



Piti-Masso Watershed Restoration Project

A proposal from
Guam Department of Agriculture,
Division of Aquatic and Wildlife Resources, and
Forestry and Soil Resources Division

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PROJECT SUMMARY

The Piti-Masso Watershed Restoration project will reduce the frequency of ungulate activity within 10 years, reduce habitat modifying weeds and invasive trees within 10 years, reforest five acres of the watershed, two acres of the emergent wetland, and two acres of stream bank with native species within 10 years, prevent the establishment of new invasive and animal species, and reduce the amount of burned native ecosystems to zero and exclude wildland fire. The restoration will enhance the habitat for the Marianas Moorhen (*Pulattat*), *Gallinula chloropus guami*, increasing the quality and function of existing wetlands, reduce the number of invasive species, such as weeds and ungulates, increase native plant species, reduce sediment entering into the Masso Reservoir and into the Piti Bomb Holes Marine Preserves, and promote educational opportunities for the public by participating as a volunteer in identifying invasive species. The restoration project contributes to the overall goal of protecting and restoring Guam's valuable watersheds through the protection of native flora and fauna. The restoration of the Piti-Masso Watershed has been an ongoing partnership with the Guam Division of Aquatic and Wildlife Resources, (DAWR), Forestry and Soil Resource Division (FSRD), Guam Coastal Management Program (GCMP), Guam Environmental Protection Agency (GEPA), and The Nature Conservancy (TNC).

Introduction

Guam, a U.S. territory located at 13°28' N, 144°45' E, is the southernmost island in the Mariana Archipelago and the largest island in Micronesia, with a landmass of 560 km². The northern portion of the island is a limestone plateau, rising nearly 200 meters above sea level in some places, which overlies rock of volcanic origin (Lander 1997). The southern half of the island is old weathered volcanic material with a cap of limestone most prominent on the Mt. Lamlam-Alifan ridge (Fosberg 1960). The highest point of the island is Mt. Lamlam, in the south, an elevation of 406 meters. The grasslands and ravine forests characterizes the vegetation in the south (Fosberg 1960). Wetlands are also an important habitat type occurring in the south.

Guam has a tropical climate, with average daily temperatures ranging from 24-30°C (75-86°F). The average annual rainfall is 218 cm (86 in) (National Weather Service, <http://www.prh.noaa.gov/guam/normal.html>, Accessed 1/24/05). The island has a wet and a dry season. The wet season runs from June to November and the dry season from January to April, with December and May being transitional months. During the wet season, humidity is high and weak southerly or southeasterly winds occur.

In contrast, during the dry season, humidity is relatively low and the island experiences northeasterly trade winds (Engbring and Ramsey, 1984). Humidity ranges from 65-90%. Typhoons can occur anytime of the year, but are more common during the wet season (NOAA 1982). Under natural conditions, Guam hosted a rich diversity of terrestrial and aquatic species. Over 100 species of birds have been documented on the island including migrant, wetland, seabird, grassland, and forest birds (Reichel and Glass 1991, Engbring and Fritts 1988). Three native mammals were also known to Guam, including the Marianas fruit bat, little Marianas fruit bat and Pacific sheath-tailed bat, although the Marianas fruit bat is the only extant species. There are six native reptiles, five skink species, and one gecko species are still found in the wild. Several native tree snail species still exist in low numbers on Guam. Two species of snails, *Samoana fragilis* and *Partula radiolata*, have been on the candidate list of the Endangered Species Act (ESA; 1973) for more than 10 years and currently do not receive federal protection. Guam has more than 320 native plant species of which six deserve greater attention, but unfortunately only one, *Serianthes nelsonii*, is eligible for funding under the ESA. In addition, Guam's marine environment includes more than 5000 known species (Paulay 2003).

