

CHAPTER 4: Conservation Actions (Element 4)

Conservation actions fall under several categories including legal protection of conservation lands and interagency agreements, restoration of conservation lands to a state useful for native animals, removal or at least control of limiting factors, public education and compatible public use of these areas, and law enforcement, especially for species historical (and currently) harvested for food. Included in these actions is the need to implement or maintain captive breeding efforts while areas are prepared for reintroduction of native species. Each conservation action considered was given a Priority 1, 2, 3. Priority 1 is highest and 3 being least. In setting these priorities, all actions should at sometime reach Priority 1. However, timing of these priorities is such that essentially, depending on the stage of the conservation effort, their priority may be lower than expected. Specific conservation actions are indicated separately in each of the species mentioned (Chapter 3). Terrestrial conservation actions are illustrated in Figure 24 [this chapter].

Terrestrial

Legal Protection for habitats and wildlife

Guam has several local laws providing protection for native flora and fauna. The Department has the authority to enforce and submit changes for adjudication the laws that govern Game, Forestry, and Conservation (5 GCA, Chapter 63, PL-6-85). In addition to ensuring the authority to enforce these laws, Guam code also provides a list of species that are to be protected (5 GCA, §63121 and §63101-63117). The Endangered Species Act, 5 GCA, §63208 allows for the adjudication of an endangered species list for Guam. The responsibility to promulgate the Endangered Species list falls to the Department who then provides the list to the Attorney General of Guam and the Legislature for adjudication.

In an effort to provide maximum legal protection for the habitats for preserving and enhancing the recovery and/or restoration of wildlife to Guam (Priority 1), the following objectives will be implemented:

- To develop cooperative agreements with USFWS, AAFB-USAF, and Navy to include federal and Guam Conservation Lands as part of the Guam Wildlife Refuge Overlay. Develop cooperative agreements for management, research and protection of endangered species and species of greatest conservation. Priority 1.
- To develop Safe Harbor Agreements with private landowners in other areas adjacent to Conservation Land where wildlife may benefit. Priority 3.
- To determine boundary lines for all the Conservation Lands, and to further pursue the possibility of incorporating previously proposed conservation areas. Priority 2
- To develop Memorandum of Understanding with the CNMI to facilitate the conservation restoration measures of shared (historically) fauna and plants. Priority 1

Habitat Assessment and Rehabilitation

Guam is approximately 48% forested but there are few large areas of uniform vegetation (Donnegan 2002, and Fosberg 1998). The need to assess the state of habitats throughout the island is vital to the rehabilitation of these areas before any reintroductions of native fauna can be done. This assessment will be done in conjunction with predator and ungulate control. The following objectives will be pursued to assess the current state of the habitat, develop and implement plans to take appropriation actions to improve the habitat, or else maintain habitat as native forestland:

- To develop plans to improve habitats in conservation areas, to include reforestation, fire prevention, and control of invasive plants. Assist the Forestry and Soil Resources Division in developing forest recovery plans to include reforestation programs for Guam's Conservation Lands to include the control and removal of invasive, noxious plant species, replanting of native species, and protection of these areas with firebreaks. Priority 1
- To determine the status of plants listed as a SOGCN. Priority 1
- To improve man-made habitat at Masso reservoir for the Mariana common moorhen, and other wetland species. Priority 3
- To protect of native trees and plants from human destruction. Priority 3
- To develop regulations controlling the harvest of medicinal plants and wood within the Conservation Lands. Priority 3

Captive Breeding and Translocation

Captive breeding and translocation are and will always be an essential management tool for natural resource managers who work with small populations. Currently, GDAWR captive propagates two species of birds, the Guam rail and Micronesian kingfisher. The facility also holds and hand-rears Mariana crows collected as eggs and chicks from the wild on Guam and Rota. The GDAWR facility can house and support 144 rails, 10 crows, and 16 kingfishers. The Department envisions the creation a new larger facility that would support conservation efforts on Guam and throughout Micronesia. Guam has the infrastructure that would support such a facility and could be the "hub" of Micronesia for captive propagation.

Most of Guam's SOGCN would benefit from a large facility which would have facilities for mammals, birds, reptiles, gastropods and other invertebrates that may be in need of captive propagation. The progeny from captive breeding efforts would be released back into the wild. In addition to the benefits for Guam's SOGCN, the new facility could serve the region as a refuge and breeding center for all terrestrial species in peril throughout Micronesia.

The beginning and/or continuation of captive breeding (propagation) and translocation efforts of regional endemics and indigenous species for Guam and Micronesia will be addressed by the following objectives:

- Construct a new captive propagation facility on Guam by 2010 that would serve the needs of Guam's SOGCN and Micronesia. Priority 1
- Determine the need to captive breed other SOGCN. Implement captive propagation of endemic species of animals and plants for release into the wild, continue captive breeding of Guam rails and Micronesian kingfishers, and hand-rearing efforts for the Mariana crow. Priority 1
- Protection of plants in the wild from insect infestation and other maladies. Priority 1
- To determine the feasibility of translocation of shared SOGCN from the CNMI. Priority 2
- To provide an adequate number of SOGCN plants for planting in Conservation Areas. Collect seeds and seedlings from the wild for transplantation to Conservation Areas. Priority 2

Control of limiting factors

Snake barriers (Aguon et al. 1999 and 2002, Campbell 1999, Perry et al. 1998, and Rodda et al. 1999a) and perimeter trapping have been demonstrated to be effective in removing snakes in areas larger than 1-hectare (Engeman and Linnell 1998, Engeman et al. 1998). A combination of both techniques may be employed considering the uneven substrate characteristic of much of Guam's northern limestone forest. As birds settle into territories and begin to breed, electrical barriers then can be used to protect their nests.

Guam DAWR, US Department of Agriculture, Wildlife Services, US Geological Survey, Biological Research Division, and several other government and private investigators made advances in the use of traps and barriers to control of brown treesnakes. Area-wide snake control, using both removal and exclusion methodologies was tested at Area 50 Northwest Field and demonstrated the possibility for successfully reintroducing Guam rails and other native forest birds in the near future. Such reintroduction efforts utilized methods originally developed for introduction of rails on Rota. Feral cat control remains a major obstacle to the establishment of a small population of rails. Given the significant advances in brown treesnake control, it is appropriate to continue activities toward the recovery of the Guam rail and establishment of a population in the wild on Guam.

Methods for eradicating snakes from remote locations in the wild need to be applied to protect swiftlet colony sites, such as Mahlac Cave, from snake predation. Currently, snake traps using a live mouse as an attractant, are used to reduce snake abundance around island swiftlet caves. This method is labor intensive, especially when applied at remote sites. More cost-effective techniques need to be developed.

The endemic Guam Micronesian kingfisher can also benefit from large scale snake control. Application of barriers and area-wide snake removal will assist in efforts to repatriate kingfishers back into the wild. Releases of other indigenous birds no longer found Guam and still found in the Marianas Islands may follow as large areas are controlled for snakes. The following objectives will be pursued to control limiting factors affecting SOGCN:

- To control brown treesnake abundance in Conservation Areas and selected sites for release of SOGCN species. Guam DAWR, USDA-WS, NWRC, and USGS-BRD will determine what appropriate snake control measures may be used for each of the areas. In addition, predator control measures will include the control of dogs, cats, and rodents. Priority 1
- To develop and implement a program for reducing abundance of ungulates in the conservation areas. Priority 1
- To establish snake control around caves for the reintroduction of vertebrates including island swiftlet and Pacific sheath-tailed bat. Priority 2
- To develop plans to combat the impacts of invasive species and to prevent the introduction of new invasive species. Priority 2

Reintroduction and restoration of SOGCN to designated habitats

The reintroduction and restoration of SOGCN to designated habitats is the ultimate goal of all the management and conservation efforts put forth in the GCWCS. The following objectives will be implemented for particular species and for all SOGCN:

- To inventory conservation areas for caves and identify other potential cave sites for brown treesnake control and translocation of *A. vanikorensis bartchi* and *E. semicaudata rotensis*. Priority 2
- To determine the status of wildlife in each of the conservation areas. Inventory fauna within each conservation area including: birds, mammals, reptiles, and insects. Priority 2
- To reintroduce native wildlife identified as SOGCN into conservation lands, GNWRO and other areas (i.e., Safe Harbors). Priority 2

Aquatic

Early aquatic management efforts by GDAWR were influenced by the USFWS and equivalent temperate zone state fish and wildlife agencies, focusing on individual species or groups of species that were important fishery resources. In the 1970s, GDAWR management decisions reflected the views and values of the times and GDAWR was responsible for a number of introductions of non-native freshwater organisms for aquaculture and sport fishing. However, beginning in the mid-1980s, due in part to an estimated 70% decline in catch per unit effort of inshore coral reef fish over a 15-year

period, the aquatics section began to shift its focus. In the mid-1990s, GDAWR resurrected the freshwater program, shifting from a focus on aquaculture and sport fish introductions to monitoring representative watersheds. During this time, GDAWR also took its first step in ecosystem based management of marine fisheries resources by creating the territories five marine preserves.

Freshwater

Most aquatic organisms on Guam use rheotaxis to find their way upstream. If these organisms are able to bypass or ascend obstructions like dams, they would reach an area of little or no current (reservoir) and are unable to continue their upstream migration. The organisms end up in the reservoir, where they are much more susceptible to predation, and are less likely to find suitable areas for feeding or spawning.

Some organisms are able to pass the reservoir, and breed. Young are passively carried downstream to the ocean for the marine portion of their life history. If the young are prevented from reaching the marine environment within a critical first few days of birth, they do not survive. Young born above a dam can become caught in the reservoir formed behind the dam, and perish. Studies by GDAWR indicate the diversity of native organisms is much lower in the three rivers feeding into the reservoir than in three control rivers located outside the Fena watershed, as well as the control river leading from the Fena dam.

To address these issues and the threats previously mentioned, the following objectives will be pursued:

- To determine the impacts of dams and other manmade structures that may have an impact on freshwater aquatic organisms. Priority 2
- To conduct a biological inventory of freshwater organisms for Guam. Priority 2
- To determine the extent and impact invasive species have on native freshwater species. Priority 2

Coral Reef Fisheries and Habitat

Guam is located near the center of biodiversity for coral reefs, with over 5000 species of marine organisms recorded on Guam's reefs. Hundreds of these are important fishery resources, while hundreds more are components of essential fish habitat. Faced with such complexity, GDAWR began to implement eco-system based management actions. One of these actions was the creation of Guam's five marine preserves in May 1997. The law creating the preserves called for setting aside areas restricting take of all marine organisms and protection for their associated habitat. That same year Governor Carl T.C. Gutierrez signed Executive Order 97-10, adopting the Guam Coral Reef Initiative and creating the Guam Coral Reef Initiative Coordinating Committee (GCRICC), of which GDAWR is a member.

As part of the GCRICC, GDAWR helped to identify the top five priority threats impacting Guam's coral reefs: land-based sources of pollution, overfishing, lack of public awareness, recreational misuse and overuse, and climate change/coral/beaching/disease. The GCRICC then selected local navigators to guide the development of 3-year Local Action Strategies (LAS) for each of these priority threats. These LAS are described in greater detail in Appendix 7.

The following objectives will be implemented:

- To continue the implementation of local action strategies (LAS), to include the determination of land-based sources of pollution, implement coral reef fisheries management actions, foster education and outreach programs, recreational use, climate change, and coral bleaching and disease. Priority 1
- To maintain established Marine Preserves. Priority 1
- To implement management actions to protect and improve the status of marine SOGCN within Guam's jurisdiction. Priority 2

Sea Turtles

Three species of sea turtles visit Guam's waters: Green sea turtles, hawksbill sea turtles, and leatherback sea turtles. Only two of these species, the green and hawksbill sea turtles, use the beaches of Guam as nesting grounds. Little is known about the habits and life histories of sea turtles in Micronesia. They are threatened by the loss of nesting habitat and foraging grounds, consumption for meat and shells, and fishing gear, especially nets and long lining.

Guam DAWR is taking steps to fill in this knowledge gap by studying both resident and nesting sea turtles in Guam's waters. Currently the focus is on green and hawksbill sea turtles as they are more frequently observed in Guam's waters and use the beaches for nesting. The objectives for protecting these species are:

- To develop and strengthen cooperative agreements with the USFWS, AAFB-USAF, and Navy to establish/continue nesting turtle monitoring, protect nesting and foraging habitat, and track migrating turtles. Priority 1.
- To facilitate a volunteer nesting turtle monitoring program, "Haggan-Watch", to involve the community in sea turtle conservation. Priority 1.
- To track resident sea turtles in order to understand their movements around the island and life history. Priority 2.

Marine Mammals

The marine mammals that visit Guam's waters have not been studied. Information is limited to sightings and for some of the dolphin species rough estimates of pod size and movements are known. The objectives for these species are:

- Educate public about marine mammals and steps they can take to help protect these species. Priority 2.
- Develop a volunteer reporting program for fishermen and tourist vessels for marine mammal sightings. Priority 3.
- Seek technical assistance from federal partners to gain information about marine mammals in Guam's waters. Priority 3.

Public Awareness and Education

Development of a Public Conservation Awareness Program

The need to foster an informed population in regard to conservation and the importance of natural resources to the island is critical to the success of any long-term conservation efforts. Guam DAWR and its partners in the GCWCS have identified a lack of public awareness as a priority threat to many of our conservation actions.

Guam has experienced success in creating public awareness for coral reef issues through Education and Outreach Local Action Strategies (EO LAS) developed by the Guam Coral Reef Initiative Coordinating Committee. For instance, the Guam Visitors Bureau (GVB) and the tourism industry are now working with the natural resources agencies to market Guam's coral reefs, and in particular the marine preserves, to the 1 million visitors that come to our island yearly. This new awareness of the economic value of our coral reef resources is beginning to create a sense of stewardship in the industry, absent during the economic boom of the 1980s and recession of the 1990s. The goal of the education and outreach local action strategy (EO LAS) is to increase awareness of the need for the protection of Guam's coral reefs through improved efforts in the community, in the classroom, and with policy makers. Other venues for introducing conservation awareness and outreach are the Island Pride Campaign and publications such as Man, Land and Sea. The Island Pride Campaign is a program that combines educational and environmental activities with fun events to teach children to love the island's resources and instill a sense of stewardship. The quarterly publication of Man, Land and Sea which is published through BSP is another outlet for public/private education and awareness campaigns.

To increase the awareness of the general public and private industry the following objectives will be implemented:

- To develop, implement and utilize existing programs to increase public awareness of natural resources and issues pertaining to them. Priority 1
- To develop outreach campaigns, educate the public and private industry of the value of preserving Guam's wildlife and habitats. Priority 1
- To develop a plan to addressing public awareness and education of conservation issues- websites, posters, presentation, public service announcements, enhance

and facilitate public involvement in conservation efforts. Develop a program to install signage and other forms of public outreach in conservation efforts. Priority 1

Recreation Activities within the Conservation Areas

The local Conservation Areas that have been established have limited accessibility for the general public. Hunters and off-road enthusiast are the main users of these areas. The Anao Conservation Area is a wonderful example of what a limestone forest should resemble. However, many individuals do not know about this Conservation Area because there are no signs indicating how to get there. The area is mainly used by the hunting community and must be accessed through private lands. By creating more opportunities for the public to get out and experience these areas firsthand, we can educate and instill a sense of stewardship of our natural resources. Providing greater accessibility through the creation of trails into and campsites on conservation lands we can ensure that future generations experience and appreciate the wonders of Guam's natural resources.

The GNWR's visitor center at Ritidian Point provides the opportunity for the public to experience nature and culture. This is the direction we should take with the conservation lands established by the Government of Guam. To assist in creating recreational activities with local conservation areas we will implement the following objectives:

- To allow public access to game species in Conservation Areas. Priority 2
- To develop signage identifying Guam's Conservation Areas; highlighting key habitat types, important fauna, geologic formations, and other key aspects of the Conservation Area. Priority 2
- To allow compatible public activities in Conservation Areas. Priority 3

Law Enforcement of Natural Resource Laws and Regulations

As stated previously, the Department and specifically GDAWR's Law Enforcement Section has the authority to enforce laws and regulations pertaining to the natural resources of Guam (Table 2). The ability of the Department's Law Enforcement officers to interdict individuals breaking laws and regulations has been hindered due to several factors. These factors include shortfalls in manpower and equipment, and public education about the rules and regulations governing natural resources on Guam. By far the biggest obstacle for enforcement is public education. The public must be properly educated as the laws and the reason for the laws that protect natural resources. To aid in the protection and enforcement of natural resource laws and regulations we will implement the following objectives:

- To protect Guam's endangered species and SOGCN from illegal harvesting or incidental take by enforcing Guam's natural resource regulations and developing regulations for SOGCN not protected under

current regulations. Priority 1

- To protect Guam's Marine Preserves. Priority 1
- By educating the public of Guam's natural resource regulations. Priority 1
- By creating and maintaining a volunteer conservation officer program to aid with monitoring activities in Conservation and other public lands. Priority 2
- By maintaining and promoting Conservation officer law enforcement skills. Priority 2

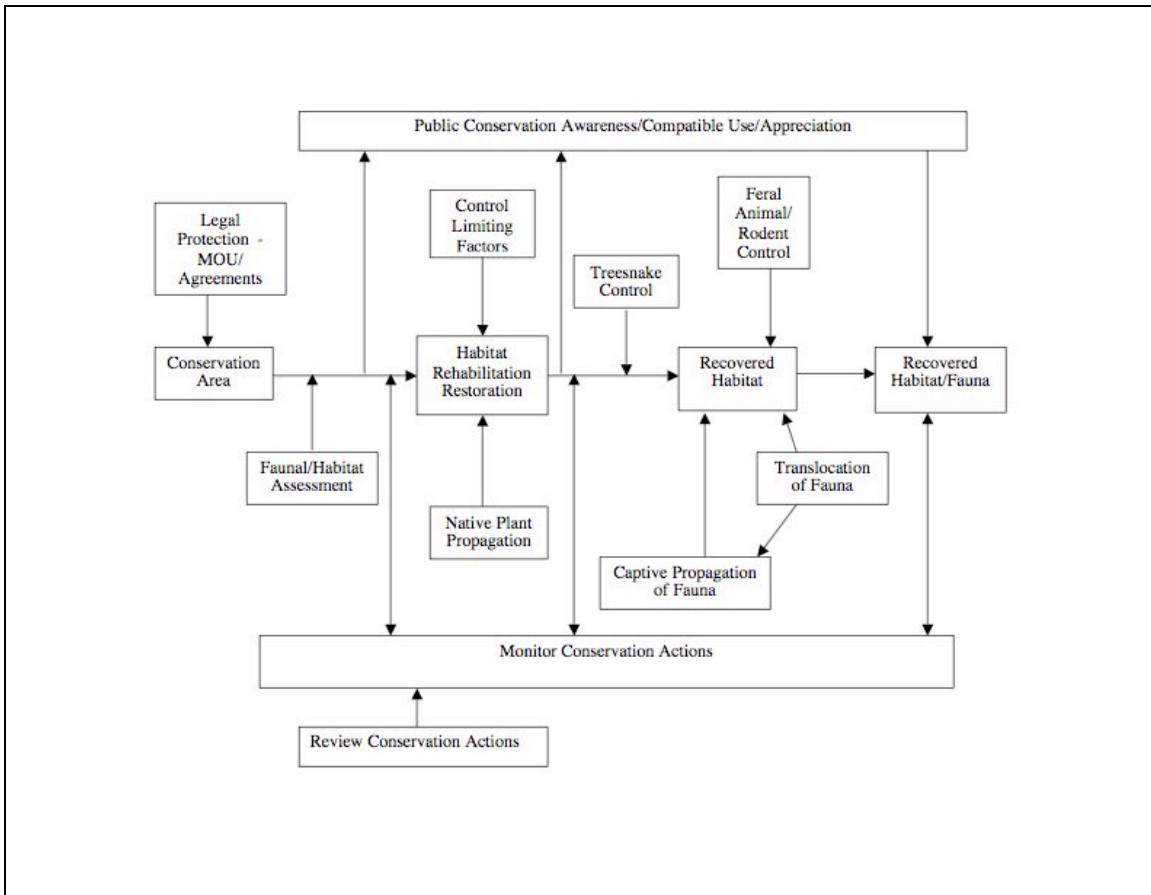


Figure 24. Diagram illustrating conservation actions for terrestrial plants and animals.

CHAPTER 5: Proposed Monitoring and Incorporation of New Information (Element 5)

Monitoring and Evaluation

Guam's CWCS encompasses monitoring and evaluation in three areas: 1) surveys (species and habitat); 2) effectiveness of proposed strategies; and 3) ten-year revision of the CWCS. The approach to monitoring and evaluation is based on expanding existing efforts in order to be cost effective, in light of limited financial resources (Schoonmaker and Luscombe 2005). For new efforts, the approach will be to focus on relevant, realistic, and effective monitoring and evaluation that is cost-effective, sustainable, and has minimal impact to native ecosystems.

Surveys of Species

Except for several species of resident native birds, a majority of Guam's terrestrial (both vertebrate and invertebrate) resident species of animals is extirpated or extinct, or found only in captivity or in low numbers. For those species still extant on Guam, monitoring of these populations as conservation actions are implemented will be important to conservation evaluations.

To standardize observations, personnel will be trained in identification and survey methods to insure that the data collected is as accurate as possible. Such training will include identification of calls for certain species, recording of number of animals observed, and use of standard bird survey techniques incorporated in Ramsey and Scott 1981.

Goals: To monitor the long-term population trends of SOGCN.

Objective 1: Conduct colony and/or island-wide counts indicating population trends over a five-year period;

Objective 2: Conduct colony and/or island-wide population surveys in relation to efforts to increase the quality and quantity of limestone and ravine forest habitats.

Mariana fruit bats and Sheath-tailed bats

- Colony Counts – Quarterly counts of all colonies. As new colonies are found they will be surveyed quarterly.
- Island-wide Survey - An island-wide survey, using randomly stratified fixed survey stations, will be established and conducted every 5 years.

Native Birds

- Direct Monitoring – A combination of radio telemetry and re-sighting banded birds will continue to be used for monitoring for extant bird populations, as well as, captive reared birds that are released into the wild. In the future, as captive flocks of Guam rails, Micronesian kingfishers are

large enough for release into the wild on Guam, monitoring with these methods will be valuable in determining the survivorship of released birds.

- Playback Surveys – As bird populations increase as a result of conservation efforts, surveys using tape-recorded crow calls along established survey transects will be reinitiated (these surveys were stopped in 1999 when Mariana crow populations were extremely low). These surveys involve playing tape-recorded calls at survey points a minimum of 300 meters apart for 2.5 minutes followed by a 2-minute silent period to record numbers, distance, and plumage condition. As the Mariana crow population increases and their distribution expands additional survey transects will be randomly selected to coincide with other forest bird surveys (see other extirpated forest birds below). Playback censuses are important in monitoring Guam rails released on Rota. Other re-introduced species of birds could be surveyed by this method as well.
- Roadside Counts – Annual May annual roadside counts along 23 survey routes around northern and southern Guam will continue to monitor the status of native and non-native bird species. Survey points are spaced 600 meters apart along roadways, and the number of birds heard and seen during a five-minute survey period at each station is recorded. This survey will expand to additional areas of Guam as populations of birds increase, and the frequency of counts may increase depending on need.
- Cave Exit Counts – Island swiftlets will be surveyed by counting the number of birds within the cave and then counting the number of birds entering and exiting the cave during a 1-2 hour period before dark (dark is defined as one hour after sunset). The swiftlet population for a cave is then estimated by subtracting the number of departures, from the number of arrivals, and adding the estimated number of swiftlets in the cave prior to the count. All counts are conducted with at least one observer at each cave entrance for a particular colony. In some cases, two observers are utilized, two counting the number of swiftlets entering a cave and the third person counting the number of birds exiting.
- Shorebird Surveys – Survey for migratory shorebirds, August through May, along shorelines (Togcha, and Dungca's Beach) and grassy fields to determine the abundance of specific shorebirds. Areas historically monitored will be surveyed initially to establish current baseline information and serve as a means of comparison. Other appropriate areas will be added. Information from Annual Marianas Audubon Christmas bird counts and other pertinent sources will be incorporated into the database on shorebird abundances in Guam.

Terrestrial Reptiles (skinks and geckos)

- Conduct annual surveys to determine the status of the each reptile SOGCN. These surveys will be conducted in Conservation Areas to monitor the status of each area, and the effectiveness of conservation measures. Additionally, surveys will be conducted in areas known to historically harbor these lizards.

Invertebrates – Gastropods

- As the populations of remaining native snails are very small, visual surveys of native snails in areas historically known to contain them will be conducted to determine the current population numbers. Initial surveys will be conducted in the Hilaan, Tanguisson and Haputo areas.
- Conduct annual surveys in key areas to determine the status of each species to determine the efficacy of conservation efforts.

Invertebrates – Insects

- Conduct an assessment on the status and distribution of Guam's native insects to identify the species needing immediate conservation attention.
- Conduct annual surveys of species determined to be in need of close monitoring.

Predator and Invasive Species Surveys

The introduction of species to Guam, whether intentional or accidental, has had a negative impact on native species or their environment. The introduced brown treesnake caused significant damage to Guam's native vertebrate fauna. The recovery of native fauna hinges on the control of the snake. However, efforts to eradicate the snake must be combined with habitat restoration, captive breeding or translocations, and even the removal of other predators such as cats, dogs, and rats. Monitoring the abundance of the brown treesnake is important in determining the efficacy of brown treesnake control measures. In addition, monitoring the presence and distribution of other invasive species must also be emphasized.

Goal: To determine population trends and control of introduced predator invasive species that limit the recovery of SOGCN on Guam.

Objective 1: Monitor monthly abundance of brown treesnakes in Conservation Areas designated for restoration and where brown treesnake control is being implemented to determine the efficacy of treesnake control measures.

Objective 2: Identify the abundance and distribution of invasive species in Conservation Areas and remove these species.

- Implement area-wide brown treesnake control by snake trapping and/or barriers in conservation areas slated for release of SOGCN.
- Continue to support studies into improving brown treesnake control techniques.
- Assess brown treesnake control threshold for non-federally listed forest bird species and other SOGCN.
- Monitor the abundance of invasive species in Guam.

Monitoring Habitats and Conservation Areas

The GCWCS plan will entail the management and monitoring of restorative actions within conservation areas on Guam. Many conservation areas on Guam, both on military and government of Guam lands, are in dire need of restoration as a result of ungulate damage (Wiles et al. 1999). Conservation actions proposed by existing plans to rehabilitate designated forest habitats are important to restoring these areas to a natural state, as well as to making them suitable to the native fauna.

Fire and ungulate damage are probably the most significant factors leading to the loss of native habitat. Some areas heavily impacted by ungulates have changed into monospecific plant communities. The species of plants are usually the one that tend not to be palatable to ungulates. For example, *O. marianensis* is a native species that easily develops monotypic stands because of it is not favored by deer. Much of southern areas of Guam is covered with *Miscanthus floridulus* because this grass species quickly flourishes in areas made available by repeated burning. The exotic palm, palma brava, has replaced native ravine forests in some areas.

Goal: To monitor the progress of restoration efforts of habitats.

Objective 1: Development of a GIS map of historic and current distribution for Guam.

Objective 2: To illustrate the reduction of habitat degradation and loss as control measures for deer and feral pigs are implemented in conservation areas.

Vegetation GIS Maps for Guam

- In 2005, the US Forest Service, FSRD, and private forestry completed a vegetation analysis for Guam utilizing 2002 IKONOS data (4 meter multi-spectral and 1 meter panchromatic) and 1994 aerial photography (USDA 2005). This research provides an assessment on habitat availability at a broad scale and will serve as a baseline for native forest restoration. A more detailed study will be completed every 10 years to monitor long-term trends in forest types on Guam.

- The map will be updated every 10-years. The map will be used to identify important trends in habitat restoration on Guam.

Monitoring Native Forests

- Conduct plant surveys (transects and counts) to determine the status and efficacy of conservation efforts for habitat in key areas. Vegetation transects will be used to assess the condition of the conservation. The abundance and diversity of the types of plant species in the conservation areas will be documented.
- Determine the status of conservation areas to determine the abundance of various native species of plants.
- Historic information will be compiled to provide baseline information on habitats and be compared to current trends and conditions.
- Information on conservation areas will be used to specifically determine what actions will be taken to improve the habitat for faunal and floral goals. Many areas principally need a reduction in feral deer and pig populations.
- Develop and implement reforestation techniques in Guam conservation areas and national wildlife refuge overlay lands.

Monitoring Wetland Habitats

- A map of the historic and current distribution of Guam's wetlands will be compiled. These maps will show trends of the distribution of the wetlands in Guam. Mitigation wetland sites, ponding basins, and other man-made ponds will be included in the inventory.
- As these areas encompass a greater area on Guam, broad scale monitoring will be used to assess conditions of these habitats. Appropriate partnership will be developed as some of these areas are privately or federally owned.

Aquatics Monitoring and Evaluation

Guam DAWR research priorities focus on the major threats to Guam's aquatic species: fishing, pollution, invasive species, development, recreation, and disease. Because freshwater and marine resources are intimately linked, impacts in the upper reaches of Guam's watersheds affect not only freshwater organisms, but are amplified throughout the watershed and impact marine organisms as well.

Partners such as the FSRD, GEPA, NPS, and scientists from the University of Guam are also seeking insight into the problems facing Guam's aquatic resources. Together these

organizations are tackling issues such as soil erosion rates, re-vegetation of badland areas, sedimentation on near-shore reef communities, pollution levels in coastal waters, and settling and recruitment rates of corals.

Survey of Freshwater Habitats and Organisms

Guam's native freshwater fauna are threatened by habitat loss due to sedimentation, eutrophication, and increased water flow caused by bank alteration and loss of riparian vegetation. Because of their amphidromous life histories, all of Guam's native fish species are vulnerable to stream blockage. Monitoring these species in their native habitat will allow GDAWR to monitor the existing stocks and to evaluate improvement due to management activities.

Goal: To monitor the long-term population trends of freshwater SOGCN.

Assessing Impacts of Dams

- Guam DAWR will be conducting a long-term study of the effect a manmade dam (Fena) has on the native freshwater fauna of Guam, as almost all of Guam's native freshwater fauna is amphidromous, with a marine larval stage in their life history before they return to freshwater to spend their adult lives. Dams affect native fauna. A dam acts as a physical barrier to some native organisms. Organisms not able to pass upstream of the dam are limited to the reaches of rivers below the dam.
- Guam DAWR will survey seven Guam rivers annually to monitor the effect a dam has on native fauna. The three rivers that feed into the Fena reservoir (Maagas, Almagosa, and Sadok) are classified experimental, and the river below Fena dam (Maulap) and three other rivers outside the Fena watershed (Ylig, Lonfit, and Manenggon) are the controls.
- In each river, a 200-meter section will be chosen, and divided into 20 10-meter segments. Within each segment, a quadrat will be randomly chosen and surveyed, for a total of 20 sample sites per river.
- Data collected at each quadrat will include species identification, number and size of individuals of each species observed, activity of observed animals, two most dominant substrate types, percentage of canopy cover over quadrat, area of quadrat, depth of water in quadrat, and average water velocity in quadrat, as well as observers, location, date and time.

River Inventory

- Guam DAWR will conduct a biological river inventory for Guam to obtain baseline biological data important for management of our freshwater resources. Of over 100 named rivers and streams, we have

biological information for about 12. Guam DAWR will be surveying rivers with no known biological information.

- Data collection includes visual surveys, as well as specimen collection using net and electrofishing. Guam DAWR now has biological information for 37 rivers, and eventually intends to collect information on all 100.

Freshwater river surveys

- The freshwater fishery resources will be monitored by surveying seven rivers in three watersheds each year for analysis and comparison between watersheds by using appropriate parametric or non-parametric tests. (See attached freshwater data collection sheet).

Reservoir Fisheries Monitoring

- Monitor the freshwater fishery in Fena Lake by conducting a stock assessment, using electrofishing and mark-recapture methodology, to determine species, species density, and other environmental parameters.
- The freshwater fishery resources in Masso reservoir will be monitored by conducting mark-recapture studies on a yearly basis to collect biological information of the freshwater fisheries resource.

Guam Environmental Monitoring and Assessment Program (EMAP) – Surface Waters

- Guam DAWR will participate in the development of the Guam Environmental Protection Agency's EMAP protocols for surface waters of the Western Pacific ecoregion. This program will monitor many parameters of river habitat health including general water chemistry, physical habitat parameters, periphyton community structure and abundance, biomass and chlorophyll, fish community structure and abundance, macroinvertebrate community structure and abundance, sediment chemistry, fish tissue chemistry, water column contaminants and rapid habitat and visual stream assessments. Guam DAWR staff will also assist GEPA with biological surveys.

Marine Species Surveys

There are a number of methods for assessing fish stocks in marine waters. Guam DAWR uses a variety of these methods to assess the impacts of fishing and effectiveness of the marine preserves as a fisheries management tools. These methods include creel surveys and in situ monitoring.

Goal: Management of Guam's Marine Fisheries Resources

Offshore Fisheries Participation, Effort, and Harvest Surveys

- To monitor the health of Guam's reef, bottom, and pelagic fishery resources by conducting 192 offshore surveys each year at the three largest boat launch facilities on island.
- To continue gathering limited biological data that will add to a long-term historical data base on Guam's fish species by conducting 192 offshore surveys over a one year period at the three largest boat launching facilities on island.

Inshore Fisheries Participation, Effort, and Harvest Surveys

- To monitor the health of Guam's reef and bottom fishery resources by conducting 192 inshore surveys each year along the coastline of Guam.
- To continue gathering limited biological data that will add to a long-term historical database on Guam's fish species by conducting 192 offshore surveys over a one-year period along the coastline of Guam.
- To monitor the health of Guam's reef and bottom fishery resources by conducting 24 aerial surveys each year along the coastline of Guam.

Assessing Guam's Reef Fish Spawning Aggregations

- Analyze 20 years of creel survey data to look for probable spawning aggregation encounters documented in the surveys to determine the species caught, approximate site location, date, time, tide, and moon phase by December 2005.
- Interview knowledgeable local fishermen and fishermen identified by the creel data analysis as having located an aggregation to locate the site on a map and provide any details about aggregations they have witnessed by April 2006.
- Analyze and compile data and enter onto a GIS map by August 2006.

Visual Stock Assessment Surveys of Marine Preserves and Control Sites

- To evaluate the effect on sport fish populations caused by the creation of five marine preserves where fishing is restricted or prohibited by conducting fish counts and timed-swim counts on at least 25 permanent transects located in reef flat and lagoon habitats in Achang Reef Flat Marine Preserve, Piti Bomb Holes Marine Preserve, Tumon Bay Preserve, Asan Bay, Pago Bay, and Cocos Lagoon over a one-year period.

- To evaluate the effect on sport fish populations caused by the creation of five marine preserves where fishing is restricted or prohibited by conducting fish counts, timed-swim counts, and video-transects/quadrant on at least 25 permanent transects located at the 20', 30', 40', and 50' depth contours of the fore reef slopes in Achang Reef Flat Marine Preserve, Piti Bomb Holes Marine Preserve, Tumon Bay Preserve, Asan Bay, and the backside of Cocos Lagoon, over a one-year period.

