

lection of data. Stock population survey data are required for this species. The recommendations below will provide baseline scientific data to enable a sound environmental management plan to be developed and implemented for these sea cucumber species.

The recommendations presented below have wider implications for other marine species located in Kosrae and should be used in this context. This is not a definitive list and additional priority areas should be developed.

- Undertake a resource evaluation of the current stocks of surf redfish on the reef edge and reef crest on the eastern side of the island when weather conditions are more favourable. Line transects and timed swims should be used.
- Collect basic life history data on both species of commercially targeted sea cucumbers (the surf redfish and greenfish). These (biological and morphological) must be collected on a monthly basis over an annual period for each sea cucumber species. Information obtained on each individual species is imperative to the development of a suitable marine management plan. These must include date of sample, location of sample, sex, body length, wet and dry weight, reproductive condition, and gonad index.
- Undertake an intensive public awareness programme to provide information on sea cucum-

ber management and why it is required. This could include, but is not limited to, public media announcements, community-based workshops and relevant public discussions groups. This programme could be expanded to include additional reef species.

- Develop a marine resource management plan for the commercial harvesting of sea cucumbers for Kosrae state. This will need to be done once the scientific information has been gathered.
- Include within the management plan marine reserves, minimal harvest size limits and bans on collection during spawning seasons for both species of sea cucumber.
- Further develop appropriate government regulations to allow control, through permits of all commercial sea cucumber harvesting operations. This should include permit requirements that include basic data reporting duties. Fines should be incorporated with all violations.
- Conduct yearly marine resource stock surveys (as undertaken in this evaluation) to provide information on the population structure and abundance of sea cucumbers over time.

References

- Edward, A. 1997. Kosrae sea cucumber report. Kosrae State Government. 7 p.

Marine resource survey and assessment of Jaluit Atoll, Republic of the Marshall Islands

John Bungitak¹ and Stephen Lindsay²

Background

The Jaluit Atoll Marine Conservation Area (JAMCA) was established in 1999. JAMCA was developed by the combined efforts of the Jaluit Atoll Development Association, the Jaluit Atoll Local Government Council, the Jaluit Community, and the National Environment Protection Authority. Assistance has been received from the South Pacific Regional Environment Programme through their South Pacific Biodiversity Conservation Programme and a Conservation Area Supporting Officer has been recently appointed to manage and develop the programme.

The goals of JAMCA are to develop and implement:

- a sustainable marine resource management plan,
- a sustainable terrestrial management plan,
- community-based management structures,
- alternative income-generating activities,
- public awareness, training and education programmes, and

1. Marine Management and Conservation Area Project, RMI. Email: eparmi@ntamar.com
2. Micronesia Aquaculture and Marine Consultant Services. Email: slindsay@mail.fm

- strengthen the capacity of the community to effectively manage a conservation area.

The starting point for the JAMCA programme was the development of an adaptive marine resource management programme that has access to reliable baseline biological information on the condition of the marine ecosystem and species-specific population data. This information will provide the basis for the formulation of a robust monitoring programme and a resource management plan.

The information summarised below provides the data collected on the commercially targeted holothurians within Jaluit Atoll during the marine resource assessment.

Summary on holothurians populations

Eleven species of sea cucumber were found on the reefs of Jaluit Atoll (*Holothuria atra*, *H. nobilis*, *H. horrens*, *H. edulis*, *H. fuscopunctata*, *Actinopyga mauritiana*, *Bohadschia argus*, *B. marmorata*, *Stichopus hermanni*, *Thelenota ananas*, *T. anax*). Population abundances are high for all species except for the commercial species currently harvested. Stocks of these commercial sea cucumbers (*H. nobilis*, *H. fuscopunctata*, *B. marmorata*, *S. hermanni*, *T. ananas*) are low to very low within the lagoon, resulting from current commercial harvesting. Stock populations of these animals below a water depth of 20 meters are unknown.

Management protocols need to be developed and implemented to preserve the existing stocks of commercial sea cucumbers to allow recruitment and sustainable commercial harvesting. Suggested protocols to consider are bans on the collection of certain species, bans on collection locations, size limits, season limits and closures.

Sea cucumber survey results and discussion

All commercially important species (*H. nobilis*, *H. fuscopunctata*, *B. marmorata*, *S. hermanni*, *T. ananas*) were found in low densities in all tows. The low occurrence of these commercially important species is a direct result of the current commercial harvesting that specifically targets the collection of these species on Jaluit Atoll.

Only eight specimens of *H. nobilis* (black teatfish), the most commercially valuable species on Jaluit Atoll, were found in one tow during the survey, although large areas within the lagoon are suitable habitat for this sea cucumber. Similarly, only 15 specimens of *T. ananas* (prickly redfish), the second most valuable species was found in 7 tows during the survey.