Above Top: Tataga or unicornfish (*Naso unicornis*)

Above Middle: Soft coral (*Simularia*)

Above Bottom: corals in Piti Bomb Holes Marine Preserve





The island possesses a variety of terrestrial habitats, including limestone and ravine forests, savanna, and strand vegetation. One hundred named rivers are found in the southern part of the island, along with 2 man-made reservoirs (Best and Davidson 1981). Marine habitats include fringing, patch, submerged and barrier reefs, offshore banks, seagrass beds, and mangroves. The combined area of coral reef and lagoon is approximately 69 km² in nearshore waters between 0-3 nmi, and an additional 110 km² in waters greater than 3 nmi offshore (Hunter 1995). Sea surface temperatures range from about 27-30°C, with higher temperatures measured on the reef flats and in portions of the lagoons (Paulay 2003a).

Given its small size, the entire island of Guam has been designated, both locally and federally, as coastal zone. This gives resource managers the authority to incorporate all aspects of the watershed in terms of planning, funding, and implementing management actions. Guam is divided into 19 watersheds in the southern half of the island. These areas are defined by hydrologic unit boundaries based on a 14-digit sub-watershed level (typically 10,000 to 40,000 acres, with a minimum of 3,000 acres) developed by NRCS in coordination with the USGS system developed for larger drainage areas (Guam Clean Water Action Plan, 1998). The Northern Guam sub-watershed was defined in the Guam Clean Water Action Plan (1998) as an area that has no clearly defined drainage ways, composed of a shallow soil layer over permeable limestone, with little or no runoff. This sub-watershed has been further delineated into sub-basins as more complete data on the flow of water through the northern aquifer become available.

Over the last 50 years Guam has experienced tremendous domestic growth and suffered significant environmental degradation island-wide. Guam's native flora and fauna have been impacted by various threats, such as the introduction of invasive species, poor land management practices, and overexploitation. These anthropogenic threats are exacerbated by the frequency with which the island is impacted by typhoons. In the last decade, Guam has been hit directly by four storms with sustained winds greater than 150 miles per hour and suffered high wave and winds from large systems passing near Guam (Guard et al. 2003). The various resource agencies of the Government of Guam continue to address these issues, knowing that economic prosperity and preservation of the Chamorro culture are dependent on the successful recovery and sustainable use of the island's natural resources.



Partners:

GDAWR – Guam Division of Aquatic and Wildlife Resources, Government of Guam

GCMP – Guam Coastal Management Program

GEPA – Guam Environmental Protection Agency

FSRD – Forestry and Soil Resources Division, DOA

TNC - The Nature Conservancy

Above left:
Hotels in Tumon Bay

Above: Brown tree snake

In southern Guam, a mountain ridge running along the western coast creates small, steep watersheds to the west and broader floodplains draining into longer, larger rivers to the east. Of Guam's 100 named rivers and streams are located in the southern half of the island (Best and Davidson, 1981), forty-six drain into the ocean. The largest of these, the Talofof, drains an area of approximately 72.84 km² (~18,000 acres) (Best and Davidson 1981).



The project is located in the Piti-Masso Watershed on the central western coast of Guam (Figure 1).

Conservation Targets

The majority of native-dominated ecosystems, natural communities, have been decimated through wildfires, ungulates and invasive species. Masso is habitat for one of Guam's native bird species the Marianas Moorhen (Pulattat) *Gallinula chloropus guami*.



The native forest and wetlands in Masso are threatened by invasive species, the aim of this project proposal is to restore the native vegetation and plant species in the wetland areas. Protecting the Moorhen habitat through the restoration of native forests and wetlands. The project will also impact the reservoir by decreasing the amount of sedimentation flowing into the reservoir. The reservoir plan is to stock it with Flagtail (locally known as Umatang) *Kuhlia rupestris*.

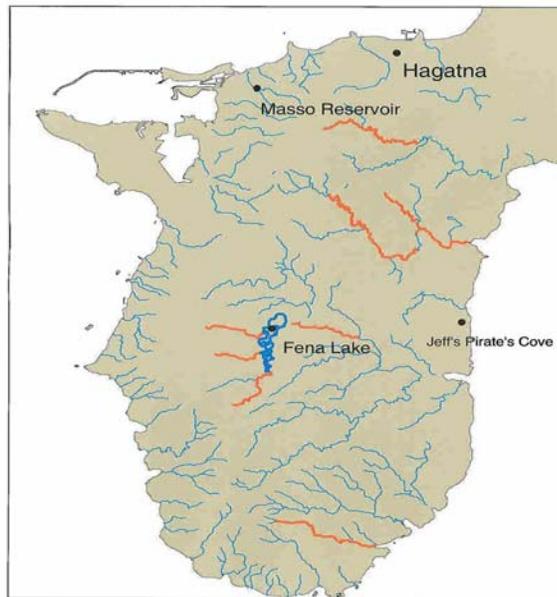
The decrease in sediment will also impact the Piti Marine Preserve area and address some of the land based source of pollution affecting the corals in the marine preserve. (See photo below)



Project location



Figure 1. Map of Guam showing project location.



Critical Threats

All of the conservation targets are impacted by multiple threats, which act together to alter their viability.

Based on information from surveys, monitoring, and personal observations over the last several decades, we ranked the main threats for each conservation target in Masso. Our highest ranking critical threats are:

- 1) Established Non-Native Ungulates
- 2) Established Habitat-Modifying Weeds
- 3) Invasive Plant & Animal Species
- 4) Wildfires

This suite of threats has direct impacts in Masso. Non-native ungulates eat native vegetation (which evolved in the absence of large herbivores) and cause severe soil disturbance. Weeds compete for habitat and other resources with native species and spread more easily with ungulate disturbance. Invasive species, like the African Tulip are well established in Masso. Wildfires have changed the very character and composition of native ecosystems in Masso.

The suite of high ranking threats above also indirectly affects freshwater and marine ecosystems. Severe overgrazing by ungulates coupled with wildfires destroys soil-holding vegetation and causes severe erosion. Resulting sedimentation adversely affects aquatic biota, especially coral reefs.



Wildfire frequently burn in Masso.



Chain of Love Vine. Currently growing in out lying areas of Masso.



The weedy and highly invasive *Clerodendrum quadriloculare*



This feral pig is 1 of the 2 non-native ungulate species affecting Masso.



The size of the native forests has been greatly reduced due to wildfires and have been converted to grasslands.

Invasive species are now the dominant plant community in Masso. Shown here are *Luceana* and the African Tulip.



Conservation Goals & Objectives

Our overall conservation goal in Masso is to: Restore the watershed and wetland areas to native ecosystem.

Enhance the viability of each conservation target.

In particular, we intend to improve the landscape context, condition, and size of native ecosystems by abating or eliminating their most critical threats.

To address the urgent and pervasive threats, we identified four threat-reduction objectives.

The objectives below are the agreed upon focus of our work in Masso, and they will serve as the basis for measuring our success (see **Measures and Monitoring**).

Description of Landscape Context, Condition, and Size

LANDSCAPE CONTEXT
An integrated measure of two factors: 1) the dominant environmental regimes and processes that establish and maintain the target and 2) connectivity.
CONDITION
An integrated measure of the composition, structure, and biotic interactions that characterize the target.
SIZE
Size is a measure of the area of the target, i.e., its geographic coverage. Minimum dynamic area, or the area needed to ensure survival or reestablishment after a natural disturbance, is another aspect of size.

Objective 1	Within 10 years, reduce the frequency of ungulate activity to in areas with active ungulate control programs.* Reduce or contain (as appropriate to specific species) the range and/or density of habitat-modifying weeds and invasive trees within selected management units.
Objective 2	Within 10 years reforest with native species the Masso watershed and restore the wetland areas identified with native plant species.
Objective 3	Prevent the establishment of new invasive plant or animal species both terrestrial and aquatic in Masso.
Objective 4	Within 5 years, reduce the amount of burned native ecosystems to zero and exclude wildfire in Masso.

* Because of the difficulty in counting ungulates directly, we measure ungulate “activity” as a substitute. To establish activity levels, we record the level of ungulate sign, e.g., ground diggings and fecal matter. The 10% annual activity level for ungulates was determined by the Moloka`i Hunter’s Working Group (MHWG) in 1999. The MHWG consists of community members and staff of The Nature Conservancy of Hawai`i, the State Division of Forestry and Wildlife, and National Park Service. There is no quantitative evidence to indicate that 10% represents a biologically significant threshold.