Marine Preserve Monitoring

- In 1997, Guam established five marine preserves around the island amounting to 11.8% of Guam's shoreline. Guam DAWR will continue to sample the fish populations and reef communities in two of the preserve areas and control sites to determine the effectiveness of the preserve system. These studies focus on the fish species targeted for consumption and for indicator species such as butterflyfish.
- The Piti Bomb Holes Preserve and the Achang Reef Flat Preserve are the experimental sites for the stock assessment surveys. Cocos Lagoon and the Asan fore reef slope serve as the control sites for the Piti Bomb Holes Preserve, while Pago Bay reef flat and Cocos fore reef slope serve as the control sites for the Achang Reef Flat Preserve.
- As in prior years, sixty-six (66) permanent belt transects (50m x5m) will be surveyed on the reef flats and fore reef slopes of two preserve sites, Piti Bomb Holes Preserve and Achang Reef Flat Preserve, and three control sites, Asan Bay, Cocos Lagoon, and Pago Bay. Two sets of transects will be on the fore reef slope at the 20', 30', 40', and 50' depth contours. Eight transects are on the reef flat at each site representing distinct microhabitats (seagrass, coral/algal/rubble, and sandy bottom).
- Fish communities will be surveyed using two different visual survey techniques along each transect. Density will be assessed using a visual fish census along a strip transect. Two fish counters following the 50 m long permanent transect, each counting all target fish within 2.5 m of their side of the transect. All target fish within this 250 m² area will be scored on data sheets based on their species and size class. Three size classes will be used based on the fork length of the fish (<15 cm, 15 cm-30 cm, >30 cm). The strip transect method will be complemented by a timed visual survey in the same area. At each site, fish counters will record the species and size class of all fish encountered in the area during a 30-minute interval.
- Data will be analyzed using Statview 4.5 for PC published by Abacus Concepts Inc. A two-tailed paired t-test (Sokal and Rohlf, 1995) will be used to compare fish densities and diversity over time within each study site. The Shannon diversity index will be used to calculate an index

number for species diversity and evenness at each site for both pre- and post-implementation data. A higher index number indicates greater diversity. If the assumptions of analysis of variance (ANOVA) are not met, even after transformations, a nonparametric test will be conducted (Sokal and Rohlf, 1995).

Guam Environmental Monitoring and Assessment Program – Coastal Waters

- This program will assess the biological condition of Guam’s marine water using standardized methods. Reef fish, macroinvertebrates, macroalgae, and coral abundance will be recorded at 50 randomly selected sites throughout Guam’s waters. This program will be complemented by water quality monitoring and sediment analysis.

Marine Turtles In-Water and Nesting Beach Surveys

- Aerial Surveys: Conduct monthly aerial surveys of species determined to be in need of close monitoring.
- Incorporate information from “Haggan-Watch” Volunteer program managed by GDAWR on turtle sightings.

Marine Habitat Monitoring and Evaluation

Since, healthy fish populations require healthy reef habitat, GDAWR and its partners also monitor the coral reef habitat through a number of projects to determine the impact of land based sources of pollution and other threats to healthy coral reef habitats.

Goal: To protect vital marine habitats and the aquatic life they contain.

Objective 1: To compile marine trend information to identify serious threats to Guam’s marine resources.

Objective 2: To determine water quality indicators important to coral reefs to help manage Guam coral reefs, thereby benefiting the marine life.

Objective 3: Participate in Marianas Archipelago Reef Assessment and Monitoring Program (MARAMP) to improve the understanding of coral reef ecosystems, evaluate and reduce adverse impacts, enhance coral reef ecosystem-based fisheries management and conservation through cooperation with partners (federal and local agencies and non-governmental organizations), and provide scientific information needed to establish, strengthen, and manage MPAs (NOAA, Pacific Islands Fisheries Science Center, Coral Reef Ecosystem Division website <http://www.nmfs.hawaii.edu/crd>).

Quantifying and Assessing the Effects of Sedimentation on Fish Abundance, Fish Diversity, and Benthic Habitats including corals

- To obtain a purchase order to obtain supplies and equipment needed for the project by December 2005.
- To assess Piti Bomb Holes Preserve and Fouha Bay, areas with current and future erosion control projects, and two appropriate control sites for detailed monitoring by December 2005.
- To conduct fish counts, timed-swim counts, and video-transects on 24 permanent transects located in the 20', 30', 40', and 50' depths of the fore reef slopes and reef flats of Piti Bomb Holes Preserve, Fouha Bay, and two control sites over a one year period.
- To install and monitor thirty sediment traps on a monthly basis each year during the study at Piti Bomb Holes Preserve, Fouha Bay, and two control sites in order to quantify sediment load at impacted sites.

Analyzing and Assessing Recreational Impacts on Coral Reef Habitat and Determining a Carrying Capacity within Marine Preserves

- Develop a scope of work and request for proposal by December 2005.
- Obtain a contract by June 2006 to assess the impacts of recreation activities within Tumon Bay and Piti Bomb Holes Marine Preserves on coral reef habitat by linking recreational activities to their effects on the abundance, diversity, and distribution of fishes, corals, macro-invertebrates, and marine plants as well as substrate cover, water clarity, temperature, dissolved oxygen, pH, and damage or pollution related to recreational activities and comparing the effects to appropriate control sites.

Guam Environmental Monitoring and Assessment Program – Coastal Waters

- Implement an Environmental Monitoring and Assessment Program (EMAP), to be conducted by GEPA and assisted by GDAWR staff. The EMAP program will assess the physical and chemical condition of Guam's Marine water using standardized methods and a suite of environmental indicators. This information will be used to rank the relative importance of various stressors on the affected resource types.

Marianas Archipelago Reef Assessment and Monitoring Program (MARAMP)

- Guam DAWR will participate in MARAMP cruise trips. The MARAMP is intended to be a long-term monitoring program with research cruises

scheduled bi-annually. The cruise usually comprised of staff from the NOAA Coral Reef Ecosystem Investigation Program, GDAWR, NPS, and the University of Guam Marine Laboratory to conduct a variety of ecological and oceanographic assessments, including the following:

- Benthic Habitat Mapping: multi-beam surveys, single beam QTC surveys, geodetic control, towed diver surveys, and TOAD towed camera surveys,
- Fish, Turtle, and Marine Mammal Surveys: belt transects, stationary point counts, towed diver surveys, roving diver surveys, and hydroacoustic surveys,
- Benthic Surveys (corals, other inverts, algae): belt transects, towed diver surveys, roving diver surveys, and TOAD towed camera surveys, and
- Oceanography: closely-spaced CTDs, drifters, subsurface temperature, ADCP transects, CREWS/SST buoys, current/wave moorings.

