

# SINUB ISLAND MARINE WILDLIFE MANAGEMENT AREA



## Plan of Management



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on behalf of Riwo Village, Madang Province, Papua New Guinea and the  
**Madang Locally Managed Marine Area Network**

## Summary

The Papua New Guinea Minister for Environment and Conservation officially declared Sinub Island as a Wildlife Management Area (WMA) on the 2nd of May 2000 under the Fauna (Protection and Control) Act (Chapter 154). Sinub Island Wildlife Management Area (SIWMA) was established by the *Azonanen* and *Badinanen* clans (customary owners) of Riwo Village to act as a refuge for marine life and habitats to facilitate stock replenishment and food security for Madang Lagoon. It is also seen as a potential eco-tourism opportunity to generate small revenue for the traditional landowners and the maintenance and management of their island.

SIWMA covers the fringing reefs of Sinub Island, which is roughly central to Madang Lagoon, Papua New Guinea. Sinub island reefs are of international, national and local significance in terms of marine biodiversity. The reefs of SIWMA contain several endemic fishes, several globally endangered species, exceptionally high diversity in most marine biota, exceptionally high soft coral cover and several sites of cultural significance.

This plan of Management sets out strategic objectives, management goals and management strategies to ensure that the natural resources of this remarkable area receive an appropriate level of protection. The plan also provides detailed information on existing natural and cultural resources of the island for resource managers. This WMA is being managed as part of a developing network of locally managed MPAs along the north coast of PNG. This plan will be reviewed annually to assess the performance of the management regime, make necessary changes and add updated information regarding the site.

The direct management authority and responsibility lies with the Sinub WMA committee who are elected the by local landowning community. Monitoring, technical and logistical advice and assistance are currently being provided by the international conservation NGO Wetlands International – Oceania. The regulations and prohibited activities within Sinub WMA are set by the landowners and, under government declaration, have the full force of law.

## **Acknowledgements**

Special thanks must be given to Mr. Paul Led for his continued dedication to marine survey and fieldwork and conservation advocacy for Riwo Village. We must also thank the continued logistical and moral support of Aquaventures Ltd and the Papua New Guinea Diving Association for assistance in putting mooring pins in around Sinub. Thanks also to Mr. Leon Cama of WWF-South Pacific for his help with maps and design. The continued support of the Bismark-Ramu group in community advocacy has also helped make this work possible. Over the years, training, monitoring, survey and technical work at Sinub Island has been made possible by grants from New England Biolabs Foundation, Oak Foundation, Evian and World Wildlife Fund. The current work being done at Sinub (including the preparation of this plan) and around Madang Lagoon is being funded by the Keidanren Nature Conservation Fund.



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## **1.Introduction**

Sinub Island is a small, coral rubble island located roughly central to the highly heterogeneous reef system of Madang Lagoon within Madang Province on the north coast of Papua New Guinea. Madang Lagoon is under customary ownership and is divided between five major village groups. Sinub Island is owned and managed by the *Azonanen* and *Badinanen* clans of Riwo Village. The Papua New Guinea Minister for Environment and Conservation officially declared Sinub Island as a Wildlife Management Area (WMA) on the 2nd of May 2000 under the Fauna (Protection and Control) Act (Chapter 154). Under this Act, there are provisions for protected areas and animals using WMAs on land held under customary ownership. This Act also provides for the establishment of wildlife management committees to administer the WMAs thereby giving control of resource use and management directly to customary landowners. Sinub Island Wildlife Management Area (SIWMA) was established primarily to act as a refuge for marine life and habitats to facilitate stock replenishment and food security for Madang Lagoon. It is also seen as a potential eco-tourism opportunity to generate small revenue for the traditional landowners and the maintenance and management of their island. The location of SIWMA within PNG and Madang lagoon is indicated in Figure 1.

The boundaries of the SIWMA are shown in Figure 2. The total area of the SIWMA is 11.8 hectares and the declaration includes all of the land included in the boundary and all of the fringing reefs of the island to a depth of about 35 meters. A copy of the declaration of the Wildlife Management Area is presented in Attachment 1.

This plan of management for SIWMA is designed to describe the past, present and future protection and use of Sinub Island. It gives a background to the establishment and management of SIWMA and plans for future integration into a network of locally-managed MPAs and a broad coastal zone management strategy for Madang Lagoon. The plan details the unique natural and cultural resources of SIWMA. It also outlines the major pressures and threats to the integrity of the ecosystems within

SIWMA and outlines the actions already taken or proposed to address these threats. The plan also outlines the rules/regulations and penalties for the WMA that were decided by the local land-owning community. These regulations have the full force and effect of the law as provided for in Fauna (Protection and Control) Act (Chapter 154)

This management plan, as agreed by the SIWMA Committee, will be reviewed on an annual basis by the Committee to update information contained within and to provide for regular evaluation of the status of the WMA and management effectiveness.

## **2. Management Authority**

Papua New Guinea has a unique land tenure and ownership system based on clan groups. Except for land that has been acquired through the National Land Act (1981) for government purposes and land that has been acquired by commercial business enterprises, virtually the whole country is under traditional land tenure systems. In certain island and coastal communities where large fringing reefs occur, these reefs are considered to be extensions of the land and are claimed as customary land. The *Azonanen* and *Badinanen* clans of Riwo Village customarily own Sinub Island and its fringing reefs.

After concerns over declining fish stocks, elders of *Azonanen* and *Badinanen* clans held meetings with the community in mid-1997 and collectively decided to set Sinub Island as a tambu (taboo) area in the form of a Wildlife Management Area (WMA). The WMA concept recognizes customary land ownership, places landowners in direct control and is the primary form of legal protected area in Papua New Guinea. The landowning clans sat and elected a Sinub Island WMA management committee and decided on rules, regulations and penalties for the WMA on 16<sup>th</sup> July 1997. The Sinub WMA committee, elected to represent the two clans and the broader Riwo community, has primary responsibility to enforce these

rules. Rule violators are taken to Village Court and, if unresolved, are taken to District Court.

The Sinub Island Wildlife Management Area was declared a category III Wildlife Management Area (WMA) on the 2nd of May 2000 under the Fauna (Protection and Control) Act (Chapter 154). The direct management authority and responsibility lies with the Sinub WMA committee. An agreement with a commercial dive tour operator in Madang (see Attachment 3), places some management responsibility of the WMA with the local operator. Monitoring and technical advice is currently being provided by the international conservation NGO Wetlands International – Oceania.

### **3. Strategic objectives**

The strategic objectives for Sinub Island Wildlife Management Area are derived from community discussions held in early July 1997 prior to formulation of rules and regulations for the WMA:

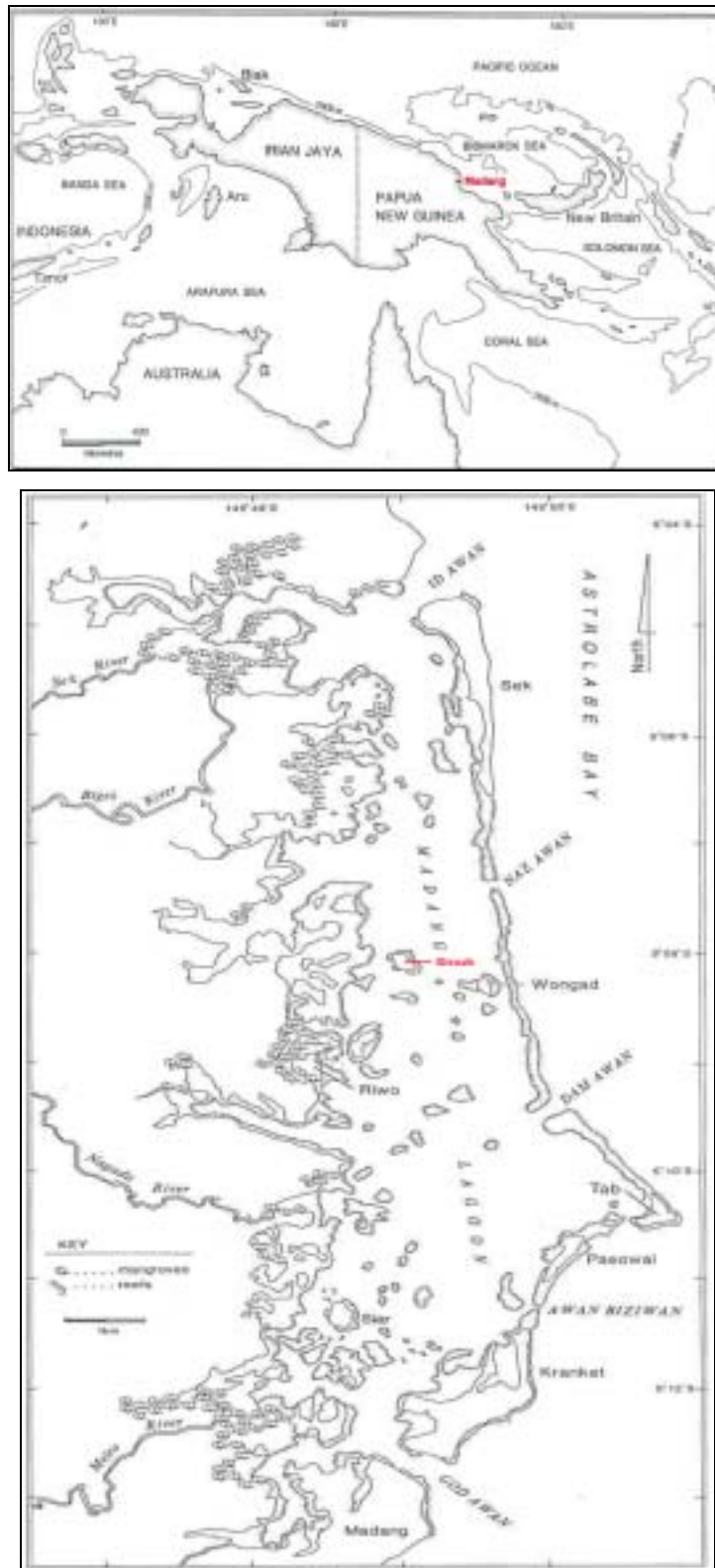
Objective 1: to protect, conserve and manage the wildlife in the marine WMA to help ensure food security for future generations;

Objective 2: to ensure the preservation of Sinub Island coral reefs in their natural condition, including objects and sites of biological, historical, paleontological, archeological, geological and geographical interest;