Conservation Strategies

We designed four strategies to achieve our conservation objectives in Masso, all of which emphasize working with partners. Each conservation strategy directly addresses one critical threat and often indirectly addresses another (e.g., strategies to control ungulates will likely stem the spread of weeds). Each strategic action below is comprised of several action steps with varying time frames.

Strategic Action 1 – Ungulate Control

Continue to develop and implement a comprehensive ungulate control program .

Primary Action Steps:

- Expand acreage managed for ungulate control
- Employ new tools to further reduce unacceptable activity levels in currently managed areas
- Continue to engage the local community and the Watershed Partnership in control efforts
- Construction of a exclusion fence in areas to be planted.

Strategic Action 2 – Integrated Weed Management

Develop and implement a 5-year comprehensive and integrated weed management plan for the landscape.

Primary Action Steps:

- Create whole-landscape distribution maps of key weed species
- Prioritize management actions and develop species specific and management area objectives
- Continue highest priority eradication efforts and monitor results
- Test new weed control methods, including bio-control

Strategic Action 3 – GISC Collaboration

Work with the Guam Invasive Species Committee to respond to new introductions and educate the public on reporting new species.

Primary Action Steps:

- Develop and implement an island-wide education & outreach program, including developing a volunteer watch group
- Become more strategic in searching for new invasive species (e.g., initiate surveys at likely points of entry)
- Investigate and respond to new sightings

Strategic Action 4 – Collaborative Fire Management

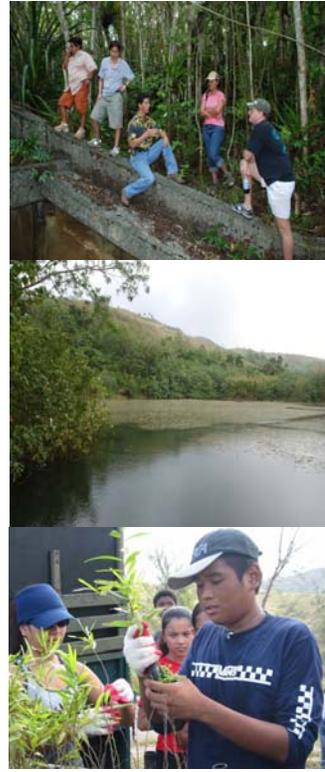
Work with key fire management partners to develop and implement a landscape fire management strategy and action plan.

Primary Action Steps:

- Form task force to organize partners and develop strategies to achieve better fire suppression
- Secure funding to develop and maintain firebreak infrastructure
- Prescribed fire in surrounding buffer areas to reduce fuel load
- Use “green” firebreaks on periphery

Future Strategies

Future iterations of this Plan will likely yield additional marine-focused strategies, for now, the terrestrial-based strategies should go a long way toward abating the critical threats to the marine conservation targets. We believe additional objectives and strategies will emerge as we learn more about threats to marine systems and potential additional actions to address them.



Above Top: Navy, Dept of Agriculture, tour of Masso.

Above Middle: View of Reservoir. Dredging planned.

Above bottom: Tree planting project.

Measures and Monitoring

The fundamental question facing any conservation project team is: “Are the conservation strategies we are using having their intended impact?” To answer this question, we are collecting data on a number of indicators that gauge how well we are keeping the critical threats in check and, in turn, whether the viability of our conservation targets is improving. At present, a monitoring framework for terrestrial ecosystems has been developed (see below). Indicators for freshwater and marine ecosystems will be developed in the near future.