Data Management and Archiving

Faunal and Vegetation survey data will be archived with GDAWR. The information collected will be analyzed and reported in State Wildlife Grant reports, to include information on species abundance and distribution, and on habitat trends. Statistical analysis (either parametric or non-parametric) will be used to determine significant changes in abundances (Sokal and Rohlf 1995).

After 5-year's, programs implemented for each SOGCN will be assessed and a five-year report detailing the efforts, population trends, and management actions will be written.

Establishment of a Monitoring Group

In order to assist in the synthesis of the information gathered from monitoring of SOGCN and relevant habitats, a Guam Monitoring Group will be established. This group will be composed of appropriate local and federal agencies including but not limited to the Department of Agriculture (GDAWR and FSRD), US NRCS, USFWS Ecological Services, GNWR, USDA-Wildlife Services, USGS-BRD, and UOG. In addition, NGOs and private landowners will be invited to participate.

This group will be composed of individuals with expertise in resource management, habitat monitoring, data management, and public involvement. They will provide a comprehensive status of the habitats, their location and condition, and what conservation actions need to be taken.

CHAPTER 6: Periodic Review of Strategy (Element 6)

Ten –Year Review of the Strategy

Guam's CWCS will be fully reviewed every 10 years with interim reviews every five years. The interim reviews will be used to assess the success or failure of management objectives and to adjust management actions accordingly.

- The proposed management actions for Guam's SOGCN will be updated as new information is gathered from these reviews. The Department will coordinate, with its partners, a complete assessment of the strategy every 10 years.
- The Department and its partners will use the original eight elements and other criteria available at the time of revision. The effort will be in consultation with other stakeholders, both public and private.
- A review of the priority levels will be made to assure SOGCN needs are being addressed.
- The revision shall start at least 2 years before the tenth year and be completed by the end of the tenth year. The countdown to revision shall commence on October 1, 2005 and the first full revision shall be completed by October 1, 2015.

**CHAPTER 7: Coordination of the development,
Implementation, Review, and Revision of the GCWCS
with Federal, State, and Local Agencies (Element 7)**

Coordination with Federal, State, and Local Partners

Guam DAWR identified federal, state, and local stakeholders that may have had interest in providing input for the GCWCS. Letters informing Government of Guam agencies, University of Guam (UOG), USAF, USN, and NGOs (The Nature Conservancy and Marianas Audubon Society) of the development of GCWCS (See Appendix Public) were sent out in October and November 2004. Each of the agencies was invited to provide their concerns, input, and assistance.

Various government, state and regional partners provided assistance in the development of the GCWCS, while the Fisheries and Wildlife Sections of GDAWR headed the development of the GCWCS. The USFWS Ecological Services field office in Hawaii provided input on SOGCN, monitoring and conservation actions. In addition, guidance was given regarding format and content for most chapters within the GCWCS. Information on common species of greatest concern was shared with the State of Hawaii's Department of Land and Natural Resources, CNMI Division of Land and Natural Resources. Most of the information pertains to migratory shorebirds' status and action plans, which are implemented in the plan. Input on various portions of the plan was provided by: the University of Guam (UOG) Marine Lab on marine vertebrates and land snails; the UOG College of Agriculture and Life Sciences on insects and plants; and FSRD on terrestrial plants, as well as digital maps of conservation areas and information on the vegetation contained in them. The Nature Conservancy provided input for marine and aquatic sections as well as the overall development of the strategy. The Government of Guam's Department of Land Management provided assistance with maps and identifying conservation and public lands. The Mayor's Council of Guam provided assistance with the public meetings that were held at the Mayor's offices at several of the villages (Dededo, Sinajana, and Yona).

The Department will be coordinating with partners to identify new projects and review of existing projects discussed in Chapter 4 (Review and Revision).

CHAPTER 8: Broad Public Participation (Element 8)

Pre-GCWCS Draft Public Meetings:

The public was invited to participate in the development of Guam's CWCS (Appendix 8). The process began with a meeting with the Mayor's Council of Guam on November 17, 2004. Guam DAWR informed the Mayor's Council about the Eight Elements and the need for such a comprehensive plan. During the meeting with the council, one mayor indicated that he would like to see more native forest and native forest birds on the island. He also mentioned that removing the snakes is greatly needed to accomplish this task. Another mayor mentioned the need to educate the public and the challenges to get them involved in environmental activities to preserve the native forest habitats on Guam. Similar testimonials involved the preservation of the Asiatic water buffalo, or carabao. Another topic of discussion involved the availability of employment or opportunities for employment related to conservation measures for island residents.

The Mayor's Council was asked to help solicit input from the public through a series of three village meetings. They were asked to provide a venue for public meetings within their respective villages, and to garner interest from residents in attending the meetings. Meetings were held at village recreation centers or mayors office. The island was divided into three regions (north, central and south) to facilitate attendance.

An announcement was placed in the village mayor's news section of the local newspaper notifying the public to the dates, times, and locations of the three meetings. The meetings were held in the villages of Dededo on December 13, Yona on December 15, and in Sinajaña on December 16. Sign-up and comments sheets were placed at the entrances of each of the venues. A short PowerPoint presentation on the requirements and development of Guam's CWCS was made to those in attendance. Open discussions followed and the public was given information regarding how they could become involved with the development process.

Some of the concerns expressed by the public included:

- The development of village-hotel partnerships in relation to ecotourism.
- The preservation of native forest in relation to game species and concerns about possible limitations of hunting activities in conservation areas.
- The need for more introductions of native bird species and facilities to observe migratory birds during the winter months.
- The need to control the brown treesnake and other invasive species.

Post-GWCS Draft Public Meetings:

As portions of the draft GCWCS were completed the public was invited to review and provide input the on the contents of the draft. The draft GCWCS was available on the GDAWR website at www.guamdawr.org. Comments on the draft could be sent via email to mpwarner@guamdawr.org.

In addition to posting the draft on the GDAWR website, a public meeting was held on September 1, 2005 at the Mangilao Community Center. The meeting date, time and

location were published via the local newspaper and copies of the press release from the Department were sent to the broadcast media. The purpose of the meeting was to inform the public that the draft GCWCS was completed and the review and commenting period had begun. Comments were accepted through September 19, 2005. All comments received on or before this date have been addressed in this final version.

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