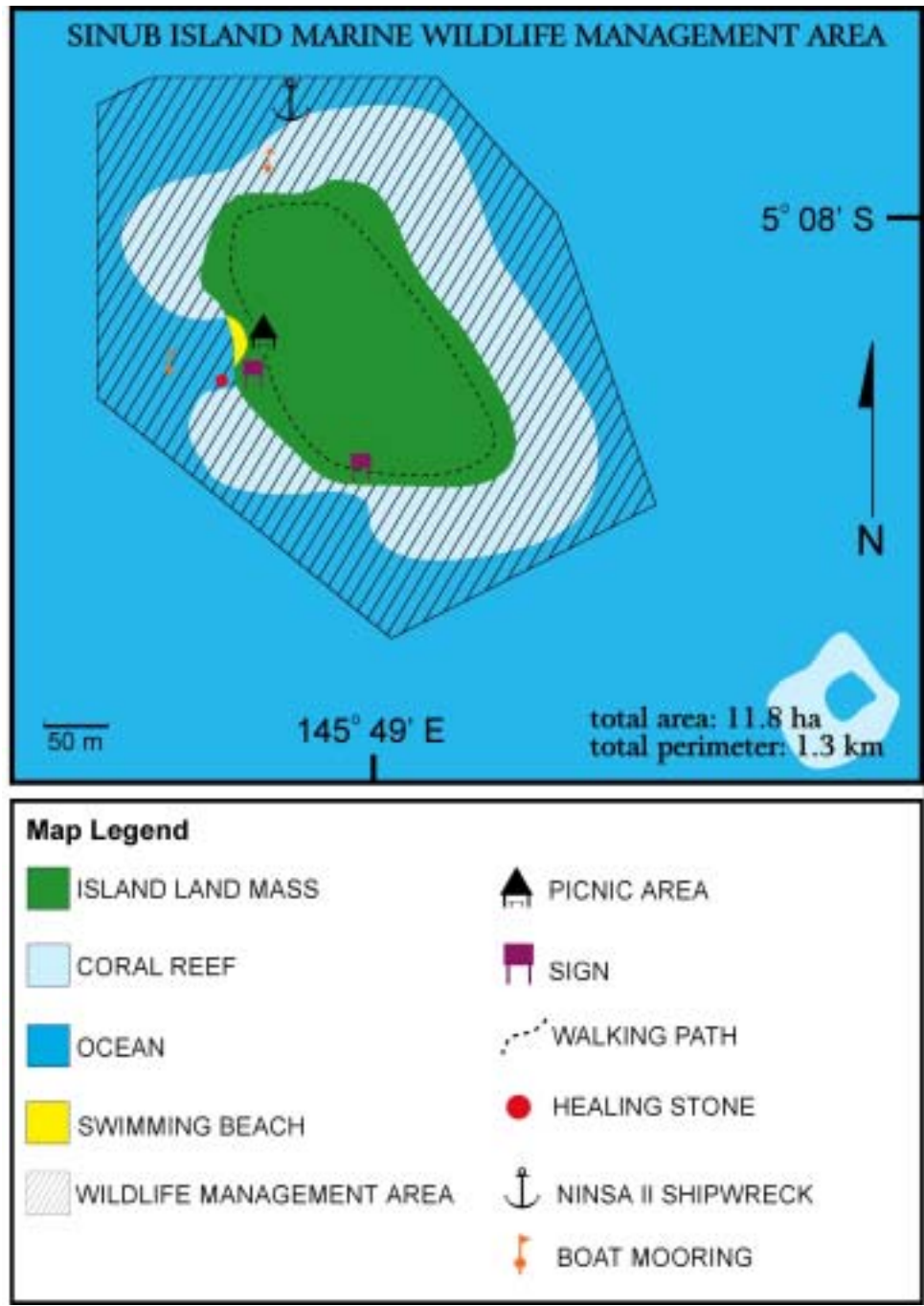
Objective 3: to encourage and regulate the appropriate use, appreciation and enjoyment of the marine WMA;

Objective 4: to manage the area as part of a comprehensive and representative system of locally managed MPAs to contribute to the long-term ecological viability of marine and estuarine systems.

#### 4. Sinub Island Marine Wildlife Management Area – A Description



**Figure 1.** Location of Sinub Island in Madang Lagoon, Papua New Guinea



**Figure 2.** Boundary and major features of Sinub Island Marine Wildlife Management Area

#### **4.1 Location**

Sinub Island is a coral rubble island located approximately in the center of Madang lagoon, the largest lagoon system along the north coast of Papua New Guinea (Figure 1). The exact boundary description of the Sinub Island Wildlife Management Area giving GPS positions is shown in Attachment 1. On the southern end of the lagoon is the entrance to Madang Harbor. Madang town is the provincial capital of Madang province and is a major port for the country and home to about 25,000 people. Five major village groups, of which Riwo Village is the largest, occupy the rest of the lagoon. Sinub Island WMA is located approximately 8 kilometers directly North of the entrance to Madang Town harbor.

Madang lagoon is about 16 km long and 4km wide (40 km<sup>2</sup>) and is bordered on the seaward edge by a thin barrier reef that drops to 400 m depth within 1 km of the reef. Within the lagoon the bottom is a constant 30 – 40 m depth apart from numerous patch reefs and coral islands that slope steeply (20° –30°) to the lagoon floor. The inner coastline contains several deep harbors and fringing reefs from between 10 – 50 m wide. There are two major river inlets within the lagoon, the Biges River at the northern end and the Wagol River at the southern end.

#### **4.2 Climate**

The climate is hot, humid and wet throughout the year. Rainfall varies from around 2500 mm in dry years to 4500 mm in wet years and local weather is strongly influenced by the El Nino Southern Oscillation (ENSO) event (Jebb and Lowry, 1995). Madang lies in the region of the NW monsoon (January – April rainfall maxima) and commonly experiences thunderstorms. Temperatures are generally stable throughout the year between 25°C and 32°C.

### **4.3 Geology and Geomorphology**

The north coast of PNG is at the boundary of the colliding Australian and Pacific plates, resulting in the steep relief of the rapidly uplifting Finisterre and Adelbert Ranges and the active and recently active offshore volcanoes (eg. Manam, Karkar, Long Islands). Madang lagoon is a unique structure on this coast. The Madang Land System is narrow coastal plains with shallow coral limestone and alluvial soils (Robbins 1976) Geological mapping has identified the coast North of Madang as Quaternary alluvium, including raised reefs and other coral deposits.

Like many of the islands within the lagoon, Sinub consists of a reasonably uniform terrace of generally unrecrystallized coral reef material 1 to >2 m above sea level. The one beach, intertidal and subtidal shelves and fringing reefs are generally narrow. The leeward (SE) side of Sinub Island is a growing face of sand and *Halimeda*-flakes, sloping gently away from the reef. The windward side of the island is a shallow fringing reef, (NW) dropping abruptly to a deeper sand slope similar to mainland fringing reefs. At the base of the windward fringing reefs coral rubble dominates and gradually becomes a thick layer of silty clay that supports a rich burrowing fauna (Jebb and Lowry, 1995).

### **4.4 Oceanography**

A body of moving water called the New Guinea Coastal Undercurrent (NGCU) dominates the oceanography of the northern New Guinean waters. The NGCU carries water from the Solomon Sea through the Vitiaz Strait and along the coastal region. The current has a maximum speed of 40 – 70 cm/ second (approximately 2 kmph) at a depth of about 200 m. The NGCU is a permanent feature of these waters despite reversals in winds and surface currents during the North West Monsoon. This water characteristically has high salinity, low tritium and high oxygen concentrations (Tsuchiya et al , 1990). It originates in the surface high – salinity cell centered around the Tropic of Capricorn in the South Pacific where it

submerges and flows WNW in the South Equatorial Current. This westward moving current hits the Australian coast at about 18° S where it bifurcates, with the northward-moving branch eventually becoming the NGCU. On the Madang coast, this westward moving current generates a clockwise gyre in Astrolabe Bay.

Between June and August, South-East trade winds generate surface currents along the North coast that flow west to east; in the same direction as the subsurface NGCU (Lukas, 1986). However, during the North-West Monsoon (generally between December – March), an eastward moving surface current is generated that induces upwelling along the coast. Upwelling is a term that describes the movement of water from deeper levels to the surface, a phenomenon that may be induced by several factors including offshore winds or where surface currents move in opposite directions. The upwelling water is of low temperature, high salinity and low tritium concentration (Colin et al, 1974), strongly suggesting derivation from the NGCU. It also gives rise to the high fertility of the Astrolabe Bay region (Colin et al, 1974). During the monsoon period the thermal structure of the coastal waters also clearly reflects coastal upwelling (Lukas, 1986). The onset of upwelling has been observed in Nagada Harbor in Madang Lagoon where the NW monsoon has been correlated with the distinct and rapid reduction in surface water temperature (Christensen Research Institute, Madang, unpublished data).

The surface sea temperatures on the north of New Guinea are among the highest known. Sea surface temperatures are on average around 28°C with surface temperatures within the lagoon often exceeding 30°C . The mean water temperature is about 28.3° C on the inner edge of the lagoon with temperatures on the outer edge about 0.5° C cooler. There is generally a slight swell within the lagoon on even the calmest of days and wave heights range from about 0.3 to 1.5 m. From 3 - 5 m depth, surge is apparent on even calm days and can be felt in 10-12 m of water in heavy seas. Currents within the lagoon appear to be predominantly tidal and can be quite fast at around 1 knot in some locations.

Visibility is generally poor by tropic oceanic standards. Visibility around Sinub Island ranges from 5 m –15m on average and very rarely exceeds 20m. During the height of the rainy season 6 - 8 m visibility is the best to be expected. Visibility is the worst when flood plumes from the Gogol River are swept into the lagoon from the Bismarck Sea. Surface salinities are variable but generally around 33-35 ppt. It appears as if, during the rainy season, the Meiro River creates a plume of low-salinity surface water and suspended particulate matter extending northward up the East side of the lagoon. After heavy rains, terrigenous debris including logs is commonly carried into the lagoon. Turbidity is much higher after heavy rains and surface salinities are depressed especially in the inner parts of the lagoon as a lens of fresh water several centimeters thick forms on the surface. Surface salinities will generally rise during warm, still surface conditions.

Tides are primarily diurnal with a small semidiurnal component; spring tide ranges are around 1m , neap tides about 0.3m and tidal flats are absent. Corals only appear above water on 1 or 2 days of the year. There is no evidence of tropical cyclone activity in the Bismarck Sea region. This implies that storm waves or surges are not a major factor in coastal geomorphology, but Miklou [c]ho – Maclay (1884, 1975) reported locally damaging tsunamis.