The two largest non-commercially targeted species of *Thelenota anax* (amberfish) and *Bohadschia argus* (leopardfish) dominated the survey counts. 503 individuals of *T. anax* were located in 19 per cent (44 tows) of all tows undertaken. Other commercially valuable species included 126 individual *B. argus* in 16 per cent (37 tows). *H. atra* (lollyfish) dominated the population numbers of the small non-commercial species; 2050 individuals were located in 17 per cent of all tows. The population of these cucumbers was high in certain areas of the reef.

The results obtained during the survey reflect only those stocks of sea cucumbers that live in less than 18 meters of water. The survey did not evaluate stocks of sea cucumbers deeper than this due to the limitation of free diving. Scuba and hookah systems have not been used on Jaluit Atoll to harvest sea cucumbers and therefore the maximum depth of collection is reflected in the survey results. The majority of large commercial sea cucumbers can live in both shallow and deep water (up to 60 m) and, therefore, stocks may be present at these depths. The size of these stocks is unknown as is the role they play in recruitment.

Stock populations of all commercially important species of beche-de-mer were low to very low within Jaluit lagoon. These low stock numbers are a direct result of commercial harvesting. Therefore, the current level of exploitation is not sustainable and a management plan must be developed and implemented. There are currently no regulations on the harvesting of sea cucumbers within Jaluit Atoll or the Marshall Islands.

The stocks of commercially valuable beche-de-mer on Jaluit Atoll have already been overharvested and stock numbers are low. Therefore, there is an urgent need for some form of community management to preserve remaining stocks within the lagoon in order to allow recruitment and future sustainable commercial harvesting to continue.

It is therefore recommended that the following management practices be considered:

- Sea cucumbers should only be collected by hand while free diving. A total ban on the use of any underwater breathing apparatus (scuba or hookah) should be introduced and enforced. In addition, the use of beche-de-mer "bombs" and other home-made equipment, which allow the collection of deeper water stocks, should also be prevented. A beche-de-mer bomb is made out of concrete or lead with a steel barb protruding from the bottom and the top, and is connected to a rope. The diver positions the bomb above the intended sea cucumber and drops the bomb onto the animal. The steel barb pierces the skin of the

sea cucumber and the animal can be hauled to the surface. In clear water this method has been successfully used in depths up to 30–35 meters. This collection method has not been used in Jaluit. A ban on the use of bombs will prevent deeper water sea cucumber stocks from being harvested.

- The suggested marine reserve areas have been designed to prevent harvesting of organisms within the area, therefore preventing the harvesting of sea cucumbers. These reserve areas will allow reproductive stocks of the commercial species to survive and reproduce in shallow water.

Sea cucumbers are only harvested on Jaluit Atoll for commercial activities; they are not used for subsistence.

Monitoring programme

A monitoring and licensing system should be developed with the community council to collect reliable data on all commercial sea cucumber activities.

Information should be collected on species, location, number, water depth, date and whether processed or not. In addition, each company (local and off island) and diver should be registered with the island council and made to provide the above information. The council may wish to place a small license fee on these commercial activities. This industry is suitable for Jaluit Atoll and should be developed along with a management plan. The Conservation Area Supporting Officer should also discuss the general biology and reasons behind the sea cucumber management plan, and assist collectors in producing a top quality product that increases profits.

In addition, biannual marine assessment surveys should be undertaken to provide baseline population numbers of sea cucumbers in the reserves and on the harvested sections of the Jaluit reef.

References

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Sea cucumber fisheries in the Mayotte reef system, Indian Ocean

Adeline Pouget¹

Introduction

On Mayotte, a small French island in the Comoros Islands, sea cucumbers (*papacajo* in Mahorais) have not yet been studied. The development of this fishery and the steep rise in the number of tickets issued for illegal underwater harvesting of sea cucumbers, justified setting up a study to examine the fishery and the status of the resource. This article provides an overview of the fishery gained through information from fishers and animal health services.

Beginning of fishery operations

In contrast to the Malagasy islands, sea cucumber fishing in Mayotte has only recently begun in a very limited way. It may be linked to a transfer of activity due to stock depletion in Madagascar.

It is difficult to state exactly when sea cucumber fishing began. In fact, no fisheries information exists for Mayotte. This is due, in part, to the fact that

those people involved perform a wide range of other work activities, and there is a high percentage of fishers who are fishing illegally.

As with most sea cucumber producing countries, production is not meant for local consumption but rather for export to Asian countries (Conand 1990). The first seafood product health and quality export certificate was issued by the Mayotte Animal Health Office (DSV) on 11 April 2002. Therefore, it is estimated that sea cucumber fishing for export first began in early 2002.

Management measures and fishing techniques

At present, sea cucumber fishing is not subject to any specific measures designed to ensure sustainable resource management. However, this activity is subject to Prefectural Order no. 3/95/CAB/AM, which provides regulations for underwater fishing in the French coastal and territorial waters adjacent to the Department of Mayotte. Articles 1 and 2 of this order respectively stipulate that: