low level poaching is assumed), and increased predation (from domestic and feral cats and dogs), physical and physiological impacts, and malicious harm (by humans) in the aftermath of **hurricanes** are the main documented sources of mortality and population declines (Daschbach 1990, Craig et al. 1994b, Pierson et al. 1996, R. Utzurrum unpub. obs. from 2004 hurricane). Along with (Western) Samoa, American Samoa were the principal sources of bat exports to Guam in the mid-1980s (Wiles and Payne 1986, Wiles 1992, Craig et al. 1994a), and this period coincided with reports of declines in numbers of bats (Craig and Syron 1992, Craig et al. 1994b). Simulations of population trends indicate that even low levels of exploitation will result in declines and retard recoveries from natural disasters (Pierson and Rainey 1992, Craig et al. 1994b). Thus, any proposals to re-open the populations for hunting should be given very careful consideration.

A potential negative consequence of the recovery in fruit bat populations is the increase in man-bat conflicts stemming from use of orchard and cultivated fruits.

If these conflicts were to escalate, the perception of bats as pests is likely to intensify and substantiate arguments calling for the culling or eradication of populations. Any management program should take this issue into consideration, and develop proactive provisions that could mitigate impact of fruit bats on fruit resources for human consumption.

Scattered reports of epidemic-related mortalities, particularly in the genus *Pteropus*, (summarized in Rainey 1998) demonstrate the potential threat of **diseases** to bat populations. Malarial infection has recently been documented in both *P. samoensis* and *P. tonganus* in American Samoa, Samoa, and Fiji (on going DMWR Wildlife Investigations W-1-R project), with nycteribiid flies as a likely vector (H. Klompen [Ohio State University], pers. comm.). Preliminary results indicate a differential rate of infection between the two species. It remains to be established whether the infection has any impact on the demographics (reproduction, survivorship, mortality) of both species. A comparative study looking into the vector-prevalence correlation is programmed for conduct in the FY2006-2010 grant period of the Wildlife Restoration Program. Additionally, preliminary tests revealed the occurrence of viral infections related to strains recently implicated in zoonotic infections in Southeast Asia (T. Kziasek [CDC Special Pathogens], pers. comm.). Thus, even if the bats themselves show resistance to these agents, the likelihood of (health) risk to human populations can trigger a mass panic resulting in clamors for eradication of the species. Thus, it would be prudent to pursue studies to determine if in fact the viral strains present in the local bat populations are of the type likely to result in human infections and, possibly, death so that appropriate measures can be established to minimize this risk.

5.9.5 OTHER BIOLOGICAL CONSIDERATIONS

Fruit bats (Family Pteropodidae), in general, have low reproductive rates. *Pteropus samoensis* and *P. tonganus* most likely bear no more than one young per year, although birth intervals of 9 months have been proposed for *P. tonganus* (Grant and Banack 1999). This limits their ability to recover from population declines (see Pierson and Rainey 1992, Craig et al. 1994, and Brooke 1997 for discussions on recovery time). Serious consideration should also be given to the genetic characteristics of these two species. On-going analyses of populations across the south central Pacific indicate substantial genetic structuring in one of the species among islands (DMWR W-1-R project). This indicates poor movement among islands (hence, low expectation of emigration as a means for repopulation), and argues for independent conservation/protection of geographically-separate populations to maintain the genetic distinctions.

5.9.6 CONSERVATION PRIORITIES

Local populations of both flying foxes are generally stable, but declines have been recorded following hurricanes, and in relation to hunting. The species may be threatened elsewhere in its distribution. Locally, both are under full legal protection, are protected from international commercial trade per listing under CITES Appendix 1, and *P. samoensis*, in particular, is designated as a Species of Concern in the US Endangered Species list. Local populations are in no imminent danger and resiliency to effects of hurricanes is evidenced by persistence of the species. However, populations elsewhere in the region are hunted at various levels and shrinking forest habitats may decrease carrying capacities for the species in the various islands where they occur, including those in American Samoa. Given that unpredictable natural disasters and exploitation by humans are a major threat to the populations, development and institution of management measures should be of high priority in on-going conservation programs for the species.

In particular, provisions should be made to:

1) continue *population monitoring*, with increased effort to determine specific demographic parameters critical in projecting models for achieving population stability or recovery under scenarios of take and no take;

2) *develop a rescue and rehabilitation program* to minimize morbidity and mortality brought on by hurricanes;

3) *secure adequate critical habitat* for foraging, roosting, and reproduction to sustain viable populations;

4) *determine threats to the population from diseases*, such as malaria and Nipah- and Hendra-like viruses; and

5) *establish management guidelines to minimize potential conflicts with humans* arising from consumption of fruits (agricultural and orchard) by bats and *risks to public health* from (bat) diseases.

All these five measures are presently covered under DMWR's 2006-2010 Wildlife Restoration program, and are being undertaken in collaboration with USGS/BRD/PIERC (C.T. Atkinson: malaria study), Ohio State University (H. Klompen: molecular analysis of vector transmission of malaria), and CDC (T. Kziasek: viral infection study).

5.10 MARINE MAMMALS

Lack of specific information on marine mammals, including their diversity and status, in the Territory has made it necessary to treat these species as a group. With the exception of THREATS and STATUS subsections, the summary on distribution and conservation needs presented in this section are excerpted from a review commissioned as part of the SWG planning process (Dolar 2005). References cited in this write-up are enumerated in Literature Cited.

5.10.1 A SUMMARY OF KNOWLEDGE FROM THE REGION

Little was known historically of the distribution, abundance and general status of marine mammals in the waters surrounding the islands and island groups in the South Pacific Ocean. Until recently, most of what is known in this region was obtained from whaling records (Townsend 1935) and the results of the “Discovery tag” scientific program that was carried out between 1932 and 1984 (Dawbin 1959 in Reeves et al. 1999; IWC SC/56/SH7). Researchers working in conjunction with modern Japanese whaling operations have also contributed information on the distribution and biology of large whales (Miyashita et al. 1995 in Reeves 1999). In recent years, collaborative efforts among various countries and territories in the South Pacific have greatly improved the knowledge on marine mammals in the region. For example, dedicated surveys and genetic studies carried out by the South Pacific Whales Consortium in waters around Tonga, Cook Islands, French Polynesia, New Caledonia, Samoa and Fiji, though focused mainly on the migration, interchanges and stock identity of southern hemisphere humpback whales, have helped document the occurrences of other marine mammal species (IWC/ SC/56/SH7, Gill et al. 1995, Garnier et al. 2000, Garrigue et al. 2002, Garrigue et al. 2004, Hauser et al. 2000). Reeves et al. (1999) in their review of the marine mammals found in the area served by SPREP (South Pacific Regional Environment Programme), acknowledge that very little is known of the marine mammals in the tropical South Pacific. Most researches in this area are devoted to large whales, and information about the smaller whales and dolphins comes from opportunistic efforts of individual researchers. Information on the distribution and ecology of small whales and dolphins in coastal waters surrounding the tropical South Pacific Islands is almost non-existent.

5.10.2 A SUMMARY ON SPECIES KNOWN FROM AMERICAN SAMOA

Only eleven of the 33 species [known to occur in the tropical South Pacific] have been confirmed present in the waters of American Samoa. These are the humpback whale, minke whale, sperm whale, killer whale, short-finned pilot whale, common bottlenose dolphin, spinner dolphin, pantropical spotted dolphin, rough-toothed dolphin, Cuvier's beaked whale and false killer whale.

The presence of the **humpback whale** (*Megaptera novaeangliae*) population in American Samoan waters was first documented in 1983 (Kaufman 1983). Four years of vessel and aerial surveys (1979, 1980, 1982, and 1983) showed that the whales inhabit the near shore waters of about 100 fathoms or less from June 26 to November 15, peaking in abundance from Sept. 15 to Oct. 1. Whales were observed as far east as Rose Atoll (140° 30'S, 170° 35'W). The presence of calves and the observed singing by the males strongly indicated that reproduction was occurring in the area (Kaufman 1983). There is believed to be an interchange between the breeding grounds of Tonga and American Samoa as suggested by the similarity in the songs recorded in the two areas and as indicated by the movement of nine animals tracked between American Samoa (14° 18'S, 170° 35'W) and Vava'u Island in Tonga (19° S, 174°10'W). Two whales were tracked westward to Samoa (13° 40'S, 172° W) (Kaufman 1983). The whales that winter in American Samoan waters are believed to be part of E stock, originally called the Group V whales (IWC, SC/56/SH7). These whales feed in the Antarctic in the summer and migrate to the tropical South Pacific ocean using two migratory "streams", one passing the east coast of Australia ("east Australia group") and the other passing New Zealand and Norfolk Island ("New Zealand group"). The New Zealand group is believed to winter in Fiji, Tonga (Reeves et al., 1999; Baker, 2000) and probably American Samoa. The wintering humpback whales, locally known as *tafola* arrive in American Samoan waters in June and leave as late as December; peak numbers are seen between September and October (Craig 1995). Numerous sightings have been made recently around Tutuila Island (Leone Bay and Fagafele Bay (NOAA/NOS 2003), Pola (P. Craig pers comm.), Olosega Island, and Ta'u Island (Utzurrum and Seamon, pers comm.). Humpbacks have also been reported wintering in Samoa, but in fairly small numbers. In the 2001 survey only three whales were seen, and in 2003, five whales were encountered (Paton and Walsh 2004 in IWC /SC/56/SH7).

Minke whales (*Balaenoptera acutorostrata* or *B. bonaerensis*) are widely distributed throughout the world's oceans. A compilation of recent observations by Japanese researchers showed that the waters around American Samoa and nearby islands have some of the highest encounter rates of minke whales in the Southern

Ocean (Kasamatsu et al., 1995). Encounter rates of four to six whales per 1000 nm were observed in October – December at the eastern end of Tuamotu Archipelago (10-20°S, 130°-140°W) and from American Samoa and Niue east to Tahiti (10-20°S, 150-170°W) (Reeves et al. 1999). Unlike the humpback whales, the southern minke whales probably do not congregate into discrete breeding grounds (Reeves et al. 1999).

Sperm whales (*Physeter macrocephalus*) are distributed in all oceans of the world. Their presence in the waters of American Samoa has been reported by R. Volk in his communication dated 2 Dec. 1991 (in Reeves et al. 1999). Most recent sightings were made by D. Mattila and J. Naughton (NOAA) (Craig 2005). Because of its large spermaceti organ, the sperm whale was one of the major target species of 19th and 20th century British and American whalers. It was frequently hunted in Samoan waters during the 1820's to the late 1840's (Reeves et al. 1999). Whaling of animals thought to belong to the same stock as those in the tropical South Pacific region continued in Australia and the Antarctic till 1980 when whaling in most of the southern hemisphere was banned by the IWC (Reeves et al. 1999).

Short-finned pilot whale skull from a stranding in Sita Bay, Tutuila (P. Craig, NPAS; Photo by L Dolar)

Short-finned pilot whales (*Globicephala macrorhynchus*) are widely distributed in warm temperate and tropical waters worldwide. Areas of distribution in the tropical South Pacific include Guam (where it is the most frequently observed cetacean), Micronesia, Northern Marianas, Fiji, Tonga, Solomon Islands, New Guinea, Loyalty Islands (where there was a stranding of 52 animals), northern Line Islands, Cook Islands, French Polynesia, Samoa, American Samoa (observation made by R. Volk in Reeves et al., 1999), Palau, Gambier and Society Islands, Pitcairn group, Marquesas and Vanuatu (Reeves et al. 1999, IWC SC/56/SH7). Recent documentation in American Samoa includes the three skulls collected from a stranding near Sita Bay northeast of Tutuila Island (currently stored at the office of the National Park of American Samoa), a sighting (with photographs) by Douglas Fenner in Fagatele Bay, Tutuila Island, and sightings by D. Mattila and/or J. Naughton of NOAA in 2004 (Craig 2005).

Killer whales (*Orcinus orca*) have a cosmopolitan distribution. They are found in all oceans and seas of the world and are even known to swim up rivers. Areas of occurrence in the tropical South Pacific include east of Phoenix Islands and north of Marianas Islands, between Phoenix and Tonga Islands, vicinity of Cook, Society and

Austral Islands, large concentrations in Samoa, American Samoa (seen on occasion- reported by R. Volk, in Reeves et al. 1999), Guam, Palau, New Guinea, Solomon Islands, New Caledonia, French Polynesia and Fiji (Reeves et al. 1999, IWC SC/56/SH7).

Bottlenose dolphins (*Tursiups truncatus*) are considered common in American Samoa (R. Volk in Reeves et al. 1999). Other areas in the tropical South Pacific where they have been documented include the Marquesas, northern Line Islands, Christmas Islands, Canton Island, Phoenix Islands, Solomon Islands, New Ireland, Papua New Guinea, Austral Islands, New Caledonia, Tonga, Cook Islands, Tuamotu Archipelago, French Polynesia and Samoa (Reeves et al. 1999, IWC/SC/56/SH7). In American Samoa, they have been sighted in Fagamutu and Fagasa Bay, and Tutuila Island (NOAA/NOS 2003, D. Mattila and/or J. Naughton in Craig 2005).

Like bottlenose dolphins, **spotted dolphins** (*Stenella attenuata*) are considered common in American Samoa (R. Volk in Reeves et al. 1999) and have been recorded in many areas in the tropical South Pacific *i.e*. in New Caledonia, Vanuatu, Fiji, Cook Islands, French Polynesia, Solomon Islands, Marquesas, and New Guinea (Reeves et al. 1999, IWC SC/56/SH7). The range is probably much wider than indicated by the sightings and strandings. The pantropical spotted dolphin is the species that is predominantly hunted by the locals in the Solomon Islands (Kahn 2004).

Spinner dolphins riding the bow (7 April 2005, Leone Bay, Tutuila Island; Photo by L. Dolar)

There have been four subspecies of **spinner dolphin** described: the eastern (*S. l. orientalis*), Central American (*S. l. centroamericana*), Gray's spinner (*S. l. longirostris*) and the dwarf form of Southeast Asia, (*S.l. roseiventris*) (Perrin 2002). The form that is found in the tropical South Pacific is the more typically patterned Gray's spinner dolphin (*S. longirostris longirostris*). Its distribution in this region is widespread, including the Line Islands, Marshall Islands, southern Micronesia, New Guinea, Solomon Islands, Fiji, Tonga, French Polynesia, Cook Islands, Samoa, American Samoa (considered common, reported by R. Volk in Reeves et al. 1999), Marshall Islands, Vanuatu, Tuamotu, Marquesas, Christmas Islands, Line Islands, Phoenix Islands (Reeves et al. 1999; IWC/SC/56/SH7). Recent documentation was made by D. Mattila and/or J. Naughton (Craig 2005). On April 6, 2005, Dolar, Utzurrum and Seamon sighted two groups of spinner dolphins in the coastal waters of Tutuila. One sighting

was in Leone Bay, composed of about ten pods of spinner dolphins with five to ten animals per pod, and the other sighting was in Afono Bay, composed of two animals.

Rough-toothed dolphin (*Steno bredanensis*) is a tropical and subtropical species, rarely ranging north or south of 40º. It often inhabits deep oceanic waters. In the tropical South Pacific, it has been recorded in Solomon Islands, French Polynesia, Marianas Islands, Line Islands and Marquesas (Reeves et al. 1999). In American Samoa, it has been sighted and identified by D. Mattila and J. Naughton (Craig 2005).

Cuvier's beaked whale (*Ziphius cavirostris*) is widely distributed in all oceans. It can reach up to 7.5 m and weigh up to 3,000 kg. It is considered not common in the tropical South Pacific . So far it has been recorded from Micronesia, Sydney Island, Phoenix Island, New Britain, Nauru and Manua Islands, French Polynesia (Reeves et al. 1999), American Samoa. The first record from American Samoa came from the stranding in June 3, 2002 (R. Utzurrum pers comm.) at Pago Pago harbor. Identification was verified by J. Mead of the Smithsonian Institution.

False killer whales (*Pseudorca crassidens*) inhabit deep offshore waters. They are found in tropical and warm temperate waters no further than 50º north and 50º south. They are believed to be present throughout the tropical South Pacific Ocean (Reeves et al., 1999). Their presence in American Samoa was documented by D. Mattila and J. Naughton (Craig 2005).

Bryde's whales (*Balaenoptera edeni*) have a pantropical distribution and are probably the most abundant mysticete in the tropical South Pacific (Reeves et al. 1999). They reach up to 15.5 m in length and 25 tons in weight (Jefferson et al. 1994). Some populations are migratory, seasonally moving over relatively short distances, but are not known to congregate into feeding or breeding grounds. Although there had been no confirmed sighting of Bryde's whales in American Samoan waters, the proximity of a "noticeable concentration" observed in nearby areas *i.e.* 10-28ºS, 157-177ºE and 21-30ºS, 179E-170ºW (Ivashin1980 in Reeves et al. 1999) makes it highly likely for this species to be found there.

5.10.3 THREATS

Commercial hunting of whales continues in areas of the Pacific and remains the biggest threat to the populations. American Samoa, as a territory affiliated with the

United States is obligated to enforce the provisions of the Marine Mammal Act; hence, takes of any form are illegal in the Territory.

Possible threats to locally occurring cetaceans would be from **interactions with fishing vessels** and **predatory marine organisms**, such as cookie cutter sharks. Fishing interactions are to be logged by vessels (i.e., long liners) as a requirement for licensing. However, there are no records of interactions reported from fishing data compiled at DMWR and documentation of the magnitude of this threat may only be achieved with the establishement of an observer program. Threats from sharks are also largely undocumented. However, all three stranded whales on Tutuila since 2002 (1 in 2002, 2 in 2005) bore the characteristic marks of encounters with cookie cutter sharks.

5.10.4 STATUS OF SPECIES CONFIRMED FROM AMERICAN SAMOA

Of the eleven species known to occur in Territorial waters, two are listed Endangered under the Endangered Species Act. These are the humpback whale (*Megaptera novaeangliae*) and the sperm whale (*Physeter macrocephalus*). There are no available recent estimates of abudances of any of the 11 species from local waters. At the close of commercial whaling in 1963, it was estimated that 95% of the Group 5a Antartctic stock of humpbacks, which includes those that migrate through American Samoa waters, have been taken. At present, all marine mammal species are protected within the 3 mile limit of Territorial waters by virtue of Executive Order No. 005-2003 (American Samoa Government 2003), a layer of protection that has been added to that afforded to the species group under the US Marine Mammal Protection Act.

5.10.5 CONSERVATION PRIORITIES

As a result of the literature review of the marine mammals of American Samoa, the consultation meeting (5 April 2005) attended by representatives from the Department of Marine and Wildlife Resources (DMWR), National Park of American Samoa (NPAS), Department of Commerce (DOC), Fagatele Bay National Marine Sanctuary (FBNMS) and the Coral Reef Advisory Group (CRAG), and a reconnaissance survey made around Tutuila Island (7 April 2005), the following priority actions were identified:

1. *Inventory the marine mammal fauna and conduct estimates of populations*

The relatively low number of marine mammal species in the territory may not be reflective of low diversity, but rather of lack of dedicated effort in finding and documenting their presence. There has only been one cetacean study documented so far, and it was to study the movement of humpback whales (Kaufman 1983). Currently,

there is a humpback whale study being carried out by the National Oceanic Atmospheric Administration (NOAA) on Tutuila Island. Collateral information such as dolphin species occurring in the area is also being gathered by the NOAA project (N. Daschbach pers comm.).

2. *Develop and augment local expertise in marine mammal research*

There is the need to develop and augment local expertise in the following areas: identification of marine mammals, dealing with strandings, performing biopsies, doing photo-identification and conducting abundance surveys. Either a training workshop could be held in American Samoa, and/or candidates could be identified for training in a marine mammal research lab or program in the U.S. or abroad. Local expertise can also be developed by having biologists/technicians assist contracted consultant(s) in the course of their field work and surveys.

3. *Determine marine mammal mortality in fishing operations*

Make use of the information collected on cetaceans accidentally caught in long line fishing operations and find ways to improve reporting of by-catch. A suggestion to place observers on or buy out days of long line boats was made. It is also important to document the various types of fishing operations that are occurring in territorial and EEZ waters, and identify the types that accidentally catch cetaceans. Effort should be made toward regional reporting of by-catch and establishment of a regional observer program.

4. *Identify cetacean stocks and their range of distribution*

DNA samples obtained during the surveys and from strandings can be used in partnership with other South Pacific countries and territories to determine stock identity and range of distribution of selected species. Collaboration with marine mammal genetics lab in the U.S. such as at the Southwest Fisheries Science Center (NOAA) in La Jolla can be established. Aside from the humpback whale, another species of interest is the bottlenose dolphin (*e.g*. determine whether the species found here is *Tursiops truncatus* or *Tursiops aduncus*).

5. *Establish a stranding network*

This can be done with the cooperation of local territorial government and villages. Given the regulatory implications of dealing with marine mammal species arising from both federal and territorial statutes, it is recommended that the Division of Conservation & Enforcement of DMWR, in liaison with the local NOAA-OLE office, spearhead any stranding response program. Local biologists (from DMWR, NPAS, FBNMS) can provide technical expertise to ensure the retrieval of all pertinent scientific information and materials (e.g., tissue samples). Potential candidate(s) will be identified for an extensive training on rescue operations and protocols involved in stranding. Short-term training may be obtained by sending a candidate to an agency with a strong

rescue and stranding program. This candidate can then serve as a resource person in the territory and train local members. A standardized stranding data sheet will be used to document strandings, and sampling kits for DNA analysis will be held ready at all times.

6. *Develop/strengthen linkages with other South Pacific countries and territories and other relevant programs and agencies*

Cetaceans are highly mobile animals and know no political boundaries, thus collaboration with neighboring countries and territories is essential for attaining meaningful research results and effective conservation strategies. Also, collaboration can help defray costs involved in research and training. Collaboration with the South Pacific Whale Consortium, SPREP and the Hawaiian project SPLASH will be desirable. A new program of research on marine mammals of the Pacific region is being organized at the Pacific Islands Fisheries Science Center in Honolulu, Hawaii; efforts should be made to coordinate research in American Samoa with elements of this program.

6 PROTECTION OF NATIVE HABITATS AS A STRATEGY FOR WILDLIFE CONSERVATION

6.1 STATE OF KNOWLEDGE

The forested habitats of American Samoa have been and continue to be the focus of scientific study. The composition and structure of natural habitats, as well as the factors responsible for spatial patterns in these variables, has been extensively documented (Whistler 1980, Amerson et al. 1982b, Webb et al. 1999, Webb et al. *in prep*). Muller-Dombois & Fosberg (1998) identified forest dynamics in Samoa as little studied, but there are in fact a number of recent and ongoing studies in American Samoa. For example, there are numerous permanent plots for the study of forest processes, including 8 0.1 ha plots in the NPAS Tutuila unit (Whistler 1995), 4 DMWR 1.2 ha Long-Term Monitoring Plots on Tutuila (Webb & Fa'aumu 1999), 30 US Forest Service Plots (ASCC Land Grant *unpub data*), and 4 NPAS plots on Ta'u totaling 6 ha (Webb et al. *in prep*). Studies on forest phenology, recruitment, and survivorship studies from these plots and elsewhere in American Samoa have been conducted (Trail 1994, Seamon et al. 2006, E. Webb *unpub data*). Other potential contributors to habitat dynamics such as disease have also been well-documented (Grandison 1996, McKenzie 1996, Brooks 2000, Brooks 2002, Brooks 2004).

The spatial distributions of habitat classes were mapped in the mid-1980s by Cole et al. (1988). Aerial photos of subsets of the island are available at scattered times (ASG *unpub.photos*), while satellite images are available from 2001 (IKONOS, Space Imaging Systems) and 2004 (QuikBird). Such remote-sensing methods have been used elsewhere to map habitat modifications (e.g., Estreguil & Lambin 1996, Comber et al. 2003). Unfortunately, due to frequent but local precipitation, cloud cover remains a serious problem for remote imaging of the territory. Likewise, resolution in many of the images is insufficient to discriminate among the heterogeneous subsets within major forest types without extensive ground-truthing (Asner et al. 2002, Wittman et al. 2002). Discriminating secondary and disturbed forest from undisturbed lowland forest is a task of particular importance when trying to assess the utility of American Samoan forested areas as wildlife resources, or to map expected wildlife distribution patterns based on habitat distributions and associations.

6.2 THREATS

There is a significant threat that land conversion to unsuitable habitat types will accelerate (Figure 4a & b), especially if the human population continues to grow or if changes in the economy cause a shift toward more agriculture. The native habitats of American Samoa have evolved in a disturbance-prone ecosystem, and are well adapted to withstand and recover from hurricanes. The presence of generalist and volant dispersers facilitates rapid regeneration in disturbed areas (Shanahan et al. 2001). All these characteristics have in the past buffered the wildlife and habitats of the territory from many of the changes wrought by humans. Unfortunately, there is likely to be a point at which the extent of clearing exceeds the rate of regeneration, potentially causing a cascade of other ecological effects such as depletion.

A major contributor to this problem is the lack of adequate land use planning and habitat management legislation in the territory (Department of Commerce 2003; McCarthy 2005). ASG has a Project Notification and Review System (PNRS), a multi-agency system of approval for which all development projects must pass. In theory such a system could suffice, but as currently implemented it has a number of significant weaknesses.

1) PNRS applies only to actual development, not clearing of habitats for agriculture. This has prompted the practice of clearing land for putative ‘agricultural’ purposes, but then shortly thereafter submitting a proposal to PNRS for development of the now-cleared land. This skirts the PNRS requirements of mitigation for clearing of forested areas.

2) The strength of a system such as PNRS could be that it is a collective decision-making body. However, as currently implemented, enforcement and decisions on approval are placed solely on individual member agencies. This greatly exacerbates the problem of political, cultural or other pressure being brought to bear on single agencies.

3) There is not a clear habitat management plan and attendant authority for the territory. DMWR has legal authority to manage habitats in the context of wildlife management, but there are numerous gaps and vagaries in the attendant legislation (McCarthy 2005), making enforcement of difficult cases particularly problematic.

4) There is unequal implementation of the PNRS system. In particular, ASG agencies themselves frequently skip PNRS review of their own projects. Besides the ecological damage directly caused by these projects, there is an attendant backlash in the public, who question the government’s commitment to the principles purportedly promoted by PNRS.

5) The zoning process, as implemented in practice by the zoning board, has no significant environmental or ecological requirement in its decisions.

Another threat to native habitats are invasive species, particularly trees. Invasive trees known to be spreading in the territory include *Falcateria moluccana*, *Castilla elastica*, *Cinnamomum verum*, *Psidium cattleianum* and *Leucaena leucocephala* (*pers. obs.*). Fast growing vines have been implicated as hindrances to regeneration (Elmqvist et al. 1994), but the rapid recovery of forests on Tutuila since hurricanes Ofa and Val in the early 1990s suggests that indigenous forest species may be resistant to this threat (Seamon et al. 2006, DMWR unpubl. data).

6.3 CONSERVATION PRIORITIES

For this reason, our priorities are to: 1) *obtain frequent, detailed, and accurate maps or images of land use patterns* in the territory, 2) use these data to *identify priority sites for conservation or land-use modifications*, 3) *implement measures and activities to improve habitat quality, expand the extent of native habitats, and protect endangered or critical habitats*, and 4) *establish appropriate legal authority* to institute and implement regulatory and statutory guidelines *for habitat conservation* (see Section 9).

Efforts to encourage the use of native species in urban and residential landscapes also have significant promise, and preliminary studies of propagation have been conducted for some tree species (Hanson et al. 2005). Under DMWR's Wildlife Restoration Program (FY2006-2010) the "Native Plants for Urban Landscape" project will be launched with the publication and distribution of a guide to native ornamental plants. This project will be implemented in partnership with ASCC-Land Grant's Forestry Division.

Efforts to control identified invasive species are also underway, primarily in the context of the American Samoa Invasive Species Team (ASIST), a cooperative working group among local and federal governmental agencies. In most cases, following established precedent, we have chosen to take rapid action rather than to undertake detailed study of the possible impacts or population dynamics of an invasive (Simberloff 2003).

However, a critically important prerequisite for the implementation of habitat management and regulation of habitat alteration is the legal mandate to do so. To this end, our highest priority is to pass legislation that would formalize the idea of habitat preservation and management in the territory. We feel that with proper implementation of such a plan, the wildlife resources of the territory could be managed in such a way as to promote both economic growth and development, as well as provide adequate protection for native plants and wildlife.

7 WILDLIFE IN THE CULTURE: ANCHORING CONSERVATION TO TRADITION AS A STRATEGY

The successful implementation of this conservation strategy will depend largely upon the support it receives from the local community, a community in which all aspects of life are influenced by Samoan culture (*fa'asamoa*). Incorporation of Samoan culture, with emphasis on wildlife's role in the culture, into the conservation strategy can therefore help elicit support through the fostering of a local, culture-based conservation ethic. Although not exhaustive, this synopsis covers published accounts of wildlife in ancient Samoan culture and can be used as a source in the development of programs designed to foster a conservation ethic in American Samoa. Wild animals are featured in all of the following aspects of ancient Samoan culture: oral tradition, artistic designs, cultural items, hunting and fishing, and religion.

Oral tradition in the form of legends and proverbs was the means by which Samoa's history and culture was preserved and passed through generations prior to the arrival of Europeans (Lotu-Drabble 2000). A few of the most well-known **legends** that feature wild animals as key characters are "The Origin of the Earth and People" in which Tuli (golden plover) is the assistant of the supreme god, Tagaloaalagi (Steubel et al. 1976), "The Birds Conference" (Muse & Muse 1982), "The Title (ao) Tonumaipe'a" featuring fruit bats as a woman's rescuers (Kramer 1902-1903), "The Story of the Sega" (Kramer 1902-1903), and "The Wailing Turtle" (Anonymous 2001).

Proverbs, many of which were taken from legends, comprise a second component of Samoan oral tradition. In the book, Proverbs of Samoa compiled by N.M.M. Saipele (2002), approximately 25% of the listed proverbs deal with wild animals in some way. A large percentage of these center around the ancient sport of lupe (pigeon) hunting. Some of the other wild animals featured in this book are *manutagi* (purple-capped fruit dove), *toloa* (wild duck), *fuia* (Samoan starling), *pe'a* (fruit bat), and *sega* (blue-crowned lorikeet). Examples of some of the many proverbs relevant to conservation are "*E le togia Fuia aua o Moso*," which means do not throw stones at the *fuia* because it is actually the feared god, Moso (Saipele, No Date) and "*Ua maua ula futifuti*," which refers to the shredding of rare lorikeet feathers and means "to be careless and wasteful" (Schultz 1980).

Song can be considered a third component of Samoan oral tradition because it is the mode by which many legends are preserved (Lutu-Drabble 2000). One of the best anthologies of old Samoan songs can be found in the book entitled “Tusi Pese Fatuga Tuai a Samoa - A Songbook of Popular Old Songs, Photographs, and Proverbs of Samoa” by T.C. Lutu-Drabble. By just scanning the table of contents, one can find 15

song titles with references to animals such as the *laumei* (turtle), *lupe*, *manu* (bird), and *isumu* (rat). These songs express everything from naturalistic observations of honeyeaters sipping flowers to frustration with and aversion towards rats. Although most of American Samoa's wildlife species are mentioned at some point in legends, proverbs, and songs, only a limited number of them appeared as designs in art or provided raw materials for cultural items.

Artistic designs can be found on *siapo* (bark cloth) and in the *tatau* (tattoo). Apparently, two of the prominent designs used in decorating siapo represented the *pe'a* (fruit bat) and the *pe'ape'a* (sheath-tailed bat) (Kramer 1902-1903). The men's *tatau*, also known as a "*pe'a*," gets its name from the shape it forms on the lower back. Perhaps the more significant connection of a wild animal to the *tatau* is the fact that part of the comb used in tattooing was made of tortoiseshell (Mallon 2002).

Other cultural items that were made with wild animal parts are whale-tooth necklaces, *tu'iga* (headdresses), and *'ietoga* (fine mats). Because Samoans did not hunt whales, they procured their whale teeth from beached whales (Kramer 1902-1903). *Tu'iga* and *'ietoga* were both decorated with red feathers plucked from the *sega* (Kramer 1902-1903). Although family heirlooms may retain their original *sega* feathers, dyed chicken feathers are used in making these articles today (Sowell 2000). In contrast to raising live *sega* for their feathers, ancient Samoans captured *lupe* for sport.

The **lupe hunt** was not only a form of recreation, but also "served as an arena for chiefly competition for prestige, status, and power" (Mallon 2002). Apparently, in ancient times the *lupe* was not eaten "for it was considered sacred," although it had become a popular food by the late 19th century (Kramer 1902-1903). Kramer also wrote that the sport (as practiced in ancient times) had been abandoned due mostly to the introduction of guns which "decimated" pigeon populations.

Other birds "hunted" (not necessarily eaten) in addition to lupe were *manutagi*, *manuali'i* (swamp hen), *ve'a* (banded rail), *tava'e* (tropicbird), *gogo* (noddy), and someother seabirds (Saipele 2002). The *manuali'i* (also called *manusa*, meaning sacred bird), was "a chief's bird" which was caught and tamed (Kramer 1902-1903). In addition to birds, bats were apparently eaten, but more as a delicacy than a daily food source (Sinavaiana & Enright 1992). Another animal eaten more often than bats was the sea turtle, also known as the *i'a sa* (sacred fish). This marine reptile was captured with coconut fiber nets, prepared for consumption according to strict rules, and served

to the highest ranking villagers, with the head going to the high chiefs (Kramer 1902-1903).

As noted above, there were several sacred wild animals in ancient Samoan culture. In many instances, this sacred status was due to the association of an animal with one of the many gods of the ancient religion (Mallon 2002). In addition to the *laumei* and *manuali'i*, other "holy animals of godly origin" were *tuli*, *sega fiti* (Fijian lorikeet), *sega*, *pe'a, fuia, ma'oma'o* (a bird), *pili* (lizard), and *lulu* (owl) (Mallon 2002). The *lulu*, specifically, was "often seen as an incarnation of a god consequently, a dead owl was usually buried quite ceremoniously" (Kramer 1902-1903).

By comparing the literature on ancient Samoa to American Samoa as it is today, one can see that most aspects of the culture have endured in spite of heavy outside influences. It is this fact that makes a culture-based conservation feasible and more appropriate for the territory. Whereas some conservation-related aspects of the ancient culture seem to have disappeared (e.g., deification of birds), other practices have been adapted in favor of conservation (e.g., substituting chicken feathers for sega feathers in *'ietoga*), and still others have simply been forgotten (e.g., the idea that *lupe* were not originally hunted for food).

The Dept. of Marine and Wildlife Resources, in collaboration with local agencies such as the "Ofisa o le Failautusi Aoao" (language preservation office), is in a position to help communities in American Samoa remember that wildlife has always been an integral part of the culture and that the preservation of wildlife is, in fact, integral to the preservation of the *fa'asamoa* for generations to come.

8 STATUTORY AND REGULATORY ASPECTS OF CONSERVATION

The need for enabling statutory and regulatory provisions that provide the legal basis for effecting conservation, particularly with respect to habitat management, has long been recognized by staff of DMWR, the PNRS, and the Department of Legal Affairs (Attorney General's Office). For this reason, DMWR commissioned a review of existing provisions with the view of developing approaches that could address this particular gap. This particular aspect of the planning process was threshed out during consultations with the Fono (Legislature). Following is an excerpt of the McCarthy (2005) review:

8.1 EXECUTIVE SUMMARY

The Department of Marine and Wildlife Resources ("DMWR") has often expressed a need for improved management and protection of terrestrial wildlife in American Samoa. Under threat due to rapidly increasing population, limited land area, encroachment by development, and international travel and trade, American Samoa's wildlife resources require improved management and habitat protections to thrive and propagate future generations. As the Territorial agency responsible for managing and perpetuating wildlife resources, DMWR has identified five areas of immediate concern: 1) protection and preservation of terrestrial wildlife habitat; 2) management of endangered and/or threatened species; 3) habitat degradation due to invasive or injurious species; 4) the world-wide problem of species "bioprospecting"; and (5) the omnipresent problem of effective enforcement.

These concerns called for an immediate analysis of the existing legal and regulatory frameworks in place in American Samoa, as well as the formulation of improved regulatory strategies. To promote awareness, collaboration, and to stimulate new ideas, this project also involved a series of meetings, presentations and consultations with members of the legislature, policy makers and DMWR staff. My conclusions derived from these consultations and analyses are as follows.

First, the legal and regulatory regimes for protection and management of wildlife habitat in American Samoa are inadequate. The statutory authority for the DMWR, A.S.C.A. Title 24, Chapter 03, speaks directly to the management and conservation of marine and wildlife resources, but is silent regarding preservation and protection of the habitats upon which wildlife depend. Therefore, the consensus among regulators and legislators was to expand the authority of the DMWR under existing law to manage and protect wildlife habitat independently of the land use permit review system.

Second, American Samoa currently has no listings for threatened or endangered terrestrial wildlife species, or any authority to protect their habitats. The territorial Endangered Species Act (ESA), A.S.C.A. Title 24, chapter 07, provides for appointment of a Commission with authority to nominate endangered or threatened species, but provides no role for DMWR in the listing process, and no authority by which to manage and conserve habitat once a species is listed. Accordingly, in Part IV suggestions are provided for expanding the territorial ESA to provide an active role for the DMWR in nominating species and in crafting habitat protection plans for listed species.

Third, invasive or injurious species of animals and plants are not addressed in existing statutes or rules, except to the extent a plant may be designated as a "noxious weed" harmful to agricultural crops or where animals are banned as "exotic" or "miscellaneous pets" by the territorial Department of Agriculture (DOA). Accordingly, suggested statute revisions are provided to enable the creation of an injurious species regulatory program within DMWR. Existing DOA authorities are also expanded to give DMWR a role in the quarantine, eradication or confiscations of injurious species of plants or animals.

Fourth, American Samoa currently lacks any system for controlling, monitoring or protecting the public inventory of biological resources from the "bioprospecting" or mining of commercially valuable species of plants and animals. A new statutory provision has therefore been created to address bioprospecting, to control the activities of species hunters, and to guaranty that a portion of any profits derived from bioprospecting are reserved to the communities from whose land species were harvested.

Finally, this report suggests modifications to existing statutes and regulations to improve enforcement, including providing DMWR with express administrative enforcement authority and the power to issue district court citations to enforce envisioned wildlife habitat protection requirements. As a whole, the recommended statutory changes provide a blueprint for improved protection of American Samoa's wildlife resources and the habitats upon which they depend.

8.2 ANALYSIS OF EXISTING REGULATORY REGIMES

The following discussion provides a brief analysis of existing statutes and regulations and identifies gaps or deficiencies in regulatory protections. In part III, I will offer suggestions for filling the gaps and providing improved protections for wildlife and wildlife habitat.

8.2.1 PROTECTIONS FOR WILDLIFE HABITATS IN AMERICAN SAMOA

The legal authorities for providing protection of diminishing wildlife habitats in American Samoa are twofold. First, there is the DMWR enabling statute set forth under Title 24, Chapter 03, of the ASCA. While this statute does not directly reference wildlife habitat protection or conservation, the DMWR is empowered to adopt regulations and to prepare and develop comprehensive plans for the management and protection of wildlife resources. (ASCA 24.0304(2)). Arguably, a critical component for perpetuating wildlife is protection of wildlife habitat, but DMWR has never tested the limits of its authority by promulgating habitat protection regulations. Instead, DMWR has adopted Hunting Regulations[2] that control the taking of various wildlife species, including fruit bats and native birds.

A separate statute, ASCA 24.2305, provides the DMWR with authority to designate for conservation bat roosts and "areas of importance" to viable bat populations. Habitat protection for these species is therefore impliedly authorized, but such protections require study, delineation, and the adoption of plans and maps via the rulemaking process. As of this time, no rules have been adopted relating to the preservation or protection of specific bat habitats.

Another source for regulatory authority relating to habitat conservation is the territorial Coastal Management Act.[3] This law establishes a land use permit (LUP) system for nearly all developments taking place in the territory, and further allows for the designation of Special Management Areas (SMA) through a delineation and nomination process to be approved by the Governor. However, it is important to note that a finalized SMA designation could take years for each area of concern, might be ultimately rejected by the sitting governor, and once designated would not necessarily preclude all development within its borders. Thus, the SMA process is both an uncertain and inadequate means for protecting areas deemed important to ensure the viability of wildlife.

The regulations adopted under the Coastal Management Act statute (ASCMA) attempt to circumvent this limitation, by providing that critical habitat(s) will be protected and preserved where they are "essential to productivity of plant or animal species" or are listed as threatened or endangered under territorial (or federal) laws.[4]

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[2] Hunting Regulations are set forth at Title 24, Chapter 08 of the American Samoa Administrative Code (ASAC).

[3] ASCA §§ 24.0501 et seq. and regulations at ASAC 26.0201 et seq.

[4] This provision (ASAC 26.0220.I.2) itself may also be inadequately authorized by the ASCMA because it effectively replaces the Special Management Area (SMA) public notice, participation and approval provisions with case by case decision-making. It also lacks any connection to the presence of endangered or threatened species and their critical habitat.

(A.S.A.C. § 26.0220.I.2). This is potent language, but the standard of proof for "critical habitat" may not always be possible to meet, particularly on smaller properties or on properties which have already been significantly degraded. Further, some common activities in the territory such as land clearing for agriculture or traditional Samoan uses do not require a LUP. These activities will not, therefore, receive scrutiny under the coastal management rules relating to critical habitat. Still other common uses, such as construction of single family residences, require only "minor" permit program review. The minor LUP review process involves an abbreviated in-house analysis and approval by the Department of Commerce, normally without referral to the PNRS Board or to the DMWR for consideration of wildlife conservation concerns. Accordingly, issuance of minor permits can result in significant loss of wildlife habitat, as permits will in most cases be approved without the involvement of the DMWR.

In conclusion, general authority exists under current territorial laws to protect individual species as well as wildlife habitats including "critical habitat." However, these authorities have either not been fully exercised, or existing authorities contain gaps through which many development activities can slip without meaningful review to the degradation of wildlife resources and their habitats.

8.2.2 ENDANGERED SPECIES AND CRITICAL HABITAT

The designation of species as endangered or threatened can also provide an effective means to protect critical habitat for species as well as habitat for other wildlife. Under federal as well as state laws, a listing of a species as threatened or endangered triggers protection for not only that species but also the geographic areas deemed to be "critical habitat" necessary for the survival and propagation of that species. Unfortunately, the existing territorial Endangered Species Act (ESA), A.S.C.A. 24.0701 et seq., fails to provide authority to designate critical habitat for any species listed as endangered or threatened pursuant to the Act. Nor has the Endangered Species Commission taken steps to make any listings or designations. Accordingly, without any listed species or the statutory authority to adopt listed species recovery plans which include critical habitat protections, the territorial ESA remains an un-utilized source of authority to protect wildlife habitat in the territory.

8.2.3 INJURIOUS OR INVASIVE SPECIES AND "BIOPROSPECTING"

The world-wide phenomenon of invasive or introduced non-native species and the damage they cause to island wildlife and their habitats are well documented. Yet territorial legal authorities to deal with this problem remain underdeveloped or

unutilized. Currently, the DMWR has authority under section 24.0304(2) of its enabling statute to adopt regulations addressing this problem. Because this authority has not been tested or utilized through regulations, the DMWR has striven to improve relations with the quarantine branch of the Department of Agriculture (DOA). The quarantine branch is tasked with inspecting and prohibiting entry to the territory of "noxious weeds" and undesirable domestic pets and other animals. Even if this cooperative approach were effective, the DOA derives its quarantine authority from a pair of statutes which do not go far enough to protect the territory's wildlife from non-native species.

Under ASCA Title 24, chapter 08, the DOA has the authority to ban, confiscate and destroy species of plants harmful to the agricultural economy. Over time, this authority was expanded by executive regulation so that the governor can ban the use or importation of any plant. (See ASCA § 24.0801). A permit from the director of the DOA is likewise required before plants may be imported to American Samoa. (See ASAC § 24.0328). These regulations,[5] however, are promulgated without consultation with the DMWR, and their focus is tuned to agricultural pests. Therefore, some plant imports may be unwittingly permitted by the DOA which could prove harmful to native flora, fauna and the delicate ecology of American Samoa.

Similarly, under ASCA Title 24, chapter 06, the director of DOA has the authority to promulgate agriculture quarantine restrictions concerning animals. Using this authority, the DOA has restricted the importation of insects, farm animals, and "domestic pets," including exotic animals, to entry by permit only. (See ASAC § 24.0305 et seq.) Yet these restrictions do not expressly extend to all non-domesticated animals, nor does the DMWR have any consultative role in restricting entry of animals (or plants) harmful to wildlife or native flora. Accordingly, existing statutes and regulations leave a great deal of discretion to the DOA, which may have neither the motivation nor the expertise to block the entry of animals harmful to native wildlife and the territory's ecology.

Perhaps not surprisingly, the statutes in American Samoa are also silent regarding the growing world-wide practice of bioprospecting. Persons engaged in bioprospecting seek animals and plants whose chemical or biological properties may have commercial value for consumer products or pharmaceuticals. The territorial "fishing regulations" require a scientific collection permit (ASAC 24.0938), but these rules apply to aquatic collections, and collectors are not required to reserve a portion of any profit derived from their discoveries to the territorial government. Suggested approaches to cope with bioprospecting are addressed in Part IV of McCarthy (2005).

[5] The DOA regulations are located under Title 24, chapter 03, A.S. Administrative Code (ASAC).

8.2.4 ENFORCEMENT

Enforcement of DMWR statutes and regulations is authorized under the provisions of ASCA 24.0312. This section allows the department to confiscate unlawful catches of marine and wildlife resources, including any equipment used in unlawful catches or takes, and to prosecute violators through the issuance of fine-citations in district court. The hunting and fishing regulations include a fine schedule setting forth the amounts violators will be penalized for violations of each regulatory provision. There are, however no DMWR penalties or prohibitions concerning wildlife habitat, except insofar as bat roosts are protected from disturbance under the hunting regulations.

In addition, the DMWR director has the authority to issue administrative orders. (See ASCA 24.0304(8)). Arguably, this authority has also been under-utilized as no administrative procedure governs the issuance of agency orders. Even if there were, no penalty is included for failure to obey an order relating to the unlawful taking of marine or wildlife resources or destruction of their habitat.

Conversely, the "critical habitat" conservation regulations (see footnote 3) under the Coastal Management Program are enforceable by administrative Stop Orders, injunctive relief, and civil penalties from the High Court. These habitat protection provisions, however, are not currently enforceable by district court fine-citation.[6] Thus, under the coastal management program, wildlife habitat can only be protected to the extent it qualifies as "critical habitat," and only to the extent that the activity taking place on the property is covered by the land use permit process or discovered by enforcement agents.

For plants and animals currently designated as "noxious weeds" or domestic animals, all statutes and regulations of the DOA are enforced by DOA officers and agents. Violations of these provisions are subject to penalties ranging from confiscation of contraband plants and animals to misdemeanor criminal prosecution in the district court. Arguably, any DMWR regulations relating to injurious species--if adopted to complement existing DOA restrictions-- could be enforced by district court fine-citation in accordance with 24.0312 ASCA.

Finally, there are no prohibitions of any kind included in the territorial ESA and no species are listed under it; hence, there are no violations or penalty provisions for terrestrial species of wildlife or their habitats under the ESA.

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[6] Though the coastal management program regulations (ASAC Title 26, chapter 02) contain rules allowing enforcement by fine-citation in the district court, this enforcement method is not authorized by the territorial Coastal Management Act and is therefore not in use due to the prevailing opinion from the Attorney General's Office that the district court lacks jurisdiction to hear controversies relating to land unless that authority is expressly provided by statute, not by administrative regulation.

8.3 RECOMMENDED STATUTORY CHANGES AND REGULATIONS

From the foregoing it is evident that the statutes and regulations governing wildlife and their habitats are insufficiently protective to ensure the viability of the territory's wildlife resources. Accordingly, this Part discusses possible approaches to improve the coverage of statutes and regulations for each of the major concerns set forth in Part I (of McCarthy 2005).

8.3.1 IMPROVING PROTECTIONS FOR WILDLIFE AND WILDLIFE HABITAT

The workshops conducted by DMWR with legislators and Fono leaders revealed significant support for amendments to existing territorial conservation statutes. Legislators and policy makers appeared to have less enthusiasm for crafting new laws to address the problem of managing and protecting wildlife habitat. Therefore, the following amendments are suggested for the DMWR enabling statute under Title 24, Chapter 03.

First, this statute should be amended to make clear that DMWR has the authority to manage and conserve not only wildlife resources but also the habitat upon which wildlife species depend. Once the general authorization is in place, two or more statutory provisions can be added to "enable" wildlife habitat management regulations. These sections are necessary to ensure that sufficient guidance is provided by the legislature to the agency in order to withstand a legal challenge that the agency's rules are in fact impermissible agency "legislation" rather than *execution* of legislative mandates. Accordingly, the first provision could indicate that the agency may manage and regulate wildlife habitat by means of a habitat removal permit program. It is suggested that the statute restrict habitats to be regulated to those *necessary* to support and propagate healthy wildlife populations. It is further suggested that permits be granted to applicants whose activities will not sufficiently degrade habitat or where applicants are willing to perform significant mitigation or replacement of habitat. The specifics of these permit requirements can be worked out later in regulations crafted by the department.

An additional statutory provision could allow villages, communities, or large land-holders to develop a habitat management plan with DMWR in lieu of seeking individual permits for each development activity. California has adopted such a voluntary program pursuant to the mandates of its state Endangered Species Act for the purpose of improving cost and efficiency of the development process while

ostensibly preserving "critical habitat" for endangered species.[7] The local statute should include, at minimum, provisions outlining the goals of the program as well as general requirements for participation in the program and the content of the implementation agreements with community stakeholders. Suggested statutory language for each of these wildlife habitat management provisions is provided in Part IV below.

By adding these provisions to the DMWR wildlife resources statute, the foundation will be laid for crafting habitat management and protection implementation regulations. These regulations will need to define the nature and extent of the habitats to be managed, and include appropriate provisions relating to permit review and approvals. The wildlife habitat permit review process could be merged with the existing Land Use Permit (LUP) approval process of the Department of Commerce (DOC), or could function independently, provided that DMWR would utilize its PNRS Board veto authority if any applicant failed to apply for and receive the wildlife habitat removal permit (when required).

Reference to the DOC's PNRS review process, however, raises the question, why not utilize the Coastal Management Program to manage wildlife habitat? Answer: there is no conclusive reason why the existing PNRS framework cannot be so used. After all, the public is already familiar with this process and DMWR works closely with the DOC to review and approve land use permit applications. Moreover, unlike the DMWR statute the Coastal Act statute primarily governs land-use statute activities such as the management and preservation of important physical features like habitat.

The DMWR could, therefore, dispense with revising its enabling statute and instead assist the DOC with regulations to be adopted and enforced under the Coastal Management Program. This approach has a simple elegance about it, when in fact it would confer actual enforcement authority on the Department of Commerce under the enforcement provisions of the Coastal Act. It would also limit wildlife habitat regulation to land use activities over which the DOC and PNRS have jurisdiction. Accordingly, there is the risk that some land use activities would slip through unregulated[8] and the primary enforcement responsibility would remain with DOC rather than wildlife officers of the DMWR.

8.3.2 PROTECTING WILDLIFE HABITAT UNDER THE ESA

[7] See CA ---- Cite. A similar cooperative regulatory approach is already in use by the DMWR to establish marine protected areas and community-based fisheries management programs.

[8] Some activities, such as traditional Samoan uses, guest fales, and most plantation activities are exempt from the PNRS review process under the CZM regulations at ASAC § 26.0208.

To utilize this statute as a means to manage and protect wildlife habitat will also require substantial revisions. First, the existing statute must be expanded to provide for creation and implementation of species recovery plans. The recovery plans must include prohibitions against the take and the "incidental take" of listed species due to otherwise lawful land use activities. They must also provide the authority to designate critical habitat to ensure propagation of surviving species. Finally, the prohibitions on taking of species and destruction of critical habitat will require provisions relating to enforcement and penalties. The enactment of these provisions will then necessitate the expertise and manpower of an appropriate administrative agency to carry them out. DMWR is the only existing executive department appropriate to this task.

Section IV below provides draft language and explanatory comments for expanding the territorial ESA. If these statutory amendments are implemented, it may become possible to utilize any listing (should listing take place!) to protect habitat from destructive land use activities.

8.3.3 PROTECTING WILDLIFE FROM INJURIOUS ALIEN SPECIES

The suggested statutory revisions in Part IV below take a two-pronged approach to controlling the problem of introduced and/or propagating injurious alien species of plants and animals. First, the DMWR enabling statute is amended to provide the department with express authority to create a regulatory program to authorize the seizure, eradication, or ban of any species deemed "injurious" by the department. Next, the existing DOA statutes are revised to expand the scope of animals and plants subject to quarantine and seizure protocols, and to provide DMWR with a "say" in determining which species of plants and animals should be subject to these restrictions.

Once these provisions become law, it will be up to the DMWR to follow through by working closely with the DOA to expand the listings under DOA regulations to include species harmful to territorial wildlife or wildlife habitats. The DMWR may then create a regulatory program of its own to work in tandem with the DOA regulations. This cooperative relationship is in use in Hawaii, for example, where the DOA quarantine division takes responsibility for policing port-of-entry facilities, while the Dept. of Natural Resources takes responsibility for controlling or eradicating species that have already become established. A similar division of responsibility could be achieved in American Samoa by allowing the DMWR to seize, eradicate or destroy alien species harmful to marine and wildlife resources and habitats, while allowing the DOA to police the ports of entry for species controlled under either DOA statutes and regulations or those of the DMWR. Care should be taken to ensure that any import permit granted by

the DOA cannot be validated if the same species is regulated or banned pursuant to DMWR wildlife regulations.

Finally, the statutory amendments in Part IV include a provision to address the problem of species bioprospecting. (See proposed ASCA section 24.0314). This new statute would provide a framework for DMWR regulations limiting bioprospecting to permitted activity, and would require prospectors to consent to a profit sharing arrangement with territorial landowners when profits are realized. The statute also provides requirements relating to various permit restrictions, including time, place, manner and species to be collected, subject to the discretion and expertise of the DMWR. Under this permit regime, DMWR will be able to track and control bioprospectors in the territory and the public will be protected against exploitation of its marine and wildlife resources.

8.3.4 IMPROVING ENFORCEMENT OF TERRITORIAL STATUTES AND REGULATIONS

The most significant suggested changes pertaining to enforcement are set forth in the DMWR enabling statute and in the proposed changes to the territorial ESA. The DMWR statute is amended to provide DMWR with authority to issue administrative orders. (See sections 24.0304 and 24.0315). Administrative orders are useful in the habitat management context because they allow the director to require that persons cease and desist from harmful activity or that they take affirmative action to safeguard wildlife resources. The suggested statutory revision would also allow the DMWR to enforce an administrative order by means of a ticket-citation in district court. (ASCA 24.0315). Accordingly, any failure or refusal to obey an order could be followed up with a citation for each consecutive day in which the order was disobeyed. Here again, the habitat management regulations should spell-out procedures for issuance and appeal of administrative orders, perhaps by reference to the existing Coastal Management Program “stop order” procedures, or through use of the Office of the Administrative Law Judge. The advice of the Attorney General’s Office will be required to ensure that “due process” requirements are properly followed.

Finally, under the territorial ESA, provisions are included to allow the DMWR to take the lead in enforcing the “no take” prohibitions and the species recovery plans. DMWR would be free to do so by administrative order, through issuance of district court citations, or any other manner authorized under proposed ASCA section 24.0315. Having acquired such broad enforcement authority, DMWR will then be empowered to enforce habitat management provisions for both endangered/threatened species (if any) as well as any other necessary wildlife habitats defined pursuant to agency regulations.

9 SUMMARY OF STRATEGIES AND MECHANISMS FOR IMPLEMENTATION

9.1 THE "WHAT" OF CONSERVATION: CATEGORIES OF IDENTIFIED STRATEGIES

Strategies for addressing various conservation needs of species, both specific (particularly Sections 3-6) and broad-based (Sections 7 & 8) were elucidated in preceding sections. To recapitulate, the identified priorities fall under one of the following strategic categories:

1) INVENTORY AND MONITORING

Inventories are particularly recommended for species groups for which information on diversity and baseline abundance are lacking or insufficient, such as sea birds, terrestrial snails, and marine mammals.

Monitoring, as a means for evaluating population performances and assessing the efficacy of targeted conservation or management initiatives, will continue for those species or species groups already under implementation (fruit bats, select terrestrial avifauna, and native forest tree species) and instituted for those species or species groups not covered under current programs (rare terrestrial birds, sea birds, marine mammals, select reptiles, endemic terrestrial snails, coconut crab, and the *Papilio* butterfly).

With support from the Wildlife Restoration Program, systematic monitoring of populations of land birds and fruit bats have been on-going since the early 1990s. Monitoring protocols for these species are under review and are expected to be revised to improve accuracy and rigor of abundance estimation. New monitoring programs are expected to commence under the aegis of DMWR's future SWG Program.

As with current monitoring, new programs will be designed for detection of acute (as in following natural catastrophes) and long-term changes in the population. In so doing, conservation and management measures may be instituted as an emergency response or revised to accommodate multiannual trends.

2) SCIENTIFIC RESEARCH

The collection of scientific information on the biology of species should be the backbone of any conservation and management program. Information on the ecological requirements of species help define needs such as critical habitat and

identify some of the threats to species. Information on such aspects as reproduction, survivorship, and mortality are necessary for determining the innate capacities for or, conversely, limitations to recovery. Determining the genetic basis for conservation and management, including decisions on reintroduction of extirpated or decimated populations are a must. Obviously, these actions need to be prioritized, as has been indicated in the preceding accounts. To date, ecological studies (such as on food habits, habitat use and determination of home ranges through radiotelemetry), analysis of intra- and inter-population levels of genetic variation and relatedness of populations, and disease studies are being conducted on fruit bats and select species of birds. With funds from SWG, additional species will be added to these studies, such as the Pacific Black Duck and the Purple Swamphen. The potential impact of rats on ground nesting sea birds and the spotless crake is also scheduled for conduct under WR and SWG funds. Other studies programmed for the 2006-2010 period are detailed in DMWR's WR proposal for the period, and will be augmented with studies on additional species proposed for funding under SWG (based on priorities identified in Section 5).

3) MANAGEMENT AND PROTECTION

In some cases, conservation will require intervention and protection. The control or eradication of exotic species that may pose a threat to native populations (such as the mynas, commensal rats, invasive plants that threaten the quality of the natural habitat) should be initiated. As examples, feasibility studies are planned for control and eradication of mynas (under SWG), and interagency efforts to control invasive plants are underway through ASIST.

Procurement of tracts of good quality natural habitats for protection is a major challenge in American Samoa, where a large proportion of the land are under customary communal holdings and conditions that permit transactions for land easements are largely absent. These not only make it near impossible to buy land for conservation purposes, but also puts the price of the small proportion of privately- or individually-owed land at impractical levels. The NPAS system was successfully negotiated as a long-term lease from villages. This is an approach that DMWR can take and will attempt to pursue in the near future to secure the protection of critical wildlife habitat in Olavalu Crater in Tutuila. Other recommended habitat preservation areas are indicated in Figure 4.

Revisions to DMWR's enabling legislation and judicious exercise of the agency's regulatory authority are critical particularly for protection of wildlife habitat. As recommended, statutory changes will not only strengthen DMWR's regulatory authority to conserve and protect its wildlife resources and habitat, but will also clarify implementation guidelines for the fair exercise of regulatory authority.

4) COMMUNITY OUTREACH AND EDUCATION

Presentations on project and project outcomes made during the SWG consultations with the Fono, government agency representatives, and village leaders were consistently met with the same response – why does not DMWR package these information for public broadcast? Indeed, one asset that can aid DMWR in reaching the community is the government-run (public) television, KVZK-TV. DMWR is presently completing 30-minute video programs of American Samoa's wildlife for airing, a project initiated under the Wildlife Conservation and Restoration Program (WCRP). Depending on the responses from the community, this video production of wildlife programs will be continued under WR and SWG, and will focus on the new species listed under Section 5 of this strategy to broaden people's understanding and appreciation of these species.

The proposed expansion of programs for inventory, monitoring, and scientific investigations will also significantly improve knowledge and understanding of the factors critical for the maintenance of populations of species that have long-been poorly known. These new body of information will enable DMWR provide better technical advise and assistance to the community, the local government, and other (federal and regional) institutions/agencies on issues pertinent to the health of the Territory's wildlife resources.

5) CAPACITY BUILDING

Although not specified in the detailed accounts of conservation strategies for species of concern, the technical expertise required to implement the various programs (both on-going and projected in the near future) were also reviewed during the planning process. In particular, the reliance on outside expertise for conduct of scientific studies can slow down implementation and achievement of project goals. Additionally, periodic changes in contractual personnel can compromise continuity of data necessary for long-term serial analysis of trends and population performances. Thus, it is very important that provisions be made for the continued training of the local technical support staff in techniques and methods necessary to continue collection of reliable data. Additionally, an initiative to develop a curriculum for wildlife biology should be discussed with the ASCC faculty.

9.2 THE "HOW" OF CONSERVATION: CATEGORIES OF MECHANISMS FOR EFFECTING IDENTIFIED STRATEGIES

The primary responsibility for ensuring that priority conservation actions identified in this document are implemented resides with DMWR, as mandated under its enabling

statute. It is recognized, however, that DMWR cannot unilaterally put all identified priorities into effect, and that auxiliary mechanisms are necessary for strategies to be fully implemented. To this end, three ancillary implementation approaches should be seriously explored and tapped.

1) LOCAL AND REGIONAL COOPERATIVE INITIATIVES

DMWR currently participates in a number of Territorial multi-agency boards and committees, such as the PNRS, the Soil and Water Conservation District Board, ASIST, and ASCC-Land Grant's Forest Stewardship Program. Through these interagency panels, DMWR is able to provide technical inputs on programs being developed or instituted by the respective parent agencies, as well as develop collaborative projects with any of these groups. The dearth in conservation organizations (particularly NGOs) and limited expertise on wildlife studies in the Territory necessitates that DMWR assume a significant role in implementing inventory, monitoring, and biological studies. However, the NPAS is instituting an inventory and monitoring program for areas within the National Park, and the FWS Remote Islands office in Hawaii is also expected to continue monitoring of wildlife resources in the Rose Atoll National Wildlife Refuge (RANWR). Management of both these entities (NPAS and RANWR) are not totally independent of the Territorial Government (through terms of the lease agreement for the Park and a co-management provision for Rose Atoll). Thus, information on the resources in these protected areas and any conservation recommendations from the NPAS and FWS as a result of their respective monitoring and biological studies will be given due consideration in any planning, program revisions, and implementation actions undertaken by the Territorial Government (primarily through DMWR). Several on-going wildlife investigation projects based at DMWR are being conducted in collaboration with federal agencies or academic institutions in the US. This collaborative approach is particularly useful for projects requiring technical facilities for processing of samples or data (such as genetic analysis and disease studies). The expansion of the conservation programs to cover additional taxa (as specified in Section 5) will render this collaborative approach even more important. Already, collaborative arrangements are being developed with NOAA-PIRO for the establishment of a marine mammal stranding response network and the development of a monitoring program for marine mammals.

On a regional scale, DMWR participates in relevant activities of SPREP, such as the recent initiative to develop a regional MOU for the protection and conservation of migratory marine mammals, and with SPC. As mentioned, an MOU between DMWR and its counterpart agency in (Independent) Samoa has been in effect since 2004. Regional linkages and participatory mechanisms will be particularly germane for conduct of scientific studies, monitoring programs, and protection of species that are

common among countries (e.g., shared species of birds and fruit bats) or are migratory in the region (such as sea turtles and marine mammals). A cooperative approach will enable collaborating agencies to pool their limited resources, make available to each other technical expertise, and assist in capacity building.

2) REGULATORY AND STATUTORY MECHANISMS

A number of strategies will require complementary legal backing for successful implementation, such as the conservation of critical habitat. Section 8 (particularly 8.3.1) of this Strategy provides very concrete approaches that can be explored to further conservation of wildlife and wildlife habitat. To achieve this, DMWR (through the Executive Branch) should continue to work closely with the Fono.

3) INTEGRATING TRADITIONAL/CULTURAL MECHANISMS

Elements of the Samoan socio-cultural structure lend themselves to conduct of outreach and consultations necessary to gain support for and participation in wildlife conservation programs. The embodiment of wildlife in traditional practices and cultural heritage provides a mechanism for fostering strong conservation ethic in the community. Suggestions to recover and restore this component of Samoa's cultural identity were voiced during SWG consultations. In recognition of the significance of the integration of nature and culture, DMWR has made the retrieval, documentation, and preservation of these traditions a priority under a proposed SWG program for 2006-2010, in collaboration with the American Samoa Historic Preservation Office.

Proposed elements to a recommended wildlife habitat protection program are also anchored to the concept of traditional exercise of responsibility over communal lands. In considering the concept of cooperative habitat management plans, DMWR acknowledges an inherent efficacy in the application of protective regulation through a cultural institutional framework.

10 PROGRAM EVALUATION AND ADAPTIVE MANAGEMENT

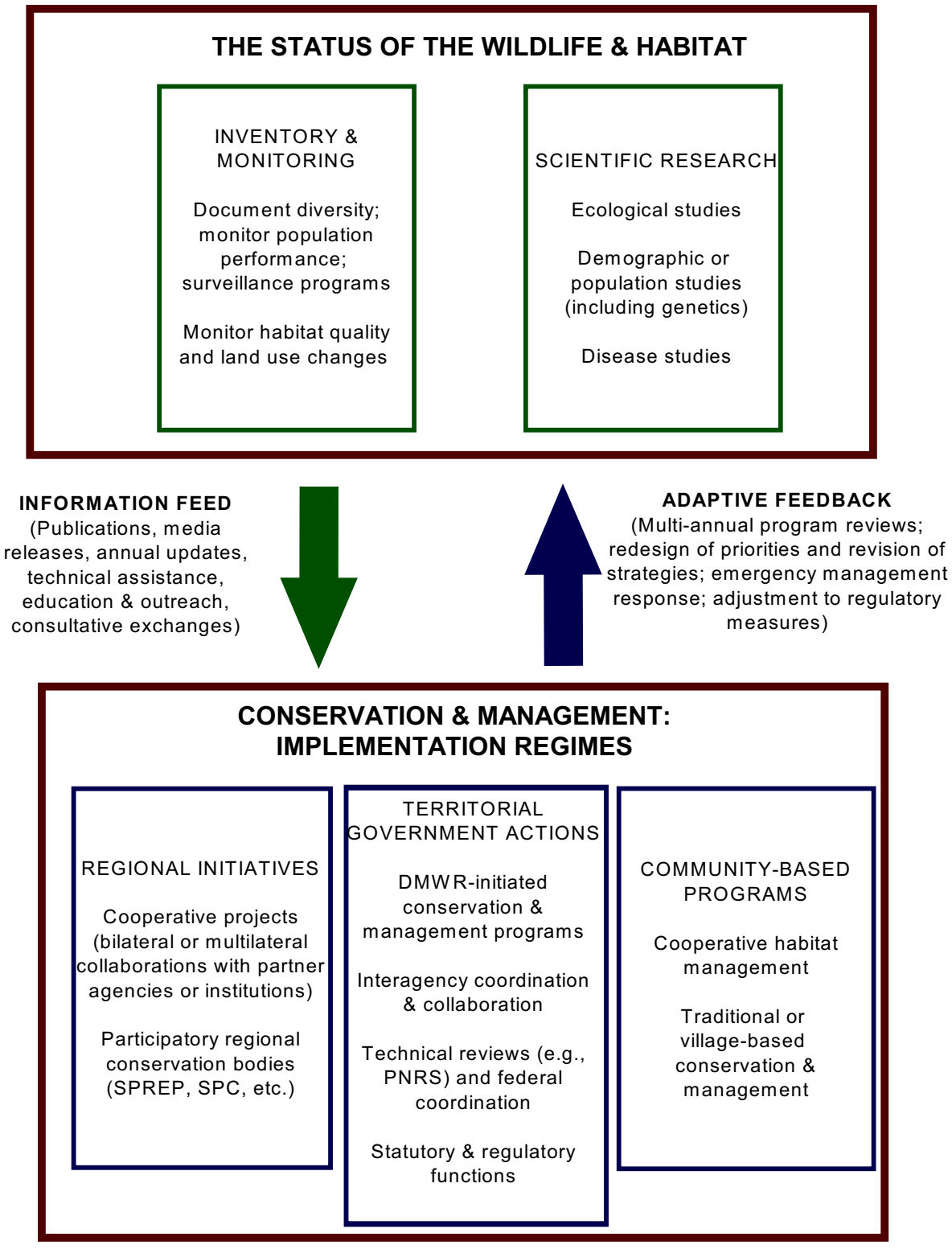
The development and implementation of a comprehensive conservation program for American Samoa's wildlife and wildlife habitat is predicated on the accumulation of sound biological information. In order to identify priority conservation actions and, correspondingly, determine the efficacy of conservation and management programs, information on the status of its diversity (through inventory), the health of populations (through monitoring), and the ecological, demographic (including genetic), and disease processes influencing populations (through scientific studies) must be obtained. Thus, Inventory, Monitoring, and Scientific Studies are considered critical elements of an **information matrix** for the determination of the state of the Territory's wildlife resources and habitats (upper box of Figure 6).

Through inventory, monitoring, and scientific studies, information pertinent to the development of appropriate conservation and management actions can be fed (green arrow in Figure 6) into an **implementation matrix** (lower box of Figure 6) consisting of three components deemed complementary for effective achievement of conservation goals (i.e., the maintenance of diversity and stable populations of wildlife). The components of this implementation matrix are the Territorial Government, Regional Entities, and Traditional Institutions. Priority measures developed based on the information matrix shall be put into effect through specific actions undertaken by government agencies (foremost of which is DMWR) and the legislature, collaborative or participatory initiatives with local and regional partners, and community-based cooperative conservation. Specific examples of measures or programs identified in this CWCS are indicated under each element or component (Figure 6).

The specifics of the various implementation measures undertaken by each component are responsive to the information flow from the status matrix. Thus, as information on population and habitat statuses are updated, conservation priorities may be revised, and implementation (conservation and management) measures may be modified accordingly. Conversely, the impact or efficacy of the implementation actions are expected to be reflected in the status of the wildlife and their habitat, and adjustments to conservation priorities should be instituted so implementation measures may be modified accordingly. Periodic (multi-annual) reviews of programs to be undertaken in-house and in consultation with various local entities (patterned after Figure 1) will permit adjustments to conservation priorities based on the efficacy and adequacy of implementation actions as reflected in the statuses of populations and the habitat (blue arrow in Figure 6). In addition, an emergency response management program will facilitate institution of immediate conservation measures (primarily through governmental and community-based actions) in the event of natural catastrophes (such as hurricanes and emergent infectious diseases).

As an example, the hunting, export, and import of the Pacific Imperial Pigeon are currently prohibited under AS Administrative Code Title 24 Chapter 08. Under the administrative rule, a hunt may be declared by the Director of DMWR, and it is implicit that such a declaration will be based on biological information that pigeon populations are, in fact, able to sustain takes. Pigeon populations have been monitored in the Territory since the ban was put into effect in 1991 following decline in numbers as a result of a hurricane. A 10-year data series from the monitoring program showed recovery in numbers and indicated the possibility of re-instituting a hunt of the species. Thus, DMWR conducted an experimental hunt in 2003, an exercise that was closely coordinated with villages (through the Office of Samoan Affairs) to ensure that hunting guidelines were observed. In the end, DMWR biologists recommended against the re-institution of pigeon hunts when populations were found to be impacted by a hurricane that befell the Territory in 2004. The ban continues to be in effect until such time when information from the monitoring program indicates re-evaluation of this particular management measure.

FIGURE 6. A BLUEPRINT FOR CONSERVATION IMPLEMENTATION, PROGRAM EVALUATION, AND ADAPTIVE MEASURES



11 LITERATURE CITED

Adler, GH & R Dudley. 1994. Butterfly biogeography and endemism on tropical Pacific islands. Biological Journal of the Linnean Society 51:151-162.

Allison, A. 1996. Zoogeography of amphibians and reptiles of New Guinea and the Pacific region. pp 407-436 *in* A. Keast & SE Miller (eds), The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes. SPB Academic Pub., Amsterdam, The Netherlands.

American Samoa Government. 2002. Territory of American Samoa - state of the environment report. ASEPA, Pago Pago AS.

American Samoa Government. 2003. Executive Order No. 005-2003, An Order Establishing the Territorial Waters of American Samoa as a Sanctuary for Sea Turtles and Marine Mammals. Office of the Governor. Pago Pago. American Samoa.

American Samoa Code Annotated. 1995. A.S.C.A. 24.08, A rule to regulate hunting by adding Chapter 08 to Title 24 of the American Samoa Administrative Code. Pago Pago, American Samoa.

American Samoa Code Annotated. 1995. A.S.C.A. 24.09, A rule to regulate fishing by adding Chapter 09 to Title 24 of the American Samoa Administrative Code. Pago Pago, American Samoa.

Amerson, AB Jr., WA Whistler, & TD Schwaner. 1982a. Wildlife and wildlife habitat of American Samoa. I. Environment and ecology. DOI-USFWS, Washington DC.

Amerson, AB Jr., WA Whistler, & TD Schwaner. 1982b. Wildlife and wildlife habitat of American Samoa. II. Accounts of flora and fauna. DOI-USFWS, Washington DC.

Anonymous.1998-1999. Samoa Nei Galo Volume 1 (Second Edition). Commercial Printers and Co. Ltd., Apia.

Anonymous. 2001. Samoa Nei Galo Volume 3. Malua Printing Press. Apia.

Asner, GP, M Palace, M Keller, R Pereira Jr, JNM Silva & JC Zweede. 2002. Estimating canopy structure in an Amazon forest from laser range finder and IKONOS satellite observations. Biotropica 34:483-492.

AS Sea Turtle Recovery Team. 1999. Sea Turtle Recovery Plan: Participation Plan for Sea Turtle Recovery in American Samoa – draft prepared for NMFS. Pago Pago, American Samoa.

Atkinson, CT, RC Utzurrum, JO Seamon, AF Savage & DA LaPointe. *In Press*. Hematozoa of forest birds in American Samoa - evidence for a diverse, indigenous parasite fauna from the south Pacific. Pacific Conservation Biology.

Baker, CS. 2000. New evidence for stock boundaries of humpback whales in the proposed South Pacific Whale Sanctuary. IWC/SC/52/IA20.

Banack, SA. 1996. Flying foxes, genus Pteropus, in the Samoan islands: interactions with forest communities. PhD dissertation, University of California, Berkeley, 281 pp.

Banack, SA. 1998. Diet selection and resource use by flying foxes (Genus *Pteropus*). Ecology 79:1949-1967.

Banack, SA. 2001. *Pteropus samoensis*. Mammalian Species 661:1-4.

Banack, SA & GS Grant. 2003a. Reproduction and behaviour of the Samoan flying fox, *Pteropus samoensis* (Chiroptera, Pteropodidae). Mammalia 67:419-437.

Banack, SA & GS Grant. 2003b. Spatial and temporal movement patterns of the flying fox, *Pteropus tonganus*, in American Samoa. Journal of Wildlife Management 66:1154-1163.

Banks, RC. 1984. Bird specimens from American Samoa. Pacific Science 38:150-169.

Baptista, LF, PW Trail & HM Horblit. 1997. Columbidae. pp.185-230 *in* J del Hoyo, A Elliott & J Sargatal (eds), Handbook of the Birds of the World, Volume 4 - Sandgrouse to Cuckoos. Lynx Edicions , Barcelona, Spain.

Bates, JM. 2002. The genetic effects of forest fragmentation on five species of Amazonian birds. Journal of Avian Biology 33:276-294.

Bearhop, S, S Waldron, SC Votier & RW Furness. 2002. Factors that influence assimilation rates and fractionation of nitrogen and carbon stable isotopes in avian blood and feathers. Physiological and Biochemical Zoology 75:451-458.

Bickel, DJ. 1996. Restricted and widespread taxa in the Pacific: biogeographic processes in the fly family Dolichopodidae (Diptera). pp. 331-346 *in* A. Keast & SE Miller (eds), The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes. SPB Academic Pub., Amsterdam, The Netherlands.

Boulon, RH Jr. 1999. Reducing threats to eggs and hatchlings: in situ protection. pp. 169-174 *in* KL Eckert, KA Bjorndal, FA Abreu-Grobois & M Donnelly (eds) IUCN/SSC Marine Turtle Specialist Group Publication No. 4, 1999.

Brooke, AP. 1997. Fruit bat studies: Pteropus samoensis and Pteropus tonganus, 1995-1996. Biological Report. Department of Marine and Wildlife Resources, Pago Pago, American Samoa.

Brooke, AP. 2001. Population status and behaviours of the Samoan flying fox (*Pteropus samoensis*) on Tutuila Island, American Samoa. Journal of Zoology, London, 254:309-319.

Brooke, AP, C Solek, & A. Tualaulelei. 2000. Roosting behavior of colonial and solitary flying foxes in American Samoa (Chirotera: Pteropodidae). Biotropica 32:338-350.

Brooks, FE. 2000. List of plant diseases in American Samoa. Land Grant Technical Report No. 31, ASCC, Pago Pago AS.

Brooks, FE. 2002. Brown root rot disease in American Samoa's tropical rain forests. Pacific Science 56:4:377-387.

Brooks, FE. 2004. Plant-parasitic algae (Chlorophyta: Trentepohliales) in American Samoa. Pacific Science 3:419-428.

Brown, IW & DR Fielder. 1991. The coconut crab: aspects of *Birgus latro* biology and ecology in Vanuatu. ACIARMonograph 8, Canberra AUS.

Bruce, MD. 1999. Tytonidae. pp. 71-72 i*n* del Hoyo, A Elliott & J Sargatal (eds), Handbook of the Birds of the World, Volume 5 - Barn-owls to Hummingbirds. Lynx Edicions , Barcelona, Spain.

Bull, LS, KR McConkey & F Tonga. 2002. Abundance and breeding habitat of noddies and white terns on a relatively unmodified island in the kingdom of Tonga. Emu 102:373-376.

Burggren, WW & BR McMahon. 1988. Biology of the land crabs. Cambridge Univ. Press, Cambridge, UK.

Callaway, RM, GC Thelen, A Rodriguez & WM Holben. 2004. Soil biota and exotic plant invasion. Nature 427:731-733.

Calsbeek, R & TB Smith. 2003. Ocean currents mediate evolution in island lizards. Nature 426:552-555.

Carlquist, S. 1996. Plant dispersal and the origin of Pacific island floras. pp 153-164 *in* A. Keast & SE Miller (eds), The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes. SPB Academic Pub., Amsterdam, The Netherlands.

Case, TJ & DT Bolger. 1991. The role of interspecific competition in the biogeography of island lizards. Trends in Ecology & Evolution 6(4):5 pp.

Chauvet, C & T Kadiri-Jan. 1999. Assessment of an unexploited population of coconut crabs, Birgus latro (Linne, 1767) on Taiaro atoll (Tuamoto archipelago, French Polynesia). Coral Reefs 18;297-299.

Chantler, P. 1999. Apodidae. pp.418-419 *in* J del Hoyo, A Elliott & J Sargatal (eds), Handbook of the Birds of the World, Volume 5 - Barn-owls to Hummingbirds. Lynx Edicions, Barcelona, Spain.

Cole, TG, CD Whitesell, WA Whistler, N McKay & AA Ambacher. 1988. Vegetation survey and forest inventory, American Samoa. USDA Pacific Southwest Forest and Range Experiment Station, Resource Bulletin PSW-25.

Collar, NJ. 1997. Psittacidae. p.353 *in* del Hoyo, A Elliott & J Sargatal (eds), Handbook of the Birds of the World, Volume 4 - Sandgrouse to Cuckoos. Lynx Edicions , Barcelona, Spain.

Comber, AJ, RV Birnie & M Hodgson. 2003. A retrospective analysis of land cover change using a polygon shape index. Global Ecology & Biogeography 12:207-215.

Comstock, JA. 1966. Lepidoptera of American Samoa with particular reference to biology and ecology. Pacific Insects Monographs 11:1-74.

Cook, RP. 2004. Macrofauna of Laufuti stream, Ta'u, American Samoa, and the role of physiography in its zonation. Pacific Science 58:7-21.

Cook, S, R Singidan & IWB Thornton. 2001. Colonization of an island volcano, Long island, Papua, New Guinea, and an emergent island, Motmot, in its caldera lake. IV. Colonization by non-avian vertebrates. Journal of Biogeography 28:1353-1363.

Cowie, RH. 1996. Pacific island land snails: relationships, origins and determinants of diversity. pp. 347-372 *in* A. Keast & SE Miller (eds), The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes. SPB Academic Pub., Amsterdam, The Netherlands.

Cowie, RH. 1998. Catalog of the nonmarine snails and slugs of the Samoan islands. Bishop Museum Bulletins in Zoology 3, Bishop Museum Press, Honolulu HI.

Cowie, RH. 2001a. Decline and homogenization of Pacific faunas: the land snails of American Samoa. Biological Conservation 99:207-222.

Cowie, RH. 2001b. Invertebrate invasions on Pacific islands and the replacement of unique native faunas: a synthesis of the land and freshwater snails. Biological Invasions 3:119-136.

Cowie, RH. 2004. Disappearing snails and alien invasions: the biodiversity/conservation interface in the Pacific. Journal of Conchology, Special Publication 3:23-37.

Cowie, RH. 2005. Disappearing land snails. Pp 56-57, *in* P. Craig (ed.), Natural History Guide to American Samoa, 2nd edition. National Park of American Samoa and Dept. of Marine and Wildlife Resources, Pago, Pago, American Samoa.

Cowie, RH & RP Cook. 1998. Partulid and other land snails of the national park of American Samoa. Tentacle 8:14-15.

Cowie, RH & RP Cook. 2001. Extinction or survival: partulid tree snails in American Samoa. Biodiversity and Conservation 10:143-159.

Cowie, RH & AC Robinson. 2002. The decline of native Pacific island faunas: changes in status of the land snails of Samoa through the 20th century. Biological Conservation 110:55-65.

Cowie, RH & RJ Rundell. 2002. The land snails of a small tropical Pacific island, Aunu'u, American Samoa. Pacific Science 56:143-147.

Cowie, RH, RJ Rundell, F Mika & P Setu. 2002. The endangered partulid tree snail *Samoana thurstoni* (Cooke and Crampton, 1930) on Olosega and the land snail diversity of the Manu'a islands, American Samoa. American Malacological Bulletin 17:37-43.

Cox, PA. 1983. Observations on the natural history of Samoan bats. Mammalia 47:519-523.

Cox, PA. 1984. Flying fox nearly extinct in Samoa. Bats 1:1-2.

Cox, PA, T Elmqvist, ED Pierson, & WE Rainey. 1991. Flying foxes as strong interactors in South Pacific island ecosystems: a conservation hypothesis. Conservation Biology 5:448-454.

Cox, PA, T Elmqvist, ED Pierson, & WE Rainey. 1992. Flying foxes as pollinators and seed dispersers in Pacific island ecosystems. pp 18-23, *in* DE Wilson & GL Graham (eds), Pacific island flying foxes: proceedings of an international conservation conference. US Fish and Wildlife Service Biological Report 90(23), Washington, DC.

Cox, PA & T Elmqvist. 2000. Pollinator extinction in the Pacific islands. Conservation Biology 14:1237-1239.

Craig, P. 1995. Whales ho! Pp. 30-32 in American Samoa: Natural History and Conservation Topics. Vol.2. Department of Marine and Wildlife Resources.

Craig, P. 2002. Rapidly approaching extinction: sea turtles in the central South Pacific. Western Pacific Sea Turtle Cooperative Research and Management Workshop. Honolulu. 5-8Feb. 2002. Western Pacific Regional Fisheries Management Council, Honolulu.

Craig, P. 2005. Natural History Guide to American Samoa. National Park of American Samoa and Dept. of Marine and Wildlife Resources, Pago, Pago, American Samoa.

Craig, P, TE Morrell & K So'oto. 1994. Subsistence harvest of birds, fruit bats, and other game in American Samoa, 1990-1991. Pacific Science 48:344-352.

Craig, P, D Parker, R Brainard, M Rice & G Balazs. 2004. Migrations of green turtles in the central South Pacific. Biological Conservation 116:433-438.

Craig, P & W Syron. 1992. Fruit bats in American Samoa: their status and future. pp. 145-149, *in* DE Wilson & GL Graham (eds), Pacific Island flying foxes: proceedings of an international conservation conference. US Fish and Wildlife Service Biological Report 90(3):1-76.

Craig, P, PW Trail, & TE Morrel. 1994b. The decline of fruit bats in American Samoa due to hurricanes and overhunting. Biological Conservation 69:261-266.

Craig, RJ & KG Beal. 2001. Microhabitat partitioning among small passerines in a Pacific island bird community. Wilson Bulletin 113:317-326.

Daschbach, N. 1990. After the hurricane. Bats 8(3):14-15.

Day, RH, BA Cooper & RJ Blaha. 2003. Movement patterns of Hawaiian petrels and Newell's shearwaters on the island of Hawai'i. Pacific Science 57:147-159.

de Boer, AJ & JP Duffels. 1996. Biogeography of Indo-pacific cicadas east of Wallace's Line. pp 297-330 *in* A. Keast & SE Miller (eds), The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes. SPB Academic Pub., Amsterdam, The Netherlands.

del Hoyo, J, A Elliott, & JSargatal. 1992. Ostriches to Auks. Volume 1 of The Handbook of the Birds of the World. Lynx Edicions, Barcelona, Spain.

Department of Commerce/American Samoa Government. 2003. Territorial General Plan, April 2003 version.

Department of Commerce Statistics Division. 2005. American Samoa Statistical Yearbook 2002. DOC Statistical Division, American Samoa Government, Pago Pago, AS. 191 p.

Diamond, J. 1984. Biogeographic mosaics in the Pacific. pp. 1-14 *in* FJ Radovsky, PH Raven & SH Sohmer (eds), Biogeography of the tropical Pacific. ASC and Bishop Museum Special Publication No. 72, Lawrence KS.

Dolar, MLL. 2005. Cetceans of American Samoa, a report submitted to the Department of Marine and Wildlife Resources, American Samoa. 24 p.

Donnegan, JA, SS Mann, SL Butler, & BA Hiserote. 2004. American Samoa's forest resources, 2001. Resour. Bull. PNW-RB-244. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 32 p.

Dudley, R & GH Adler. 1996. Biogeography of milkweed butterflies (Nymphalidae: Danainae) and mimetic patterns on tropical pacific archipelagos. Biological journal of the Linnean Society 57:317-326.

Elmqvist, T, PA Cox, WE Rainey, & ED Pierson. 1992. Restricted pollination on oceanic islands - pollination of *Ceiba pentandra* by flying foxes in Samoa. Biotropica 24:15-23.

Elmqvist, T, WE Rainey, ED Pierson & PA Cox. 1994. Effects of tropical cyclones Ofa and Val on the structure of a Samoan lowalnd rain forest. Biotropica 26:384-391.

Elmqvist, T, M Wall, A Berggren, L Blix, A Fritioff & U Rinman. 2001. Tropical forest reorganization after cyclone and fire disturbance in Samoa: remnant trees as biological legacies. Conservation Ecology 5:10[online]

Engbring, J & FL Ramsey. 1989. A 1986 survey of the forest birds of American Samoa. DOI-USFWS, Honolulu HI.

Esselstyn, JA, GJ Wiles, & A Amar. 2004. Habitat use of the Pacific sheath-tailed bat (*Emballonura semicaudata*) on Aguiguan, Mariana Islands. Acta Chiropterologica 6:303-308.

Estreguil, C & EF Lambin. 1996. Mapping forest-cover disturbances in Papua New Guinea with AVHRR data. Journal of Biogeography 23:757-773.

Fenner, M (ed). 2000. Seeds - the ecology of regeneration in plant communities. CABI Publishing, Oxon, UK.

Flannery, TF. 1995. Mammals of the southwest Pacific and Mollucan islands. Cornell University Press, Ithaca. 646 p.

Fletcher, WJ, IW Brown & DR Fielder. 1990. Movement of coconut crabs (*Birgus latro*) in a rain forest habitat in Vanuatu. Pacific Science 44:407-416.

Freifeld, HB. 1999. Habitat relationships of forest birds on Tutuila island, American Samoa. Journal of Biogeography 26:1191-1213.

Freifeld, HB & DW Steadman. 2001. Landbirds on offshore islands in Samoa. Journal of Field Ornithology 72:72-85.

Freifeld, HB, C. Solek & A. Tualaulelei. 2004. Temporal variation in forest bird survey data from Tutuila island, American Samoa. Pacific Science 58:99-117.

Garnnier A, S Bourreau, and C Casacci. 2000. Preliminary results on the distribution of wintering humpback whales (*Megaptera novaeangliae*) in French Polynesia 1997-1999. IWC/SC/52/IA9.

Garrigue, C, A Aguayo, VLU Amante-Helwig, CS Baker, S Caballero, P Clapham, R Constantine, J Denkinger, M Donoghue, L Florez-Gonzales, J Greaves, N Hauser, C Olavarria, C Pairoa, H Peckham, & M Poole. 2002. Movements of humpback whales in Oceania, South Pacific. Journal of Cetacean Research and Management 4:255-260.

Garrigue, C, K Russell, & R Dodemont. 2004. A preliminary survey of humpback whales and other cetaceans in Vanuatu, South-West Pacific. A contribution to the South Pacific Whale Research Corsortium. IWC SC/56/SH18.

Gibson, J & G Smith. 1999. Reducing threats to foraging habitats: in situ protection. pp. 184-188 *in* KL Eckert, KA Bjorndal, FA Abreu-Grobois & M Donnelly (eds), IUCN/SSC Marine Turtle Specialist Group Publication No. 4, 1999.

Gill, PC, EJ Eyre, C Garrigue, & WH Dawbin. 1995. Observations of humpback whales (*Megaptera novaeangliae*) on cruise to New Caledonia and the Chesterfield Reefs. Memoirs of the Queensland Museum 38(2): 505-511.

Gochfeld, M & J Berger. 1996. Sternidae. pp 664-667 *in* J del Hoyo, A Elliott & J Sargatal (eds), Handbook of the Birds of the World, Volume 3 - Hoatzin to Auks. Lynx Edicions , Barcelona, Spain.

Grandison, GS. 1996. Plant-parasitic nematodes of American Samoa, Technical Paper No. 205. South Pacific Commission, Noumea, New Caledonia.

Grant, GA. 1994. Juvenile leatherback caught by longline fishing in American Samoa. Marine Turtle Newsletter 66:3-5.

Grant, GS. 1996. Prey of the introduced *Bufo marinus* on American Samoa. Herpetological Review 27:67-69.

Grant, GS & SA Banack. 1995. Predation on *Pteropus tonganus* by a barn owl in American Samoa. Australian Mammalogy 18:77-78.

Grant, GS & SA Banack. 1999. Harem structure and reproductive behaviour of *Pteropus tonganus* in American Samoa. Australian Mammalogy 21:111-120.

Grant, GS, SA Banack, & P Trail. 1994. Decline of the sheth-tailed bat *Emballonura semicaudata* (Chiroptera: Emballonuridae) on American Samoa. Micronesica 27:133-137.

Grant, GS, P Craig & GH Balazs. 1997a. Notes on juvenile hawksbill and green turtles in American Samoa. Pacific Science 51(1): 48-53.

Grant, GS, P Craig, & P. Trail. 1997b. Cyclone induced shift in foraging behavior of flying foxes in American Samoa. Biotropica 29:224-228.

Green, PT. 1997. Red crabs in rain forest on Christmas island, Indian ocean: activity, density and biomass. Journal of Tropical Ecology 13:17-38.

Green, PT, DJ O'Dowd & PS Lake. 1997. Control of seedling recruitment by land crabs in rain forest on a remote oceanic island. Ecology 78:2174-2186.

Hanson, DE, JD Nichols & OC Steele. 2005. Propagation methods for some important Samoan timber tree species. Journal of Tropical Forest Science 17:315-318.

Harrison, P. 1983. Seabirds, an identification guide. Houghton-Mifflin, Boston MA.

Hauser, N, P Hoyt, & P Clapham. 2000. Humpback whales in the Southern Cook Islands. South Pacific Journal of Cetacean Research and Management. 3:159-164.

Haynes, A. 1990. The numbers of freshwater gastropods on Pacific islands and the theory of island biogeography. Malacologia 31:237-248.

Hicks, JW. 1985. The breeding behavior and migrations of the terrestrial crab Gecarcoidea natalis (Decapoda: Brachyura). Australian Journal of Zoology 33:127-142.

Hjerpe, J, H Hedenas & T Elmqvist. 2001. Tropical rain forest recovery from cyclone damage and fire in Samoa. Biotropica 33:249-259.

Hole, DG, MJ Whittingham, RB Bradbury, GQA Anderson, PLM Lee, JD Wilson & JR Krebs. 2002. Widespread local house-sparrow extinctions. Nature 418:931-932.

Holloway, JD. 1996. The lepidoptera of Norfolk island, actual and potential, their origins and dynamics. pp.123-151 *in* A. Keast & SE Miller (eds), The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes. SPB Academic Pub., Amsterdam, The Netherlands.

Hopkins, GHE. 1927. Butterflies of Samoa and some neighboring island groups. pp. 1-64 *in* Insects of Samoa and other terrestrial arthropods, Brit. Museum of Nat. Hist., London UK.

Howarth, FG. 1991. Environmental impacts of classical biological control. Annual Review of Entomology 36:485-509.

Howe, HF & LC Westley. 1988. Ecological relationships of plants and animals. Oxford University Press, New York NY.

Hughey, KFD, R Cullen & E Moran. 2003. Integrating economics into priority setting and evaluation in conservation management. Conservation Biology 17:93-103.

Hunter, MD, T Ohgushi & PW Price (eds). 1992. Effects of resource distribution on animal-plant interactions. Academic Press Inc., San Diego CA.

Hutson, AM, SP Mickleburgh, & PA Racey. 2001. Microchiropteran bats: global status survey and conservation action plan. IUCN/SSC Chiroptera Specialist Group, International Union for the Conservation of Nature and Natural Resources, Gland. 259 pp.

IWC/C/56/SH7. 2004. Report of the Annual Meeting of the South Pacific Whale Research Consortium: 2-6 April, 2004 in Byron Bay, NSW, Australia.

Jarvi, SI, MEM Farias, H Baker, HB Freifeld, PE Baker, E Van Gelder, JG Massey & CT Atkinson. 2003. Detection of avian malaria (*Plasmodium* spp.) in native land birds of American Samoa. Conservation Genetics 5:1-9.

Jenkins, M, RE Green & J Madden. 2003. The challenge of measuring global change in wild nature: are things getting better or worse? Conservation Biology 17:20-23.

Jimenez, C, A Ortega-Rubio, S Alvarez-Cardenas & G Arnaud. 1994. Ecological aspects of the land crab *Gecarcinus planatus* (Decapoda: Gecarcinidae) in Socorro island, Mexico. Biological Conservation 69:9-13.

Jourdan, H. 1997. Threats on Pacific islands: the spread of the tramp ant *Wasmannia auropunctata* (Hymenoptera: Formicidae). Pacific Conservation Biology 3:61-64.

Kadiri-Jan, T & C Chauvet. 1998.Distribution of the juvenile coconut crab, *Birgus latro* (L.), on the island of Lifou, New Caledonia. Ecoscience 5:275-278.

Kahn, B. 2004. (Unpublished) Technical report prepared for the Solomon Islands Marine Assessment Coordinating Committee (SIMACC).

Kami, KS & SE Miller. 1998. Samoan insects and related arthropods: checklist and bibliography. Bishop Museum Technical Report No. 13, Honolulu HI.

Kasamatsu, F, S Nishiwaki, & H Ishikawa. 1995. Breeding areas and southbound migrations of southern minke whales *Balaenoptera acutorostrata*, Marine Ecological Progress Series. 119:1-10.

Kaufman, G. 1983. Ecology of Humpback whales in American Samoa. Society for Marine Mammalogy 5th Biennial Conference, Biology of Marine Mammals. New England Aquarium, Boston, Massachusetts, 27 Nov.-1 Dec., 1983. Abstract.

Keast. A. 1996. Avian geography: New Guinea to the eastern Pacific. pp 373-398 *in* A. Keast & SE Miller (eds), The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes. SPB Academic Pub., Amsterdam, The Netherlands.

Kitihara, M & K Fujii. 1994. Biodiversity and community structure of temperate butterfly species within a gradient of human disturbance: an analysis based on the concept of generalist vs. specialist strategies. Researches in Population Ecology 36:187-199.

Knowles, WC. 1988. The status of the wildlife and wildlife habitats in American Samoa. DMWR Annual Report. Department of Marine and Wildlife Resources, Pago Pago, American Samoa.

Knudsen, PA, KD Kluge & RD Volk. 1992. American Samoa resource management bibliography. Le Vaomatua Pub, Pago Pago AS.

Koopman, KF. 1979. Zoogeography of mammals from islands off the northeastern coast of New Guinea. American Museum Novitates 2690:1-17.

Koopman, KF. 1993. Chiroptera. p. 151, *in* DE Wilson & DM Reeder (eds), Mammal species of the world, second ed. Smithsonian Institution Press, Washington, DC. 1,206 p.

Koopman, KF. 1997. The subspecies of *Emballonura semicaudata* (Chiroptera: Emballonuridae). Journal of Mammalogy 78:358-360.

Koopman, KF & DW Steadman. 1995. Extinction and biogeography of bats on 'Eau, Kingdom of Tonga. American Museum Novitates 3125:1-3.

Kramer, A.F. 1902-1903. Die Samoa Inseln, 2 vols. B. Schweitzerbart, Stuttgart. Germany.

Kunin, WE & KJ Gaston. 1993. The biology of rarity: patterns, causes and consequences. Trends in Ecology & Evolution 8:298-301.

Lee, MAB. 1985. The dispersal of Pandanus tectorius by the land crab Cardisoma carnifex. Oikos 45:169-173.

Lemke, TO. 1986. Distribution and status of the sheath-tailed bat (*Emballonura semicaudata*) in the Mariana Islands. Journal of Mammalogy 67:743-746.

Levey, DJ, WR Silva & M Galetti (eds). 2002. Seed dispersal and frugivory: ecology, evolution and conservation. CABI Publishing, Oxon UK.

Levings, SC & DM Windsor. 1982. Seasonal and annual variation in litter arthropod populations. pp. 355-387 *in* EG Leigh Jr, AS Rand, & DM Windsor (eds) The ecology of a tropical forest - seasonal rhythms and long-term changes. Smithsonian Inst. Press, Washington DC.

Li, X, D Li, Y Li, Z Ma & T Zhai. 2002. Habitat evaluation for crested ibis: a GIS-based approach. Ecological Research 17:565-573.

Lott, CA, TD Meehan & JA Heath. 2003. Estimating the latitudinal origins of migratory birds using hydrogen and sulfur stable isotopes in feathers: influence of marine prey base. Oecologia 134:505-510.

Louda, SM & PH Zedler. 1985. Predation in insular plant dynamics: an experimental assessment of postdispersal fruit and seed survival, Enewetak Atoll, Marshall islands. American Journal of Botany 72:438-445.

Louda, SM, AE Arnett, TA Rand & FL Russell. Invasiveness of some biological control insects and adequacy of their ecological risk assessment and regulation. Conservation Biology 17:73-82.

Lovegrove, T, B Bell, & R Hay. 1992. The indigenous wildlife of Western Samoa: impacts of cyclone Val and a recovery and management strategy. New Zealand Department of Conservation. 61 pp.

Lutu-Drabble. 2000. Tusi Pese Fatuga Tuai a Samoa A Songbook of Popular Old Songs, Photographs and Proverbs of Samoa. Brebner Print. Auckland.

Lydeard, C, RH Cowie, WF Ponder, AE Bogan, P Bouchet, SA Clark, KS Cummings, TJ Frest, O Gargominy, DG Herbert, R Hershler, KE Perez, B Roth, M Seddon, EE Strong, and FG Thompson. 2004. The global decline of nonmarine mollusks. Bioscience 54:321-330.

Madeiros, AC, LL Loope & FR Cole. 1986. Distribution of ants and their effects on endemic biota of Haleakala and Hawaii volcanoes national parks: a preliiminary assessment. pp. 39-52 in Proceedings, 6th Hawaii Volcanoes Science Conference, CNPRSU, University of Hawaii Manoa, HI.

Mallon, S. 2002. Samoan Art and Artists - O Measina a Samoa. Craig Potton Publishing. Nelson, New Zealand.

Mauffrey, J-F & F Catzeflis. 2003. Ecological and isotopic discrimination of syntopic rodents in a neotropical rain forest of French Guiana. Journal of Tropical Ecology 19:209-214.

McCarthy, M. 2005. Wildlife habitat planning and protection in American Samoa: analysis and suggested approaches. Report Submitted to DMWR as part of the SWG Planning, Pago Pago, American Samoa. 19 p. + Appendix A, 10 p.

McKenzie, EHC. 1996. Fungi, bacteria and pathogenic algae on plants in American Samoa. Technical Paper No. 206, South Pacific Commission, Noumea, New Caledonia.

Mickleburgh, SP, AM Hutson, & PA Racey. 1992. Old Word fruit bats: an action plan for their conservation. IUCN/SSC Chiroptera Specialist Group, International Union for Conservation of Nature, Gland, Switzerland.

Miller, CA & DE Wilson. 1997. *Pteropus tonganus*. Mammalian Species 552:1-6.

Miller, SE. 1993. Final report on surveys of the arboreal and terrestrial snail fauna of American Samoa. Internal Report, Submitted to US Fish & Wildlife Service, Honolulu HI

Miller, SE. 1996. Biogeography of Pacific insects and other terrestrial invertebrates: a status report. pp. 463-475 *in* A. Keast & SE Miller (eds), The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes. SPB Academic Pub., Amsterdam, The Netherlands.

Morrell, TE and P. Craig. 1995. Temporal variation in fruit bats observed during daytime surveys in American Samoa. Wildlife Society Bulletin 23:36-40.

Morrison, LW. 1997. Polynesian ant (Hymenoptera: Formicidae) species richness and distribution: a regional survey. Acta OEcologica 18:685-695.

Mueller-Dombois, D & FR Fosberg. 1998. Vegetation of the tropical Pacific islands. Springer-Verlag, New York NY.

Munroe, E. 1996. Distributional patterns of lepidoptera in the Pacific islands. pp. 275-295 *in* A. Keast & SE Miller (eds), The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes. SPB Academic Pub., Amsterdam, The Netherlands.

Muse, C. and S. Muse. 1982. The Birds and Birdlore of Samoa O Manu ma Tala'aga o Manu o Samoa. Pioneer Press. Walla Walla, WA.

Myllyntaus, T, M Hares & J Kunnas. 2002. Sustainability in danger? Slash-and-burn cultivation in nineteenth century Finland and twentieth-century southeast Asia. Environmental History 7:267-302.

Nafus, DM. 1992. Impact of intentionally and accidentally introduced biological control agents on unintended hosts, *Hypolimnas anomala* and *H. bolina* (Lepidoptera: Nymphalidae), on Guam. Pacific Science 46:394-395.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998. Recovery plan for U.S. Pacific populations of the green turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998. Recovery plan for U.S. Pacific populations of the hawksbill turtle (*Eretmochelys imbricata*). National Marine Fisheries Service, Silver Spring, MD.

Nelson, SL. 2003. Nutritional ecology of Old-world fruit bats: a test of the calcium-constraint hypothesis. PhD dissertation, University of Florida, FL. 139 pp.

Nelson, SL, MA Miller, EJ Heske, & GC Fahey, Jr. 2000a. Nutritional consequences of a change in diet from native to agricultural fruits for the Samoan fruit bat. Ecography 23:393-401.

Nelson, SL, MA Miller, EJ Heske, & GC Fahey, Jr. 2000b. Nutritional quality of leaves and unripe fruit consumed as famine foods by the flying foxes of Samoa. Pacific Science 54:301-311.

NOAA-NCCOS. 2005. Atlas of the shallow water benthic habitats of American Samoa, Guam, and the Commonwealth of Northern Marianas. NOAA Technical Memorandum NOS-NCCOS 8, Biogeographic Team. Silver Spring, MD.

Norberg, U, AP Brooke, & WJ Trewhella. 2000. Soaring and non-soaring bats of the family Pteropodidae (flying foxes, *Pteropus* sp.): wing morphology and flight performance. Journal of Experimental Biology 203:651-664.

Nunn, PD. 2001. Ecological crises or marginal disruptions: the effects of the first humans on Pacific islands. New Zealand geographer 57:11-20.

O'Connor, PJ & MJ Rauzon. 2003. Inventory and monitoring of seabirds in national park of American Samoa. National Park of American Samoa Technical Report 132.

O'Connor, RJ. 1986. Dynamical aspects of avian habitat use. pp. 235-239 *in* J Verner, ML Morrison & CJ Ralph (eds) Wildlife 2000: modelling habitat relationships of terrestrial vertebrates. University of Wisconsin Press, WI.