#### **4.5 Water Resources**

Sinub Island does not have any freshwater resources of its own. The closest river inlet is Nagada River about 3.5 km south of the island. There are two major river inlets within the lagoon, Biges River on the extreme north and Meiro on the extreme south. These rivers carry silty water throughout the lagoon after heavy rains. However, this silt-laden water generally leaves the lagoon quickly and doesn't mix appreciably. Several other minor inputs occur, but in relative terms, the catchment behind the lagoon is small. The watershed is around six kilometers inland (Jebb and Lowry, 1995)

## **4.6 Biological Values**

Sinub Island Wildlife Management Area is directly central to Madang Lagoon, which is considered to be one of the most biologically diverse marine sites in the Asia Pacific region (Pandolfi, 1992; Hunnam et al, 2001). Wetlands International-Oceania has been studying the fringing reefs of Sinub, in conjunction with reef monitoring in Madang Lagoon, over the last four years. This research has resulted in detailed, species-level fish population data and benthic data at a form level. Other information on the biota of Sinub Island is generally lacking and is garnered from WI-O field notes and inferences from other regional or local studies.

### **Flora**

There have been no specific studies on the marine flora of Sinub Island fringing reefs. Some of the commonly encountered green algae include; *Caulerpa racemosa*, *Halimeda maculosa*, *Halimeda micronesica*, *Halimeda opuntia*, *Velonia ventricosa* (Jenkins, 1999). Scattered stands of the sea grass *Enhalus acoroides* are also present, primarily on the lee side of the island. Other sea grasses recorded in the vicinity of Sinub Island are *Cymodocea serrulata*, *Halodule uninervis*, *Halophila ovalis* and *Thalassia hemprichi*. These beds support a diverse holothurian fauna (18 species) (Pearse, 1988). Algae cover currently accounts for approximately 37.7 % of the benthic cover of Sinub Island fringing reefs (Jenkins, unpublished data) and is dominated by an unidentified filamentous blue-green algae that lives on dead coral and dead coral rubble.

### **Fauna**

The faunal studies of Sinub Island have focused on the reef fish communities (Jenkins, 1999) in accordance with management requests from the Riwo community. Other information on the fauna of Sinub Island is lacking and details come from field notes (Jenkins, 1999-2001) and inferences from other Madang Lagoon studies (see

Bibliography). These studies collectively show a rich and diverse fauna that is internationally, regionally and locally important in terms of biodiversity conservation and food security.

## **Fishes**

The biodiversity of reef fish fauna within Sinub Wildlife Management Area is of high global, national and local importance. The island fringing reefs contains at least three endemic reef fishes including the Blackstripe blenny (*Meiacanthus vittatus*), Collette's blenny (*Ecsenius collettei*) and the Whitespot damselfish (*Pomacentrus albimaculatus*) and at least one globally endangered fish, the Humphead wrasse (*Cheilinus undulatus*). To date, 447 species of reef fishes have been recorded on the fringing reefs of Sinub Island . This constitutes about half (49%) of the predicted total diversity of 908 reef fish species for Madang Lagoon (Jenkins, 1999). To put this level of species diversity in global perspective, it is helpful to look at an index called the Coral Reef Fish Diversity Index (CFDI) that is a rating system based on the number of species present in the following six families: Wrasses, Damselfishes, Butterflyfishes, Angelfishes, Parrotfishes and Surgeonfishes. These families are very good indicator groups of reef fish diversity and are taxonomically well documented (Werner and Allen, 1998)

**Table 1.** Coral Reef Fish Index (numbers of species) for Sinub WMA fringing reefs compared on local, regional and global scales.

<b>Family</b>	<b>Sinub WMA</b>	<b>Madang Lagoon*</b>	<b>Indo-West Pacific</b>	<b>Worldwide</b>
Wrasses	62	78	350	402**
Damselfishes	56	84	274	330
Butterflyfishes	27	34	105	122
Angelfishes	8	15	69	82
Parrotfishes	18	23	64	83
Surgeonfishes	20	25	63	71
<b>Total (CFDI)</b>	<b>191</b>	<b>259</b>	<b>925</b>	<b>1090</b>

\*combined species lists of Allen and Jenkins

\*\* tropical species only

From a global perspective, this data suggests that Sinub WMA contains 17.5 % of the world's species, 20.6 % of the species in the Indo-West Pacific and 74.6 % of Madang Lagoon's species diversity within these six globally important reef fish indicator families. These figures highlight the importance of the area for marine conservation as very few known locations, apart from some sites in Papua New Guinea and Indonesia, contain such a concentrated biodiversity of reef fishes (Allen, 1998). A complete species list for Sinub Island WMA is included as Attachment 3. Detailed longitudinal abundance data, collected in conjunction with reef monitoring, is available on 250 + species over 4 years for the WMA. Summaries are presented in Attachment 4.

### **Corals**

Sinub is likely to have exceptional coral species diversity on a global scale. Although there have been no species-level inventories of corals on Sinub Island fringing reefs, Sinub lies in the middle of Madang Lagoon and Madang Lagoon lies

within the global center of coral species diversity, sometimes referred to as the “coral triangle.” Estimates of coral species diversity for Madang lagoon are as high as 700 species (Potts, personal communication), which is exceptionally higher than the estimated 343 species in the Great Barrier Reef, or even the 420 species in Milne Bay, PNG (Werner and Allen, 1998).

Sinub Island fringing reefs contain among the highest and least damaged live coral cover in Madang (Jenkins, 2000). In association with monitoring in Sinub WMA, coral forms and percentage cover have been recorded (English et. al., 1994) for four years. Live coral currently covers approximately 45.6% of the fringing reef of SIWMA (see Attachment 5). Hard reef-building corals make up 25.8% of the coral cover. Branching *Acropora* and large *Porites* coral heads are most common in more stable areas. Often the steeper drop-offs contain large tabulate *Acropora*, *Montipora* and *Anacropora*. Sinub WMA is likely to have among the highest level of soft coral coverage in the lagoon. Soft corals are still well represented (19.8% of total reef cover) even though, prior to a coral bleaching event in 2000, estimates for soft coral cover were as high as 32.9 % (Attachment 5). *Xenia* is most common but other genera such as *Sinularia*, *Tubipora*, *Briarium*, *Sarcophyton*, and *Lemnalia* can also be found in abundance. Spectacular Sea Whip (*Juncella fragilis*) gardens are located on the SE (leeward) fringing reefs. The commonly encountered hard and soft corals are listed in Attachment 6.

## **Echinoderms**

There have been no specific studies of the echinoderms on Sinub Island. Sea Stars are relatively abundant with *Linckia spp.* and *Choriaster grannulatus* among the more common species encountered. Crown-of-thorns starfish, *Acanthaster planci*, exist in very low numbers on Sinub fringing reefs. *Acanthaster* are seen on less than 1% of dives, and never more than 2 individuals per dive. The crown-of-thorns starfish, is widespread if not ubiquitous on PNG reefs, usually at low population densities (Quinn and Kojis 1987). *Diadema* sea urchins are also relatively common in

the shallows. Sinub WMA possesses at least 7 species of holothurian (sea cucumber) including *Bohadschia argus*, *Bohadschia graeffei*, *Thelenota anax*, *Thelonota ananas*, *Holothuria fuscopunctata*, *Holothuria edulis* and *Stichopus variegates*. Pearse (1988) documented 18 species of holothurians in seagrass beds in Madang Lagoon. Holothurians are in relatively low numbers around Sinub and Madang Lagoon in general because of intensive collection for Asian market buyers. Feather stars are in very high abundance and diversity around Sinub fringing reefs as the silty water is perfect for these colorful filter feeders. Some of the commonly seen feather stars are *Colobometra perspinosa*, *Tropiometra afra*, *Oxycomanthus bennetti*, *Himerometra bartschi*, *Comanthina schlegli* and *Cenometra bella*.

## **Molluscs**

At least two species of CITES-listed Giant clams (*Tridacna croacea*, *T. derasa*) are present on the SIWMA fringing reefs in low numbers.

No estimates are available for species diversity or abundance of molluscs around Sinub Island. Diversity of molluscs is exceedingly high on the coral reefs of the Indo-West Pacific. Gosliner et al (1996) estimated that approximately 60% of all marine invertebrate in the Indo- West Pacific are molluscs. No estimates are available of total number of species in any Indo-west Pacific coral reef systems (Wells, 1998). Intensive collections of opisthobranchs (one type of mollusc) in Madang Lagoon produced over 600 species (Gosliner et al., 1996) a number that is virtually unrivalled anywhere on earth. It is relatively safe to say that the diversity of mollusks on Sinub island fringing reefs is high in global terms.

Cephalopods such as Reef cuttlefish (*Sepia latimanus*), Bigfin reef squid (*Sepioteuthis lessoniana*) and Common reef octopus (*Octopus cyanea*) are seen occasionally in Sinub WMA.

## **Crustaceans**

No specific collections or studies have been done of the Crustacea of Sinub Island. Studies of the Amphipoda (Crustacea) of Madang Lagoon, including Sinub Island, revealed an unprecedented 180 species of gammaridean Amphipoda (Jebb and Lowry, 1995). In this context, Sinub is certainly likely to have a high diversity of crustacean fauna. The island has a local reputation for an abundance of the Painted rock lobster *Panulirus versicolor*. Unfortunately, these currently appear to be fished to very low numbers and only a few juveniles are visible. Other crustacean biodiversity indicators such as the Banded Cleaner Shrimp (*Stenopus hispidus*) are relatively common at deeper (> 15m) areas of the reef. Fish lice (Isopoda) are commonly seen on Holocentrid fishes. Also commonly seen are mantis shrimp (*Odontodactylus scyllarus*), snapping shrimps (Alpheidae), cleaner shrimps (Hyppolytidae), symbiotic shrimps (Hyppolytidae), boxer shrimps, hermit crabs (Diogenidae), shore crabs (Grapsidae) and Sponge crabs (Dromidae).

## **Reptiles**

Sinub Island fringing reefs are feeding grounds for the globally endangered (IUCN) Hawksbill (*Eretmochelys imbricata*) and Green turtles (*Chelonia mydas*). Green turtles appear to be locally most abundant on the reefs but both species are only seen occasionally. There are known green turtle and hawksbill rookeries all along the north coast of Madang.

Part of the local folklore about Sinub Island (see Folklore) stems from the local abundance of the banded sea snake, *Laticauda colubrina*. When the island was first gardened, decades ago, villagers killed over 100 sea snakes on the island. Now, these snakes are rarely seen on the island but are commonly encountered in the water on the shallow fringing reefs. Apparently, abundances of sea snakes are much reduced now from their historical levels.