Overview of Measures Framework for Terrestrial Ecosystems

	INDICATORS
THREAT MONITORING	
1. Ungulate activity	• Frequency of ungulate sign
2. Extent of habitat-modifying weeds	• Acres and density of weeds
3. New invasive plants & animals	• Number of priority incipient, invasive species kept off the island • Number of discovered or reported incipient, invasive species eradicated
4. Extent of wildfires	• Acres of ecosystem burned • Miles of firebreak • Number of hours between reporting & containment
VIABILITY MONITORING	
Landscape Context	
5. Connectivity to native or protected areas	• Percent of ecosystem boundary adjacent to lands managed for threat reduction or biodiversity conservation
Condition	
6. Vegetation canopy condition	• Percent of native canopy cover
7. Vegetation understory condition	• Percent of native understory and/or ground cover
8. Diversity of indicator plant species	• Percent and frequency of native, indicator plant species in understory
Size	
9. Extent of ecosystem	• Acres of ecosystem

Approach

In 2006, the Department of Agriculture obtained ownership of the Masso Reservoir and surrounding land totaling 29.59 acres. The property with its reservoir will be used for public benefit: 1) providing freshwater fishing area; 2) improvement of wetlands; 3) reforestation of a portion of the watershed; and 4) reduce sedimentation into the Piti Bomb Holes Marine Preserve. Once restored, this area will be a showcase for other restoration projects that combine marine, terrestrial, and wetland ecosystems.

Budget

Activity	USFWS Request	Other Sources
Plant 5 acres x \$3500 per acre	\$17,500	\$0
Restore 2 acres of freshwater emergent wetland x 2,500 per acre	\$ 5,000	\$0
Remove Invasive plant species and re-plant with native plants and trees, enhance stream bank 2 acre area	\$ 7,500	\$0
Total =	\$30,000	

How our project addresses the 13 criteria of the USFWS Coastal Wetlands Grant (plus summary worksheet)

1. **Wetlands conservation:** i.e. points determined by percentage of acreage of nationally decreasing or nationally stable coastal wetland types relative to the total project area (Max: 7 points) A total of 7 acres of wetland have been identified around the Masso Reservoir. This includes 2 acres of riverine wetland and 2 acres of emergent wetland.
2. **Maritime forests on coastal barriers:** i.e. need to describe forest in sufficient detail for reviewers to assess if it meets the definition in the FRN (Max: 7 points) The project will not have any effect on maritime forests or coastal barriers.
3. **Long-term conservation:** i.e. project must provide at least 20 years of conservation benefits to be eligible (Max: 7 points, if project protects area in perpetuity) The parcel of land the reservoir is on was given to the Department of Agriculture in 2006. This project is meant to be a permanent resource for the people of Guam for public benefit.
4. **Coastal watershed management:** i.e. does project contribute to existing watershed management plan (Max: 3 points) - include the Masso Reservoir Restoration Project, the Coral Reef Initiative Local Action Strategy focused on Piti Bomb Holes and the adjacent watershed, and Guam's Comprehensive Wildlife Conservation Strategy.
5. **Conservation of threatened and endangered species** (Max 5 points) – This project will contribute to the achievement of objectives identified in the recovery plans of the Mariana common moorhen (*Gallinula chloropus guami*), green turtle (*Chelonia mydas*) and hawksbill turtle (*Eretmochelys imbricata*).