O'Dowd, DJ & PS Lake. 1990. Red crabs in rain forest, Christmas island: differential herbivory of seedlings. Oikos 58:289-292.

O'Dowd, DJ & PS Lake. 1991. Red crabs in rain forest, Christmas island: removal and fate of fruits and seeds. Journal of Tropical Ecology 7:113-122.

Park, G, R Hay, A Whistler, & T Lovegrove. 1992. The national ecological survey of Western Samoa: the conservation of biological diversity in the coastal lowlands of Western Samoa. New Zealand Department of Conservation. 205 pp.

Perrin, WF. 2002. Spinner dolphin. In Perrin, W.F., Würsig, B., Thewissen, J.G.M. *Encyclopedia of Marine Mammals*. Academic Press. San Diego, pp.1174-1178.

Pierson, ED, T Elmqvist, WE Rainey, & PA Cox. 1996. Effects of tropical cyclonic storms on flying foxes on the South Pacific islands of Samoa. Conservation Biology 10:438-451.

Pierson, ED & WE Rainey. 1992. The biology of flying foxes of the genus Pteropus: a review. pp. 1-17, *in* DE Wilson & GL Graham (eds), Pacific Island flying foxes: proceedings of an international conservation conference. US Fish and Wildlife Service Biological Report 90(3):1-76.

Pratt, HD, PL Bruner & DG Barrett. 1987. A field guide to the birds of Hawaii and the tropical Pacific. Princeton Univ. Press, NJ.

Pyle, P., L. Spear & J Engbring. 1990. A previously unreported population of herald petrel on Ta'u island, American Samoa. Colonial Waterbirds 13:136-138.

Raghu, S, AR Clarke, RAI Drew & K Hulsman. 2000. Impact of habitat modification on the distribution and abundance of fruit flies (Diptera: Tephritidae) in southeast Queensland. Population Ecology 42:153-160.

Rainey, WE. 1990. The flying fox trade: becoming a rare commodity. Bats 8:6-9.

Rainey, WE. 1998. Conservation of bats in remote Indo-Pacific islands. pp. 326-341, *in* TH Kunz & PA Racey (eds), Bat biology and conservation. Smithsonian Institution Press, Washington, DC. 365 p.

Rainey, WE, ED Pierson, T Elmqvist, & PA Cox. 1995. The role of flying ofxes (Pteropodidae) in oceanic island ecosystems of the Pacific. Symposia of the Zoological Society of London 67:47-62.

Reeves, RR, S Leatherwood, Stone, S Gregory, & LG Eldredge. 1999. Marine Mammals in the area served by the South Pacific Regional Environment Programme (SPREP). SPREP, Apia, Samoa.

Richmond, JQ, Sa Banack, & GS Grant. 1998. Comparative analysis of wing flight behaviour, and habitat use in flying foxes (Genus *Pteropus*). Australian Journal of Zoology 46:283-289.

Ricketts, T & M Imhoff. 2003. Biodiversity, urban areas, and agriculture: locating priority ecoregions for conservation. Conservation Ecology 8:1[online].

Roubik, DW & H Wolda. 2001. Do competing honey bees matter? Dynamics and abundance of native bees before and after honey bee invasions. Population Ecology 43:53-62.

Rudd, H, J Vala & V Schaefer. 2002. Importance of backyard habitat in a comprehensive biodiversity conservation strategy: a connectivity analysis of urban green spaces. Restoration Ecology 10:368-375.

Sabater, MG and SB Tofaeiono. *In Press*. Effects of scale and benthic composition on biomass and trophic group distribution of reef fishes in American Samoa. Pacific Science.

Saipele, N.M.M., No Date. Proverbs of Samoa. Australian High Commission for Western Samoa. Wellington, New Zealand.

Schleucher, E & PC Withers. 2002. Metabolic and thermal physiology of pigeons and doves. Physiological and Biochemical Zoology 75:439-450.

Schultz. 1980. Samoan Proverbial Expressions. Polynesian Press. New Zealand.

Schwaner, TD. 1980. Reproductive biology of lizards on the American Samoan islands. Occ. Papers, Museum of Natural History, Univ. of Kansas 86:1-53.

Seamon, JO, SS Mann, OC Steele & RCB Utzurrum. 2006.The conservation value of remnant forest patches: tree composition, spatial patterns and recruitment in the Ottoville lowland forest, American Samoa. Pacific Science 60:319-332.

Shanahan, M, RD Harrison, R Yamuna, W Boen & IWB Thornton. 2001. Colonization of an island volcano, Long island, Papua New Guinea, and an emergent island, Motmot, in its caldera lake. V. Colonization by figs (*Ficus spp.*), their dispersers and pollinators. Journal of Biogeography 28:1367-1377.

Sherman, PM. 2002. Effects of land crabs on seedling densities and distributions in a mainland neotropical rain forest. Journal of Tropical Ecology 18:67-89.

Simberloff, D. How much information on population biology is needed to manage introduced species? Conservation Biology 17:83-92.

Sinavaiana C. and J. Enright. 1992. The Cultural Significance of the Flying Fox in Samoa: A Legendary View. In D.E. Wilson and G.L. Graham (Eds.). Pacific Island Flying Foxes: Proceedings of an International Conservation Conference. Pp. 36-38. USFWS Biological report 90(23). USFWS, Washington D.C.

Slikas. B, SL Olson & RC Fleischer. 2002. Rapid, independent evolution of flightlessness in four species of Pacific island rails (Rallidae): an analysis based on mitochondrial sequence data. Journal of Avian Biology 33:5-14.

Sowell, T.L. 2000. Worn with Pride Celebrating Samoan Artistic Heritage. Oceanside Museum of Art.

SPREP/CMS. 2005. Memorandum of understanding for the conservation of cetaceans and their habitats in the Pacific Island Region – A proposal of the formal meeting of the Drafting Group on the Memorandum of Understanding. Third Meeting on the CMS and Marine Mammal Conservation, 5-7 July 2005, Nadi, Fiji.

Stattersfield, AJ, MJ Crosby, AJ Long & DC Wege. 1998. Endemic bird atlas of the world - priorities for conservation. Birdlife Intl., Cambridge UK.

Steadman, DW, J Franklin, DR Drake, HB Freifeld, LA Bolick, DS Smith & TJ Motley. 1999. Conservation status of forests and vertebrate communities in the Vava'u island group, Tonga. Pacific Conservation Biology 5:191-207.

Steadman, DW & GK Pregill. 2004. A pre-historic, noncultural vertebrate assemblage from Tutuila, American Samoa. Pacific Science 58:615-624.

Steubel, C., A. Kramer, and B. Herman. 1976. Tala o le Vavau - The Myths, Legends, and Customs of Old Samoa. Pacifika Press. Auckland, New Zealand.

Surman, CA & RD Wooller. 2003. Comparative foraging ecology of five sympatric terns at a sub-tropical island in the eastern Indian ocean. Journal of Zoology, London 259:219-230.

Swezey, OH. 1921. The butterflies of the Samoan islands. Proceedings of the Hawaiian Entomological Society 4: 601-605.

Swezey, OH. 1942. Notes on food habits of Lepidoptera in Samoa. Proceedings of the Hawaiian Entomological Society 11:202-216.

Swihart, RK, TM Gehring, MB Kolozsvary & TE Nupp. 2003. Responses of 'resistant' vertebrates to habitat loss and fragmentation: the importance of niche breadth and range boundaries. Diversity & Distributions 9:1-18.

Tarburton, MK. 2002. Demise of the Polynesian sheath-tailed bat *Emballonura semicaudata* in Samoa. Micronesica 34:105-108.

Taylor, PB. 1996. Rallidae. pp. 163-197 *in* J del Hoyo, A Elliott & J Sargatal (eds), Handbook of the Birds of the World, Volume 3 - Hoatzin to Auks. Lynx Edicions , Barcelona, Spain.

Thomson, SD, AP Brooke, & JR Speakman. 1998. Diurnal activity in the Samoan flying fox, *Pteropus samoensis*. Philosophical Transactions of the Royal Society of London, Series B 353:1595-1606.

Townsend, CH. 1935. The distribution of certain whales as shown by logbook records of American whaleships. Zoologica 19: 1-50 + maps.

Trail, PW, T. Morrell & A. Tualaulelei. 1992. Declines in land bird populations on Tutuila island, American Samoa, 1986-1992. DMWR Biological Report Series, No. 32.

Trail, PW. 1994. The phenology of rainforest plants in Tutuila, American Samoa. DMWR Biological Report Series No. 58.

Tsutsui, ND & AV Suarez. 2003. The colony structure and population biology of invasive ants. Conservation Biology 17:48-58.

Tuato'o-Bartley, N, TE Morrell & P Craig. 1993. Status of sea turtles in American Samoa in 1991. Pacific Science 47(3): 215-221.

US Fish & Wildlife Service. 2005. Regional seabird conservation plan, Pacific region. USF&WS Migratory Birds and Habitat Program, Portland OR.

Utzurrum, RCB. 2002. Sea turtle conservation in American Samoa. pp. 33-36, *in* I Kinan (ed), Proceedings of the western Pacific sea turtle cooperative research and management workshop. Western Pacific Regional Fishery Management Council, Honolulu.

Utzurrum, RC & JO Seamon. 2001. Monitoring for conservation and management: some empirical and theoretical approaches. Sylvatrop: The Tech. Journal of Phil. Ecosys. and Nat. Res. 10:88-105.

Utzurrum, RCB, GJ Wiles, AP Brooke, & DJ Worthington. 2003. Count methods and population trends in Pacific Island flying foxes. pp. 49-61, *in* TJ O'Shea & MA Bogan (eds), Monitoring trends in bat populations of the United States and Territories: problems and prospects. US Geological Survey, Biological Resources Discipline, Information and Technology Report , USGS/BRD/ITR–2003-0003. 274 p.

van Balgooy, MMJ, PH Hovenkamp & PC van Welzen. 1996. Phytogeography of the Pacific - floristic and historical distribution patterns in plants. pp.191-213 *in* A. Keast & SE Miller (eds), The origin and evolution of Pacific island biotas, New Guinea to eastern Polynesia: patterns and processes. SPB Academic Pub., Amsterdam, The Netherlands.

Vargo, D. 2000. Soil invertebrates of American Samoa. Micronesica 33:1-10.

Wang, HG, RD Owen, C Sanchez-Hernandez & MDL Romero-Almaraz. 2003. Ecological characterization of bat species distributions in Michoacan, Mexico, using a geographic information system. Global Ecology & Biogeography 12:65-85.

Watling, D. 2001. A guide to the birds of Fiji and western Polynesia. Environmental Consultants Ltd., Suva Fiji.

Webb, EL & S Fa'aumu. 1999. Diversity and structure of tropical rain forest of Tutuila, American samoa: effects of site age and substrate. Plant Ecology 144:257-274.

Webb, EL, BJ Stanfield & ML Jensen. 1999. Effects of topography on rainforest tree community structure and diversity in American Samoa, and implications for frugivore and nectarivore populations. Journal of Biogeography 26:887-897.

Webb, EL, M van de Bult, W Chutipong & ME Kabir. In Prep. Composition and structure of lowland rainforest tree communities on Ta'u, American Samoa.

Whistler, WA. 1980. The vegetation of eastern Samoa. Allertonia 2:45-190.

Whistler, WA. 1983. The flora and vegetation of Swains island. Atoll Research Bulletin 262:1-25.

Whistler, WA. 1992. Vegetation of Samoa and Tonga. Pacific Science 46:159-178.

Whistler, WA. 1995. Permanent forest plot data from the National Park of American Samoa. Cooperative National Park Resources Study Unit, Honolulu, HI, Technical Report 98.

Whistler, WA. 2002. The Samoan rainforest - A guide to the vegetation of the Samoan archipelago. Isle Botanica, Honolulu HI.

Wiles, GJ. 1992. Recent trends in th fruit bat trade on Guam. pp. 53-60, *in* DE Wilson & GL Graham (eds), Pacific Island flying foxes: proceedings of an international conservation conference. US Fish and Wildlife Service Biological Report 90(3):1-76.

Wiles, GJ, J Engbring, & D Otobed. 1997. Abundance, biology, and human exploitation of bats in the Palau islands. Journal of Zoology, London, 241:203-227.

Wiles, GJ & NH Payne. 1986. The trade in fruit bats, *Pteropus* spp., on Guam and other Pacific islands. Biological Conservation 38:143-161.

Wilson, DE & J. Engbring. 1992. The flying foxes, *Pteropus samoensis* and *Pteropus tonganus*: status in Fiji and Samoa. pp. 74-101, *in* DE Wilson & GL Graham (eds), Pacific Island flying foxes: proceedings of an international conservation conference. US Fish and Wildlife Service Biological Report 90(3):1-76.

Wilson, EO & RW Taylor. 1967. The ants of Polynesia. Pacific Insects Monographs 14:1-109.

Witherington, BE. 1999. Reducing threats to nesting habitat: in situ protection. pp. 179-183 *in* KL Eckert, KA Bjorndal, FA Abreu-Grobois & M Donnelly (eds), IUCN/SSC Marine Turtle Specialist Group Publication No. 4, 1999.

Wittmann, F, D Anhuf & WJ Junk. 2002. Tree species distribution and community structure of of central Amazonian varzea forests by remote-sensing techniques. Journal of Tropical Ecology 18:805-820.

Wodzecki K & H. Felton. 1975. The peka, or fruit bat (*Pteropus tonganus tonganus*) (Mammalia, Chiroptera), of Niue Island, South Pacific. Pacific Science 29:131-138.

Wodzecki K & H. Felten. 1981. Fruit bats of the genus *Pteropus* from the islands Rarotonga and Mangaia, Cook Islands, Pacific Ocean (Mammalia: Chiroptera). Senckenbergiana Biologica 61:143-151.

Woodall, P. 2001. Alcedinidae. pp. 219-22 *in* del Hoyo, A Elliott & J Sargatal (eds), Handbook of the Birds of the World, Volume 6 - Mousebirds to Hornbills. Lynx Edicions, Barcelona, Spain.

APPENDIX 1. A GUIDE TO THE EIGHT REQUIRED ELEMENTS AS FULFILLED IN AMERICAN SAMOA'S CWCS

ELEMENT No.	DESCRIPTION	APPLICABLE SECTIONS
1	Information on the distribution and abundance of species	Sections 3 & 5
2	Descriptions of locations and relative condition of key habitats and community types	Section 4 & 6 Figures 3, 4a & 4b
3	Description of problems, and priority research and survey efforts	Sections 3, 4, 5, 6; also see Section 9
4	Description of conservation actions	Detailed descriptions in Sections 3, 5, & 6 (subheading Conservation Priorities); also see Section 7 (Cultural Approach) & Section 8 (Statutory and Regulatory Approaches). General action categories summarized in Section 9
5	Proposed plans for monitoring & Adaptive management	See Sections 9 & 10; also Sections 3 & 5 for wildlife species; Section 6 for habitat; Figure 6
6	Descriptions of procedures to review the strategy	See Section 2.2. A similar process will be employed; review will be held in five year cycles; also Section 10
7	Plans for coordinating the development, implementation, review, and revision of the plan with Federal, State, and local agencies	See Section 2.2, with appropriate agencies; also see Sections 9 & 10
8	Public participation	See Section 2.2