## **Seabirds and Migratory birds**

No studies have been conducted of the seabirds and migratory birds of Sinub Island. Seabirds are generally few in number on Sinub. Small groups of terns (*Laridae*) are sometimes seen around the island.

## **Marine Mammals**

Observations from around Madang Lagoon indicate that the reefs around Sinub Island may be visited by feeding populations of several vulnerable marine mammals including Dugong (*Dugong dugon*), Spinner dolphin (*Stenella longirostris*), Bridled dolphin (*S. attenuata*) and possibly transient pods of Pacific Pilot whales (*Globicephala macrorhynchus*).

## **4.7 Social and Economic Values**

No studies have been carried out on the socio-economic values of Sinub Island to the local resource owners. A full socio-economic and health assessment is planned by Papua New Guinea Institute of Medical Research in 2002 in collaboration with Wetlands International - Oceania. This data will be incorporated into the plan upon annual revision.

Sinub Island is currently uninhabited. Access is by boat only and is limited to private vessels or commercial guided tours. Local uses of the island include collecting coconuts for copra marketing and coconut fronds for building material. There is an abandoned garden in the middle of the island and an abandoned slab from a house that has long since collapsed. Signs declaring Sinub as a WMA are posted on the island and a small shade-house has been erected. A written agreement has been established with a local dive operator (Attachment 2) and a verbal one with a resort (Jais Aben) to begin using the area for recreational diving and snorkeling and some shore-based recreational activities. Fees for access will be collected and

deposited in an account for the Sinub WMA to be used for maintenance of the island. Mooring pins have been installed on both sides of the island. The agreement provides for the establishment of chains and buoys for the mooring pins and a barbecue for visitors. It is beginning to be used for local diving as an alternative to outer lagoon dive sites during particularly rough weather.

### **Recreational activities**

Sinub WMA offers a unique and often spectacular diving experience. The flora and fauna of Sinub Island form a globally unique coral reef community of unusually high diversity and abundance. There are opportunities for both divers and snorkelers to see several locally endemic species and globally endangered fauna. Corals are in relatively pristine condition with spectacular soft coral and whip coral gardens also easily accessible by both divers and snorkelers. Conditions are never rough and even during bad weather the conditions are fine for diving. The wreck of a small ship, Ninsa II, is located on the NW of the island in about 16 m of water. Several very large cod and snapper live in the wreck and can reliably offer “big fish encounters” that divers often desire. The new agreement (Attachment 2) should facilitate an increasing number of diving and snorkeling visitors.

### **Shore-based recreational activities:**

There are also several potential shore-based recreational activities that have gone relatively unrealized. There is a good small beach for swimming with an adjacent shade house for picnicking. A barbecue plate is to be installed on the island for visitors to cook meals. There is also a short walking path around the island. Along this path there is the potential to do both natural history and folklore guided walking tours. Again, the new agreement (Attachment 2) should facilitate an increasing number of shore-based activities.

## **Research**

Sinub WMA offers tremendous opportunities for tropical reef research. Diving and marine laboratory infrastructure is only a 5-minute boat ride away in Nagada harbor. It is currently a site of long term reef monitoring of fishes and corals by Wetlands International – Oceania (WI-O). This WI-O monitoring program has been going for four years. Studies were also conducted around Sinub in 1996 –7 in conjunction with PhD research (Cornell University) on the social systems of the anemone fish, *Amphiprion percula* (Peter Buston, personal communication). There was a request in 1999 by an American bio-prospecting firm to work on the island that was rejected by the Sinub WMA committee.

In consultation with the Sinub WMA committee, the PNG Diving Association, local conservation NGOs, government and other relevant stakeholders, WI-O is trying to develop a sustainable, community-led, long-term monitoring for the WMA to assist with continued management.

### **4.8 Folklore and traditional management systems**

Papua New Guinean coastal communities practice a wide range of traditional land ownership customs and systems of natural resource use. These traditional practices and knowledge are passed on from generation to generation through oral traditions. Overlaying this are the range of recent laws and legislation that provide a modern framework for “good management” principles at the local, community, provincial and national level. Much of traditional ownership and management systems have not been documented mostly because the practice of oral traditions for passing on information to succeeding generations is very much intact, so there is no need for written records (Kolkolo, 2000). Some underlying systems of traditional management are imbedded in local folklore about the area. Here is a short summary of some current popular local folklore about Sinub Island:

Madang Lagoon is inhabited by spirits (*masalai*) of various temperaments and personalities that interact in both helpful and harmful ways with local resource owners. It is said that Sinub Island is inhabited by a relatively mean *masalai* named Milimoyau that can take on a variety of forms. As far as the reef is concerned, people tend to steer clear of the area around where the ship wreck is, as it is thought that the *masalai* spends time living in the wreck and will capsize canoes or bring general misfortune upon those that venture too close. Two of the widely spoken about appearances of the *masalai* in recent collective memory are as a giant two-headed sea snake and a strange man covered from head to foot in thick, dark hair.

Within the last few decades, Sinub Island was inhabited by large numbers of banded sea snakes and most people tended to steer clear because they are deadly poisonous. In recent years the numbers of snakes have been dwindling due to people killing them in fear while gardening on the island. About 10 years ago, one of the island's landowners and his son went to pick coconuts on the island and were terribly frightened when they saw a giant two-headed sea snake wrapped around a coconut tree that was almost as thick as the tree itself! They paddled furiously back to land and told everyone in the village that would listen. There have also been several sightings on Sinub, as recently as five years ago, of a "hairy" man, high in the trees and running around the island. He is apparently completely covered in thick black hair from head to foot. Even prior to the establishment of the WMA there were few visitors to the island, despite its high biological value. These commonly repeated *masalai* stories are part of the reason for the limited usage of the island and the quick community decision to set it up as a WMA.

There is also a stony outcrop in the sheltered sandy area on the SE of the island that protrudes from about 1.5 m of water and sits conspicuously by itself between the main island and the fringing reef. Many people claim that this stony outcrop has special healing powers. It is said that several people have been cured overnight of skin sores and joint and back pain just by touching and swimming in the vicinity of

the stone. Apparently, people still use this stone to cure ailments that are incurable by modern methods.

## **5. Pressures on Sinub Island Marine Wildlife Management Area**

Any natural area subject to human visitation is subject to pressures from human usage or impacts. Table 2 presents an analysis of the main factors with the potential to effect the key values of Sinub WMA. There are also potential pressures from natural disasters, such as large storms, predators, such as crown-of-thorns starfish and global phenomena, such as increased sea water temperatures, which would impact on the values listed. The proposed management strategies focus on those existing and potential pressures caused by human activities that can be influenced by management.



**Figure 3.** North-west Sinub Island Marine Wildlife Management Area

**Table 2.** Major factors with the potential to affect the values of Sinub Island Marine Wildlife Management Area.

<b>VALUES</b>	<b>POTENTIAL PRESSURE on VALUE</b>
<b>i Physical</b>	
1. Water quality	<ul style="list-style-type: none"> <li>- increased sedimentation due to logging/agriculture and catchment development</li> <li>- Pollution: contaminants, litter, sewage, pollution arising from mining or upstream industrial development</li> <li>- Global warming</li> </ul>
2. Coral formations in pristine condition	<ul style="list-style-type: none"> <li>- Direct threats: anchoring, diving, collecting, fishing</li> <li>- Reduction in water quality (see above)</li> <li>- Coral predator infestation eg. Crown-of-thorns starfish</li> <li>- Global warming affecting sea temperatures</li> </ul>
<b>ii Biological</b>	
1. Rich and diverse marine communities/habitats	<ul style="list-style-type: none"> <li>- fishing</li> <li>- collection of fauna eg. Clams, sea cucumber</li> <li>- Pollution</li> </ul>
2. Undisturbed marine communities and habitats eg. corals	<ul style="list-style-type: none"> <li>- Anchoring; establishing moorings</li> <li>- Diving (contact damage); collecting</li> <li>- Pollution from boats or other activities (see Water quality)</li> <li>- Coral predator infestation</li> <li>- Mining, urban, industrial or agricultural development</li> </ul>
3. High abundance of marine fauna eg. fishes	<ul style="list-style-type: none"> <li>- fishing and collecting</li> <li>- Pollution (see Water quality)</li> </ul>
<b>iii Social</b>	
1. Destination for tourism operators	<ul style="list-style-type: none"> <li>- island facilities undeveloped</li> <li>- inter-clan landowner disputes</li> </ul>
2. Uniqueness as a diving area	<ul style="list-style-type: none"> <li>- Degredation of physical features (eg. Anchor damage)</li> <li>- Fishing and collecting</li> <li>- Pollution (see Water quality)</li> <li>- Mining, urban, industrial or agricultural development</li> </ul>
3. Wilderness/ aesthetic character	<ul style="list-style-type: none"> <li>- too many visitors, noise pollution, visual impact of facilities</li> <li>- boat traffic</li> <li>- Litter and shore pollution</li> <li>- Garden re-development</li> </ul>
<b>iv Cultural</b>	
Folkloric sites (eg. Ninsa II shipwreck, the Healing stone)	<ul style="list-style-type: none"> <li>- deterioration due to natural elements</li> <li>- vandalism due to increased exposure</li> <li>- loss of legends relating to sites due to increasing urban and western religious beliefs</li> </ul>

## **6. Managing Sinub Island Marine Wildlife Management Area**

This section of the plan deals with the management authority, each of the main values and major uses of the Sinub Island WMA. Potential pressures, management goals and strategies are presented for each value or use. Performance measures, targets and additional monitoring strategies can be developed from these. Some performance measures and results from the current monitoring program are presented.

### **6.1 Biodiversity Values**

One of the primary reasons for the declaration of Sinub Island as a WMA is to protect the diverse and abundant marine wildlife for food security and aesthetic (eco-tourism) purposes. For management purposes, the marine wildlife can be classified as fishes, benthic communities, reptiles, mammals and birds. Due to limited numbers of non-fish vertebrates and community directed monitoring needs, most monitoring and management effort is concentrated on the fishes and their benthic community habitats.

#### **6.1.1 Potential pressures – biodiversity values**

##### **Illegal fishing and collecting**

Any removal of flora or fauna from the island for whatever purpose will affect the community structure of the fringing reefs and the recreational experience of other users. Fishing reduces both the size and abundance of fishes as well as reduces the tameness and their ability to be observed. Importantly, stocks of predatory and large herbivorous reef fishes are rapidly depleted at low levels of fishing effort (Lock 1986b). Such fishes are known to play an important role in structuring reef

communities, in the case of herbivorous fishes by regulating the abundance of macroalgae (Hay 1991).

A range of practices by artisanal and subsistence fishermen can be destructive to reefs. These include the use of makeshift anchors that drag across the reef, trampling in the course of spearfishing, deploying nets, and/or hand gleaning, dragging weighted net lines across the reef, and the use of push poles to move boats along the reef.

The removal of any wildlife from the Sinub WMA is prohibited under the Sinub WMA Regulations. Regulations 1-7, 12, 14-16 are directly applicable (see attachment 1)

#### **Physical damage from boating and recreational activities**

Anchoring can cause significant damage to fragile features such as coral. Divers can also inadvertently damage through touch and fin damage. Reef walking will also damage coral features. These three destructive activities are prohibited in Sinub WMA under regulations 9, 10 and 11 (see attachment 1).

#### **Reduction in water quality**

The current high water quality is vital for the continued health of the coral and other fauna and flora as well as the value of the recreational diving and snorkeling experience. Increased turbidity can cause mortality, especially of corals. Excess nutrients can encourage growth of exotic and sometimes toxic flora and fauna. Increased water temperatures can cause the death and bleaching of corals.

Pollution can result from boating and recreation within the Sinub WMA, or from passing ships. Potential hazards include fuel and oil spills, release of sewage, gray water and litter, especially plastics and fishing line. Due to its more limited water circulation, the lagoon is most at risk from pollutants. Environmentally unmanaged

industrial, agricultural and urban development within the catchment (and even directly adjacent catchments) could have impacts including increased turbidity and toxicity depending on the distance from the WMA and the water circulation patterns.

Current WMA regulations only address issues of litter within the WMA with regulation 8 (see attachment 1). Other issues must be dealt with at the lagoon and catchment level.

### **6.1.2 Management goals – biodiversity values**

1. To protect the diversity, distribution and abundance of fishes and other vertebrate fauna.
2. To minimize damage to corals and other benthic organisms.
3. To maintain high water quality especially in the lagoon.

### **6.1.3 Management strategies – biodiversity values**

#### **Illegal fishing and collecting**

1. Maintain the prohibition on fishing within the Sinub WMA
2. Continue to implement monitoring and research programs for fishes
3. Provide information to stakeholders in various media on regulations of Sinub WMA
4. Investigate compliance of “no take” in Sinub in association with planned socio-economic study.
5. Develop system of community rangers for enforcement and monitoring purposes.
6. Develop Sinub WMA’s involvement within a broadly integrated coastal management framework addressing lagoon-wide and catchment activities.

## **Physical damage from boating and recreational activities**

1. Maintain the prohibition on anchoring and reef walking in Sinub WMA
2. Continue to liaise with PNGDA on the establishment of chains and floaters for existing mooring pins
3. Develop educational and interpretive material for distribution to charter operators, tourist areas and other distribution avenues.
4. Continue to implement monitoring and research programs for benthic communities.

## **Water quality**

1. Develop a cooperative approach between WMA users and management for the surveillance of pollution events
2. Develop and implement a water quality monitoring program in association with WWF and other relevant agencies
3. Develop Sinub WMA's involvement within a broadly integrated coastal management framework addressing lagoon-wide and catchment activities. This framework needs to address marine pollution including disposal of waste and bilge water, sewage and gray water. Provide information on the implications of such pollution for the marine environment.
4. Maintain prohibition on rubbish disposal in Sinub WMA

## **6.2 Cultural Values**

At least two sites of cultural importance have been identified within Sinub WMA. More may be identified with further investigation. First is the wreck of the Ninsa II on the NE of the island. This wreck is important as an artificial reef and shelter for large fishes and is also a "taboo" site thought to be inhabited by spirits of the island. The second major site is the "healing stone" on the SW of the island that is traditionally believed to have powers to cure physical ailments.

### **6.2.1 Potential pressures – cultural values**

Potential physical pressures to the cultural values of the WMA include deterioration due to natural elements and vandalism. The legends associated with the WMA are cultural values themselves and also face the pressures of being lost due to urban and modern religious influences.

### **6.2.2 Management goals – cultural values**

1. To preserve the remains of the wreck in situ
2. To preserve the sites of folkloric importance on Sinub Island
3. To document and preserve the folklore associated with Sinub Island

### **6.2.3 Management strategies – cultural values**

1. Develop educational and interpretive material for distribution to charter operators, tourist areas and other distribution avenues on the cultural values of Sinub Island
2. Investigate further the cultural values of Sinub Island in association with socio-economic study

## **6.3 Recreational Values**

The recreational values of the Sinub WMA depend largely on the physical attributes of the area and on the diversity, abundance and beauty of the marine wildlife. The tropical island setting and warm climate enhance the recreational experience. Specific recreational activities include boating, observation of wildlife by diving and snorkeling, swimming, picnicking and walking. Most users would come to the WMA with a commercial charter but private vessels also visit

occasionally. The use of Sinub WMA as a recreational facility has yet to be fully developed but will likely increase with further promotion.

### **6.3.1 Potential pressures – recreational values**

The recreational experience at Sinub Island could be negatively impacted by significant damage to or removal of habitat and fauna; recreational activities that conflict with other users and impact on wilderness type experience; over crowding due to too many users at once.

### **6.3.2 Management goals – recreational values**

1. To ensure that all users of Sinub WMA have a minimal environmental impact
2. To ensure that appropriate anchoring and mooring areas are available.
3. To ensure that appropriate picnicking facilities are available (eg. Bins, BBQ plate)

### **6.3.3 Management strategies – recreational values**

1. Educational and interpretive material will be developed and distributed with an aim to reach private users of the Sinub WMA as well as the commercial tour users.
2. Maintain the prohibition on anchoring, reef walking and other destructive practices in Sinub WMA
3. Maintain prohibition on fishing and collection in Sinub WMA
4. Continue to liaise with PNGDA on the establishment of chains and floaters for existing mooring pins
5. The numbers of visitors using commercial tours will be monitored.
6. General island maintenance will be encouraged and facilitated.

## **6.4 Commercial Tours**

There is one primary commercial tour operator, who through a negotiated agreement with the Sinub WMA committee(Attachment 2), is permitted to take customers to Sinub WMA. The main activities carried out are diving, snorkeling, picnicking, swimming and walking. With further negotiation and promotion, other commercial operators may be allowed to bring customers to Sinub. At the moment pressures are minimal but due to the small size it could quickly become over visited.

### **6.4.1 Potential pressures – commercial tours**

### **6.4.2 Management goals – commercial tours**

1. To allow access to Sinub Island WMA by visitors who do not have a private means of accessing the area.
2. To ensure that commercial operators carry out their activities in a manner which is safe and has minimal impact upon the natural values of the Sinub Island WMA.
3. To both enhance the environmental experience and reduce the impact of visitors to Sinub Island WMA by providing educational and interpretive material.

### **6.4.3 Management strategies – commercial tours**

1. Management of commercial operations will be carried out through consultation with the Sinub WMA committee, consultation with operators, agreement negotiation on a case-by-case basis and education of visitors and operators of the management rules of Sinub WMA
2. There will be a restricted number of commercial operators granted permission to operate in the Sinub WMA.

3. The numbers of visitors using commercial tours will be monitored and limits will be established if deemed necessary.
4. Commercial operators will be encouraged to participate in monitoring, research, surveillance and certain local operators may be gazetted as rangers if agreed by the Sinub WMA committee.
5. Educational and interpretive material will be developed and distributed to the commercial tour operators to enhance the experience and reduce the impact of tourists.

## **6.5 Research**

Research is both a use of the Sinub Island WMA and a potential management tool. Sinub Island fringing reefs provides a great site for pure research, surveys and monitoring to increase knowledge of tropical reef ecosystems. Specific monitoring is currently being carried out by Wetlands International – Oceania to provide information for management of the Sinub WMA. Sinub Island Wildlife Management Area Committee must approve all research undertaken in Sinub WMA. The PNG Office of Environment and Conservation must also approve all research permits for PNG.

### **6.5.1 Potential pressures – research**

Research has the potential for negative environmental impacts resulting from, for example, collection or collateral damage. There are also potential for negative interactions between research users and other users, such as researchers and tourists. There is also the issue of intellectual property rights if research should yield profitable results, particularly in regard to bioprospecting.

### **6.5.2 Management goals – research**

1. To encourage appropriate research that will increase the knowledge of the natural and/or physical environment of Sinub Island/Madang Lagoon/North coast PNG.
2. To provide valuable information for management through research and monitoring
3. To ensure research activities will have a minimal environmental impact on the Sinub Wildlife Management Area.
4. To monitor and manage conflicts with other users.
5. To ensure that the results of research, if potentially profitable, benefit the local community equitably and recognize traditional property rights.

### **6.5.3 Management strategies –research**

1. Sinub WMA committee will have the final say on the approval of research permits in the Sinub WMA but this will be based on the technical advice of Wetlands International – Oceania, Worldwide Fund for Nature – South Pacific and the previous approval of the PNG Office of Environment and Conservation.
2. Sinub WMA committee members and Wetlands International –Oceania will liaise with researchers to ensure the information resulting from the research is available to the local community, managers and the national government.
3. Current research and monitoring will continue to provide detailed information on important management issues. Local rangers also need training in low-tech monitoring techniques.
4. Develop Sinub WMA’s involvement within a broadly integrated coastal management framework addressing lagoon-wide and catchment research priorities.
5. The Sinub WMA committee, WI-O, WWF and OEC will liaise to discuss the means by which to screen bioprospecting research proposals.

## **6.6 Other Commercial Activities**

The use of Sinub Island WMA for any other commercial activities besides commercial tours, such as filming, requires the authorization of the Sinub Island WMA committee and will be considered on a case-by-case basis. Any activities potentially harming the environment of Sinub WMA will not be approved.

## **7. Reviewing the Plan**

It is important that this plan has the degree of flexibility to be able to operate and change in the village context but be realistically rigid enough to deliver on the conservation objectives. Sinub Wildlife Management Area committee members and relevant stakeholders will meet annually to discuss the performance of the current plan and whether the management objectives are being met. Changes will be made, if necessary, upon majority vote of the SIWMA committee. Performance assessment criteria are currently based on biological monitoring of SIWMA reefs. Socio-cultural criteria will also be developed over the coming year and monitored on an annual basis.

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## 9. Attachments

### Attachment 1: Declaration of Sinub Island Marine Wildlife Management Area boundary, committee, rules and penalties

INDEPENDENT STATE OF PAPUA NEW GUINEA

*Fauna (Protection and Control) Act (Chapter 154)*

#### DECLARATION OF "SINUB WILDLIFE MANAGEMENT AREA" AND THE APPOINTMENT OF MANAGEMENT COMMITTEE MEMBERS OF SINUB WILDLIFE MANAGEMENT AREA, AND IT RULES AND IT PENALTIES/FINES/FEEES

I, HEROWA AGIWA, M.P., Minister for Environment and Conservation by virtue of the powers conferred by Sections 15 and 16 of the Fauna (Protection and Control) Act (Chapter 154) and all other powers me enabling having consulted with the owners of the land described in Schedule 1, hereby: -

Declare as described in Schedule 1., to be a Wildlife Management Area to be known as "Sinub Wildlife Management Area" for the purpose of that Act; and establish a Wildlife Management Committee for that Wildlife Management Area; and specify that the number of members of the Committee to be 15; and appoint each person specified in Schedule 2., to be a member of that Committee.

SCHEDULE 1.           -       Detail Boundary Description

All that piece of land containing an area of 11.8 hectares or thereabouts known as Sinub Wildlife Management Area located in Madang Lagoon, Madang Province, commencing from the point being the intersection of approximately Position South Latitude 5 Degrees, 7 Minute, 93 Seconds and approximately East Longitude 145 Degrees, 48 Minutes, 69 seconds and thence in a northwesterly direction for 300 meters to the second point at Position South Latitude 5 Degrees, 7 Minutes, 80 Seconds, East Longitude 145 Degrees, 48 Minutes, 69 Seconds and thence turning Eastward for 150 m to the third point at Position South Latitude 5 Degrees, 7 Minutes, 79 Seconds, East Longitude 145 Degrees, 48 Minutes, 72 Seconds and thence in an Easterly direction for 250 meters to the fourth point at Position South Latitude 5 Degrees, 7 Minutes, 79 Seconds, East Longitude 145 Degrees, 48 Minutes, 81 Seconds and thence in a South Easterly direction for 200 meters to the fifth point at Position South Latitude 5 Degrees, 7 Minutes, 85 Seconds, East Longitude 145 Degrees, 48 Minutes, 86 Seconds and thence in a Southerly direction for 250 meters to the sixth point at Position South Latitude 5 Degrees, 7 Minutes, 98 Seconds, East Longitude 145 Degrees, 48 Minutes, 89 Seconds thence in a South Westerly direction for 400 meters to the seventh point at Position South Latitude 5 Degrees, 8 Minutes, 0 Seconds, East Longitude 145 Degrees, 48 Minutes, 77 Seconds and thence a further 250 meters in a North Westerly direction closing back at its commencement and original point.

**SCHEDULE 2. - The Sinub Wildlife Management Area Committee**

1. Francis Wadul (Chairman)
2. Dabel Ud (Vice Chairman)
3. Sam Dabel (Treasurer)
4. Flier Gatedai (Secretary)
5. Kubulan Kinei (Member)
6. Bubuze Gufon (Member)
7. Gubuk Kadegum (Member)
8. Moses Bu (Member)
9. Tazig Sakol (Member)
10. Kalaman Dauz (Member)
11. Lasek Lam (Member)
12. Philip Dibun (Member)
13. Susan Dabel (Member)
14. Masila Kalaman (Member)
15. Dug Wongmai (Member)

**SCHEDULE 3. - Management Rules**

The Wildlife Management Committee as shown in decided the following Rules Schedule 2 with consultation with the community members. Within the boundaries of the Sinub Wildlife Management Area as described in Schedule 1, the following activities are banned:

1. Dynamite fishing
2. Line fishing
3. Spear gun fishing
4. Trapping
5. Net fishing
6. Night fishing
7. Light fishing
8. Littering
9. Anchoring on the reef
10. Scuba Diving
11. Walking on reef
12. Collecting reef life
13. Collecting bush materials
14. Hunting bird life
15. Killing of snakes and insects
16. Garden making
17. Picnicking
18. Fruit collecting

SCHEDULE 4. - Infringement, Penalties/ Fines/Fees

1. An infringement of the above Rules from 2 to 18 (Schedule 3) will result in a fine of K50.00.
2. An infringement of Rule 1 will result in a fine of K1000.00 payable to the Chairman of the Wildlife Management Committee (Schedule 2) in Village Court.

DATED:..... 2<sup>ND</sup> .....day of..... MAY .....2000



Hon. Herewa Agiwa, M.P  
Minister for Environment and Conservation

**Attachment 2: Agreement between Sinub Island Marine Wildlife Management Area committee and Aquaventures Ltd.**

**Tok Orait i stap namel long  
Sinub Ailan Wailaip Manesmen Eria (SAWME) Komiti  
(Azonanen/Badinanen Klen)  
na Aquaventures (Tim Rowland)**

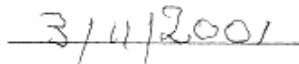
Mipela olgeta lain i sainim nem unanit i tok orait long:


1. Ol *Azonanen/Badinanen Klen* makim pinis komiti husait bai lukautim na kamapim wok long Sinub Ailan unanit long ol lo na mekim save ol komiti yet i makim na minista bilong environment i oraitim long de namba tu long namba faiv mun bilong yia 2000 (dispela pepa istap wantaim tok orait). Ol komiti bilong SAWME tu i gat wok long stretim na lukautim gut win haus, sain bod na ol eria bilong waswas, pikinik na sindaun. Na tu ol i gat wok long stretim gut rot bilong wakabaut na raunim ailan. Bigpela wok i stap long olgeta Azonanen/Badinanen lain long mekim save long husait manmeri i brukim lo bilong SAWME.
2. *Aquaventures* ken kisim ol manmeri i go long SAWME bilong daiv, waswas, pikinik na lukluk raun. Wanwan manmeri husait Aquaventures kisim i go mas baim K2.00 na bai dispela moni i go long akaunt bilong SAWME long olgeta tripela mun. Manmeri i laik go long ailan mas raitim nem bilong ol long wanpela buk bai i stap long daivsop na ridim gut ol lo na mekim save bilong SAWME pastaim long go raun long ailan. Aquaventures na ol wok manmeri bilong ol tu bai bihainim lo bilong SAWME na helpim ol Azonanen/Badinanen klen long mekim save long ol lain i brukim lo. Aquaventures bai putim sen na flota bilong pasim bot na putim wanpela ain plet bilong kukim kaikai klostu long haus win.

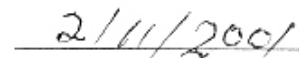
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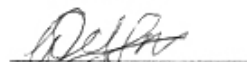
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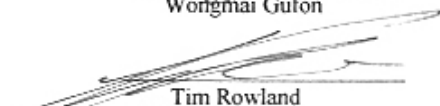


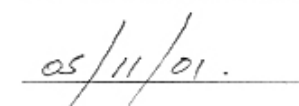
  
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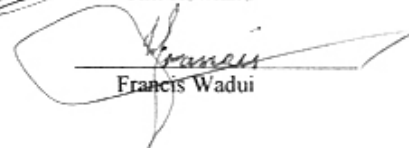


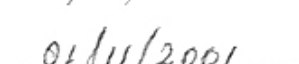
  
Wongmai Gufon



  
Tim Rowland



  
Francis Wadui



**Attachment 3: Fishes of Sinub Island Marine Wildlife Management Area (families in bold)**

**Pomacentridae:**

*Pomacentrus*

*albimaculatus*  
*adelus*  
*burroughi*  
*amboinensis*  
*bankanensis*  
*brachialis*  
*chrysurus*  
*coelestis*  
*grammorhyncus*  
*lepidogenys*  
*moluccensis*  
*nagasakiensis*  
*nigromanus*  
*pavo*  
*phillipinus*  
*reidi*  
*simsiang*  
*smithi*  
*vaiuli*

*Chrysiptera*

*biocellata*  
*oxycephala*  
*parasema*  
*rex*  
*rollandi*  
*talboti*  
*unimaculata*

*Chromis*

*amboinensis*  
*atripectoralis*  
*atripes*  
*lepidolepis*  
*lineata*  
*margaritifer*  
*retrofasciata*  
*ternatensis*  
*viridis*  
*xanthochira*  
*xanthura*  
*weberi*

*Dischistodus*

*melanotus*  
*prosopotania*

*Ablyglyphidodon*

*aureus*  
*curacao*  
*leucogaster*  
*ternatensis*

*Neoglyphidodon*

*melas*  
*nigrorus*

*Plectroglyphidodon*

*dickii*  
*lacrymatus*

*Neopomacentrus*

*azysron*

*Hemiglyphidodon*

*plagiometopom*

*Dascyllus*

*aruanus*  
*melanurus*  
*reticulatus*  
*trimaculatus*

*Amphiprion*

*chrysopterus*  
*clarkii*  
*melanopus*  
*percula*  
*perideraion*  
*sandracinus*

*Premnas*

*biaculeatus*

*Acanthochromis*

*polyacanthus*

*Abudefduf*

*vaigiensis*  
*septemfasciatus*

*Segastes*

*fasciolatus*

*Chelioprion*

*labiatus*

**Labridae**

*Thalassoma*

*hardwicke*  
*janseni*  
*lunare*  
*purpureum*  
*amblycephalum*

*Cheilinus*

*celebicus*  
*chlororus*  
*diagrammus*

	<i>fasciatus</i>		<i>meleagris</i>
	<i>orientalis</i>		<i>neuginaceous</i>
	<i>sp. (green in Halimeda)</i>		<i>twistii</i>
	<i>trilobatus</i>		<i>caeruleopunctatus</i>
	<i>undulatus</i>	<i>Hemigymnus</i>	
	<i>unilineatus</i>		<i>fasciatus</i>
<i>Halichoeres</i>			<i>melapterus</i>
	<i>biocellata</i>	<i>Gomphosus</i>	
	<i>chloropterus</i>		<i>varius</i>
	<i>fasciatus</i>	<i>Macropharyngodon</i>	
	<i>hortulanus</i>		<i>meleagris</i>
	<i>margaritaceus</i>	<i>Parachielinus</i>	
	<i>marginatus</i>		<i>filamentosus</i>
	<i>melanurus</i>	<i>Pseudodax</i>	
	<i>prosopeion</i>		<i>mollucans</i>
	<i>purpurescens</i>	<i>Coris</i>	
	<i>purpurescens</i>		<i>schroderi</i>
	<i>scapularis</i>	<i>Novaculichthys</i>	
	<i>richmondi</i>		<i>taeniurus</i>
	<i>trimaculatus</i>	<i>Chelio</i>	
	<i>vrolicki</i>		<i>inermis</i>
	<i>nebulosus</i>	<i>Pteragogus</i>	
<i>Coris</i>			<i>cryptus</i>
	<i>shroederi</i>	<i>Hologymnus</i>	
<i>Cirrhilabrus</i>			<i>annulatus</i>
	<i>punctatus</i>		<i>doliatus</i>
<i>Epibulus</i>		<i>Wetmorella</i>	
	<i>insidiator</i>		<i>nigropinnata</i>
<i>Bodianus</i>		<b>Acanthuridae</b>	
	<i>mesothorax</i>	<i>Acanthurus</i>	
<i>Choerodon</i>			<i>blochii</i>
	<i>anchorago</i>		<i>dussumieri</i>
<i>Stethojulis</i>			<i>flavicauda</i>
	<i>bandanensis</i>		<i>lineatus</i>
	<i>interrupta</i>		<i>mata</i>
	<i>strigiventor</i>		<i>nigricans</i>
	<i>trilineata</i>		<i>nigricauda</i>
<i>Labroides</i>			<i>pyroferus</i>
	<i>bicolor</i>		<i>triolestegus</i>
	<i>dimidiatus</i>		<i>thompsoni</i>
	<i>pectoralis</i>		<i>xanthopterus</i>
<i>Labropsis</i>		<i>Ctenochaetus</i>	
	<i>australis</i>		<i>binotatus</i>
<i>Diproctacanthus</i>			<i>striatus</i>
	<i>xanthura</i>		<i>tominiensis</i>
<i>Labrichthys</i>		<i>Naso</i>	
	<i>unilineatus</i>		<i>annulatus</i>
<i>Psuedochelinus</i>			<i>brevirostris</i>
	<i>evanidus</i>		<i>brachycentron</i>
	<i>hexataenia</i>		<i>lituratus</i>
<i>Anampses</i>			

*unicornis*  
*vlamingi*  
*Zebrasoma*

*scopas*  
*veliferum*

### **Chaetodontidae**

*Chaetodon*

*auriga*  
*baronessa*  
*bennetti*  
*citrinellus*  
*ephippium*  
*kleinii*  
*lunula*  
*melanurus*  
*ocellicaudis*  
*octofasciatus*  
*ornatissimus*  
*oxycephala*  
*pelewensis*  
*rafflesi*  
*semion*  
*speculum*  
*trifascialis*  
*trifasciatus*  
*ulietensis*  
*unimaculatus*  
*vagabundus*

*Heniochus*

*chrysostomous*  
*singularis*  
*varius*  
*acuminatus*

*Forcipiger*

*flavissimus*  
*longirostris*

*Parachaetodon*

*ocellatus*

### **Pomacanthidae**

*Pomacanthus*

*navarchus*  
*sexstriatus*  
*xanthometopom*

*Pygoplites*

*diacanthus*

*Centropyge*

*bicolor*  
*bispinosus*  
*nox*  
*vroliki*

*Chaetodontoplus*

*mesoleucas*

### **Serranidae**

*Pseudanthias*

*tuka*  
*hutchii*

*Cephalopholis*

*cyanostigma*  
*ongus*  
*urodeta*  
*argus*

*Epinephalus*

*fasciatus*  
*merra*  
*maculatus*  
*hexagonatus*

*Anyperodon*

*leucogrammicus*

*Plectropomus*

*leavis*  
*leopardus*

### **Zanclidae**

*Zanclus*

*cornutus*

### **Nemipteridae**

*Scolopsis*

*bilineatus*  
*ciliaris*  
*lineatus*  
*margaritifer*  
*temporalis*  
*trilineatus*

*Pentapodus*

*trivittatus*  
*sp.*

### **Belonidae**

*Tylosorus*

*crocodilus*

### **Scaridae**

*Bolbometopom*

*muricatum*

*Scarus*

*bleekeri*  
*bowseri*  
*chameleon*  
*dimidiatus*  
*flavipectoralis*  
*forsteni*  
*frenatus*  
*ghobban*  
*microrhinos*  
*niger*

	<i>pyrhurus</i>	<i>Sufflamen</i>	
	<i>qouoyi</i>		<i>bursa</i>
	<i>rivulatus</i>		<i>chrysopterus</i>
	<i>shlegeli</i>		<i>frenatus</i>
	<i>sordidus</i>	<i>Balistoides</i>	
	<i>spinus</i>		<i>viridescens</i>
<i>Cetoscarus</i>		<i>Pseudobalistes</i>	
	<i>bicolor</i>		<i>undulatus</i>
<i>Calatomous</i>		<i>Paraluteres</i>	
	<i>carolinus</i>		<i>prionurus</i>
<b>Siganidae</b>		<b>Lutjanidae</b>	
<i>Siganus</i>		<i>Lutjanus</i>	
	<i>spinus</i>		<i>biguttatus</i>
	<i>canaliculatus</i>		<i>bohar</i>
	<i>corallinus</i>		<i>carponotatus</i>
	<i>doliatus</i>		<i>ehrenbergi</i>
	<i>lineatus</i>		<i>fulvus</i>
	<i>puellus</i>		<i>gibbus</i>
	<i>punctatissimus</i>		<i>kasmira</i>
	<i>virgatus</i>		<i>rivulatus</i>
	<i>vulpinus</i>		<i>semicinctus</i>
<b>Apogonidae</b>		<i>Macolor</i>	
<i>Apogon</i>			<i>niger</i>
	<i>angustatus</i>		<i>macularis</i>
	<i>bandanensis</i>	<b>Ephippidae</b>	
	<i>compressus</i>	<i>Platax</i>	
	<i>cyanosoma</i>		<i>orbicularis</i>
	<i>exostigma</i>	<b>Monacanthidae</b>	
	<i>fragilis</i>	<i>Amanses</i>	
	<i>frenatus</i>		<i>scopas</i>
	<i>fuscus</i>	<i>Aluteres</i>	
	<i>leptacanthus</i>		<i>monocerus</i>
	<i>quinquelineatus</i>	<i>Oxymonacanthus</i>	
	<i>nigrofasciatus</i>		<i>longirostris</i>
<i>Cheilodipterus</i>		<i>Cantherhines</i>	
	<i>artus</i>		<i>dumerili</i>
	<i>macrodon</i>	<i>Pervagor</i>	
	<i>quinquelineatus</i>		<i>janthinopterus</i>
	<i>singaporensis</i>	<i>Acreichthys</i>	
<i>Archamia</i>			<i>radiatus</i>
	<i>zosterophora</i>	<b>Lethrinidae</b>	
	<i>biguttata</i>	<i>Monotaxis</i>	
	<i>fucata</i>		<i>grandoculis</i>
<i>Sphaeramia</i>		<i>Lethrinis</i>	
	<i>nematoptera</i>		<i>olivaceous</i>
	<i>orbicularis</i>		<i>atkinsoni</i>
<b>Balistidae</b>			<i>erythropterus</i>
<i>Balistapus</i>			<i>nebulosus</i>
	<i>undulatus</i>	<i>Gnathodentex</i>	
<i>Rhineacanthus</i>			<i>aurolineatus</i>
	<i>aculeatus</i>		

**Mullidae***Parupeneus*

*barabarinus*  
*barbarinoides*  
*bifasciatus*  
*cyclostomus*  
*heptacanthus*  
*multifasciatus*

*Mulloides*

*flavolineatus*  
*vanicolensis*

*Upeneus*

*tragula*

**Tetraodontidae***Arothron*

*mappa*  
*nigropunctatus*

*Canthigaster*

*solandri*  
*valentini*  
*amboinensis*

**Ostraciidae***Ostracion*

*cubicus*  
*meleagris*  
*solarensis*

**Pinguipedidae***Parapercis*

*clathrata*

**Caesionidae***Pteroceasio*

*latovittata*  
*pisang*  
*trilineata*  
*tile*

*Caesio*

*caerulaurea*  
*cuning*  
*lunaris*  
*teres*

**Aulostomidae***Aulostomus*

*chinensis*

**Fistularidae***Fistularia*

*commersoni*

**Blennidae***Atrosalarius*

*fuscus*

*Salarius*

*fasciatus*

*Meiacanthus*

*atrodorsalis*  
*vittatus*  
*grammistes*

*Exallias*

*brevis*

*Istiblennius*

*periophthalmus*

*Ecsenius*

*colletti*

*Plagiotremus*

*laudanus*

**Gobiidae***Amblygobius*

*rainfordi*  
*decussatus*

*Gunnelichthys*

*curiosus*  
*sp. (black/blue)*

*Gobiodon*

*citrinus*  
*echinocephalus*

*Valenciennea*

*strigata*  
*puellaris*

**Cirrhitidae***Cirrhitichthys*

*falco*

*Paracirrhites*

*forsteri*  
*arcuatus*

**Carangidae***Caranx*

*lugubris*  
*melampygus*  
*sp*  
*fulvus*

*Carangoides*

*ferdau*

*Atule*

*mate*

*Gnathodon*

*speciosus*

**Holocentridae***Myripristis*

*kuntzei*  
*violacea*

*Neonipon*

*argenteus*  
*opercularis*  
*sammara*

*Sargocentron*  
*caudimaculatum*  
*cornutum*  
*spiniferum*  
*microstoma*

**Microdesmidae**

*Ptereleotris*  
*evides*

**Kyphosidae**

*Kyphosus*  
*cinerascens*  
*vaigiensis*

**Scombridae**

*Rastrelliger*  
*kanagurta*  
*Euthapterus*  
*affinis*  
*Seriola*  
*dumerili*  
*Katsuwonus*  
*pelamis*  
*Scomberoides*  
*lysan*

**Synodontidae**

*Synodus*  
*ulae*  
*variegatus*

**Scorpaenidae**

*Scorpaenopsis*  
*oxycephala*  
*Pterois*  
*antenatta*

**Pseudochromidae**

*Pseudochromis*  
*fuscus*  
*pacagnellae*  
*Ogilbyina*  
*queenslandiae*

**Pholydichthidae**

*Pholydichthys*  
*leucotainia*

**Plotosidae**

*Plotosus*  
*lineatus*

**Gobiescosidae**

*Diademichthys*  
*lineatus*

**Haemulidae**

*Plectrorhyncus*  
*chaetodontoides*  
*orientalis*  
*lineatus*  
*Diagramma*  
*pictum*

**Sphyraenidae**

*Sphyraena*  
*obtusata*  
*flavicauda*

**Centriscidae**

*Aoliscus*  
*strigatus*

**Callyonymidae**

*Synchiropus*  
*sp.*

**Hemiscyllidae**

*Hemiscyllium*  
*trispiculare*

**Carcharinidae**

*Carcharinus*  
*melanopterus*

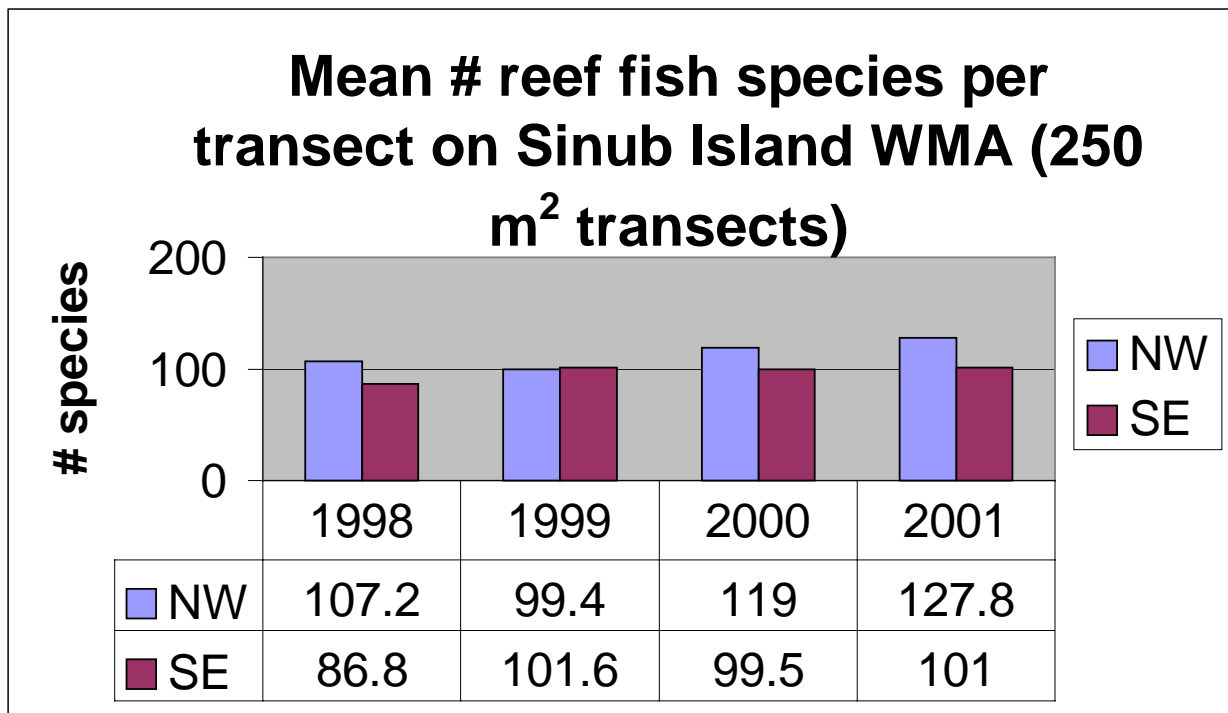
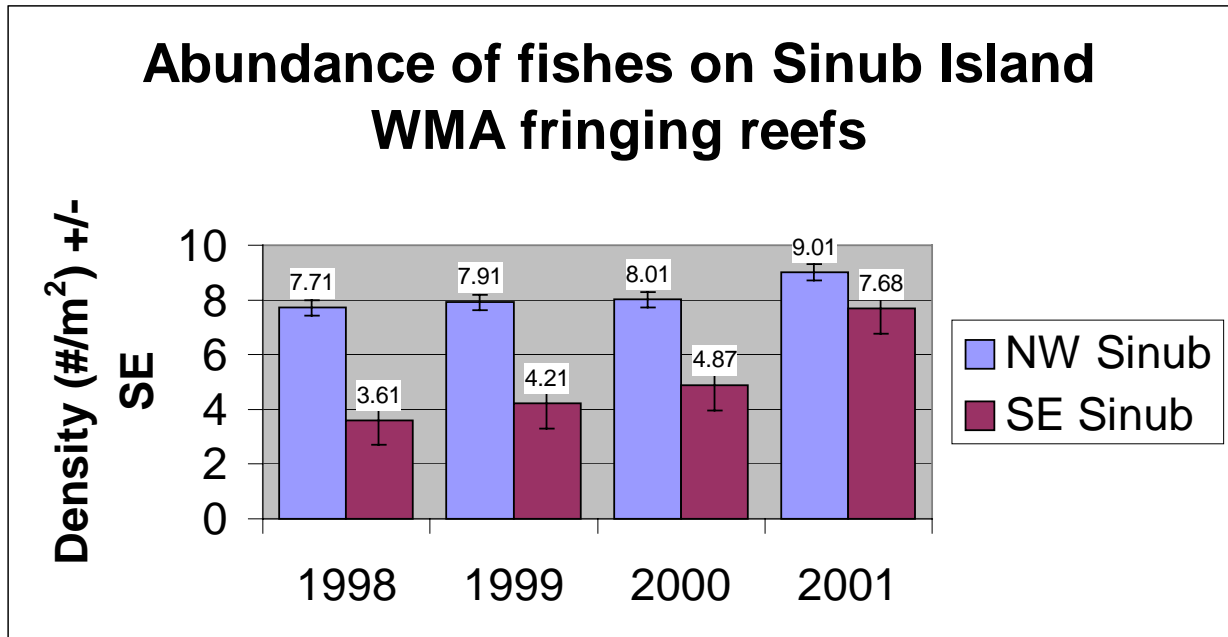
**Priacanthidae**

*Priacanthus*  
*hamrur*

**Sygnathidae**

*Siokunichthys*  
*nigrolineatus*

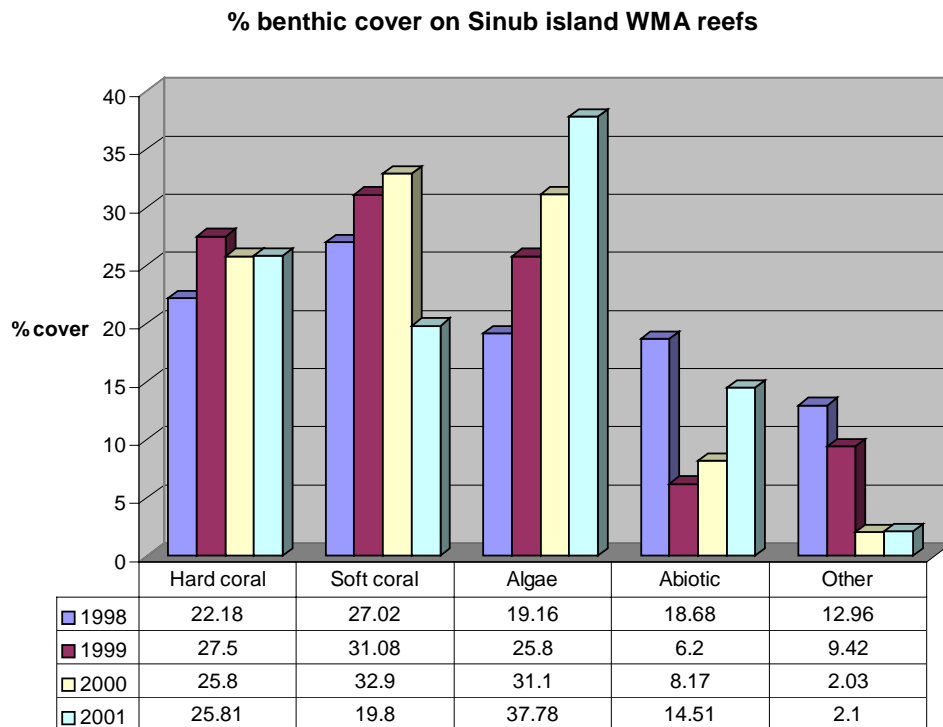
**Attachment 4:** Summary of longitudinal fish abundance and diversity data for Sinub Island Marine Wildlife Management Area



Shannon Diversity (H') and Evenness (E) for fish communities of Sinub WMA

	NW Sinub		SE Sinub	
	H'	E	H'	E
1999	3.12	0.68	3.74	0.81
2000	3.60	0.75	3.82	0.83
2001	3.46	0.71	3.67	0.80

**Attachment 5:** Summary of longitudinal benthic data for Sinub Island Marine Wildlife Management Area



**Attachment 6: Common benthic flora and fauna in Sinub Island Marine Wildlife  
Management Area**

**Soft coral**

*Sarcophyton sp.*

*Lobophyton sp.*

*Sinularia sp.*

*Xenia sp.*

*Nepthea sp.*

*Efflatournaria sp.*

*Anthelia sp.*

Fan-*Subergorgia mollis*

Sea whip-*Juncella fragilis*

**Hard coral**

*Seriatophora histrix*

*Montipora sp.*

*Montipora danae*

*Anacropora puertogalerae*

*Acropora hyacinthus*

*Acropora humilis*

*Acropora monticulosa*

*Acropora grandis*

*Acropora loris*

*Acropora palifera*

*Acropora robusta*

*Acropora cerealis*

*Acropora formosa*

*Stylophora pistillata*

*Goniopora sp.*

*Pavona explanulata*

*Pachyseris sp.*

*Porites sp.*

*Pocillapora verrucosa*

*Fungia sp.*

*Oulophyllia crispa*

*Oulophyllia benettae*

*Platygyra sp.*

*Euphyllia ancora*

*Euphyllia sp.*

*Goniopora sp.*

*Diploastrea heliopora*

*Favites sp.*

*Symphyllia sp.*

*Hydnophora sp.*

*Plerogyra sp.*

**Sea snakes**

*Laticauda sp.*

**Green Algae**

Sea grape- *Caulerpa racemosa*

*Halimeda macroloba*

*Halimeda micronesica*

*Halimeda opuntia*

*Velonia ventricosa*

**Marine worms**

*Spirobranchus giganteus*

**Giant Clams**

*Tridacna sp.*

**Sea Stars**

*Linckia sp.*

*Choriaster grannulatus*

**Tunicates**

*Didemnum molle*

*Lissoclinum pattela*

*Rhopalea crassa*

**Sponges**

*Gelliodes fibullatus*

*Stylotella aurantium*

*Cribrochalina sp.*

**Sea Cucumbers**

*Bohadschia argus*

*Bohadschia graeffei*

*Thelenota anax*

*Thelonota ananas*

*Holothuria fuscopunctata*

*Holothuria edulis*

*Stichopus variegatus*

**Anemones**

*Stichodactyla gigantea*

*Stichodactyla mertensii*

**Crinoids**

*Colobometra perspinosa*

*Tropiometra afra*

*Oxycomanthus bennetti*

*Himerometra bartschi*

*Comanthina schlegli*

*Cenometra bella*