6. **Benefits to fish** (Max 5 points) - This project will contribute to the enhancement of sea grass and coral reef habitats in PBHMP which offer refuge for a wide range of juvenile and adult reef fish. This project will also enhance habitat for native freshwater fish by removing invasive species and removing accumulated sediment from the reservoir.
7. **Benefits to coastal-dependent or migratory birds:** (Max: 5 points) – Migratory birds are known to use Masso reservoir, including stilts, egrets, bitterns, shorebirds, and several species of ducks. This project will enhance and maintain an open water area that will benefit these species.
8. **Prevent or reduce contamination:** (Max: 5 points) – This project aims to reduce the amount of sedimentation entering the waters of Piti Bomb Holes Marine Preserve and the reservoir (that includes the wetland) through replanting 5 acres of upland forest and groundcover by 2020. Additionally, sediment traps will be installed in the Masso River upstream of the reservoir to help reduce sedimentation. Sediment monitors are proposed to be installed in the Masso River downstream of the reservoir. Installation of these devices will allow monitoring of changes in the sediment load as a result of this project.
9. **Catalyst for future conservation** (Max: 4 points) – This project will provide the impetus for future conservation efforts through the purchase of coastal properties in Piti, or consummating conservation agreements where appropriate through easements, etc.
10. **Partners in conservation:** i.e. will project receive financial or in-kind support from private, local, or other Federal interests? (Max: 4 points) The Sportfish Restoration Fund is providing a grant of over \$360,000 to pay for dredging of Masso Reservoir and construction of a fishing platform. Navy will be providing \$235,000 for other reforestation projects in the area.
11. **Federal share reduced:** i.e. in our case, since we are not required to come up with match, do we have any financial support from sources other than the Territory (Max: 5 points).
12. **Education / outreach program or wildlife-oriented recreation:** (Max: 3 points) – This project compliments the Masso Reservoir Restoration Project, which incorporates a recreational fishing component. In addition, the Coral Reef Initiative Local Action Strategy focused on Piti Bomb Holes and the adjacent watershed both have education and outreach components. Department of Agriculture will be working with Guam Public School System and Jose Rios Middle School, located across the street from the reservoir, to incorporate some work at Masso into the science curriculum of the middle school.
13. **Other factors:** i.e. anything unique or valuable about this project? (Max: 4 points) There are currently no freshwater fishing facilities available for the general public of Guam. This project will provide an area for recreational fishing as well as an area to see native and endangered wildlife of Guam. Guam is the largest island on the migratory bird route between Japan and Australia, serving as a resting point for bird migration.

Description of the State Trust Fund

Guam is not required to share the costs of projects under the USFWS Coastal Wetlands Grant program (Federal Register Notice Vol. 67, No. 146).

List of other current coastal actions

The project area was selected to further enhance wetland restoration activities in the vicinity and improve Guam's coral reefs in the area. There are several planned or ongoing conservation efforts, restoration and monitoring projects in the area, including the Guam Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR) marine preserve effectiveness monitoring project, the Piti/Asan Watershed Restoration and Management Enhancement Project, the Masso Reservoir Restoration Project, the Coral Reef Initiative Local Action Strategy focused on Piti Bomb Holes and the adjacent watershed, and the National Park Service sedimentation monitoring project.

Public involvement

This project will be a multi-agency partnership among several Government of Guam agencies including the Guam Department of Agriculture, the Guam Coastal Management Program, the Guam Environmental Protection Agency, the Department of Land Management, Department of Education, and the Piti Mayor's Office. Additional non-governmental partners include The Marianas Audubon Society.

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Appendix A. Viability Assessment of Conservation Targets in the Piti-Masso Watershed *

Conservation Targets		Landscape Context	Condition	Size	Viability Rank
		Grade	Grade	Grade	
1	Reef fish	Fair	Fair	Fair	Fair
2	Sea Grass	Good	Fair	Fair	Fair
3	Coral Reef Ecosystem	Fair	Fair	Fair	Fair
4	Native forest	Poor	Poor	Poor	Poor
Project Biodiversity Health Rank					Fair

* Based on our current understanding of the health of the conservation targets and their threats.

Appendix B. Overview of Threats, Piti - Masso Watershed *

Threats Across Targets		Reef fish	Sea Grass	Coral Reef Ecosystem	Native forest	Overall Threat Rank
<i>Project-specific threats</i>		1	2	3	4	
1	Invasive species	-	-	-	Very High	High
2	Wildland fires	-	-	-	Very High	High
3	Poor Land Use Practices	-	Medium	High	High	High
4	Recreational use	-	High	High	-	High
5	Artificial food supply	High	-	-	-	Medium
6	Illegal fishing	High	-	-	-	Medium
7	Stormwater runoff	-	-	High	-	Medium
8	Urban development	-	-	-	High	Medium
9	Degraded habitat	Medium	-	-	-	Low
10	High levels of pollutants	Low	-	-	-	Low
Threat Status for Targets and Project		High	Medium	High	Very High	High

* Based on our current understanding of the health of the conservation targets and their threats.