

Summary of data collected from the sea cucumber fishery on Rota, Commonwealth of the Northern Mariana Islands

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Abstract

A sea cucumber fishery in the Commonwealth of the Northern Mariana Islands (CNMI) began in October 1995 on the island of Rota, and continued through May 1996, when the company began preparations to move operations to the island of Saipan. In January 1996 the CNMI Division of Fish and Wildlife required the harvest company to submit harvest and financial data. Examination of the submitted data identified inaccuracies, such as the lumping of the two target species, the surf redfish, *Actinopyga mauritiana*, and the black teatfish, *Holothuria whitmaei*. Summary of the data set revealed trends in catch that showed an increase in catch per unit effort over time, concluded to be a result of calmer weather conditions providing access to previously unharvested areas. Mean dried weight data were used to estimate the number of sea cucumbers harvested prior to the data collection programme. The estimated number harvested was 148,950. Product recovery data were also examined. It was concluded that sound regulations and preliminary harvest surveys are necessary to ensure coherent management.

Introduction

Throughout Micronesia sea cucumbers were harvested on a commercial scale during the Japanese Mandate years although the specific species harvested were not identified in export records (Smith 1947). The harvest was estimated at 20–30 tonnes per year, with the chief centres of production being Saipan (6%), Palau (18%), Yap (4%), Chuuk (61%), and Pohnpei (11%) (Smith 1947). Richmond (1995) estimated that over 30,000,000 sea cucumbers were harvested during those years, and suggested that areas around Chuuk have yet to recover from the high exploitation rates of the 1920s and 1930s. In reference to Micronesia, Smith (1947) stated, 'According to Japanese reports, overfishing had reduced the numbers in many places, as no conservation regulations applied to these animals. Our own observations tended to confirm the Japanese statements, as the larger and more desirable commercial species were not very abundant compared with the unutilised species.'

Descriptions of the sea cucumbers observed on the island of Saipan in the Mariana Islands by Smith (1947, 50–52) can be tentatively interpreted as the lolly fish, *Holothuria atra*, the greenfish, *Stichopus chloronotus*, the elephant trunkfish, *Holothuria fusco-punctata*, and probably the black teatfish, *Holothuria whitmaei* (formerly *H. nobilis*, Rowe and Gates 1995). The first two were found to be abun-

dant in Saipan Lagoon in surveys conducted by Chandran (1988) and Duenas & Associates (1997), and both are listed as being of low commercial value (Conand 1990, SPC 1994).

Smith (1947) did not survey for sea cucumbers on the island of Rota and referenced Japanese Mandate harvests as from 'Saipan' only, perhaps due to Saipan being the probable port of export, rather than the only island where harvest occurred. He did mention that the local population did not consume sea cucumbers, but whether or not any commercial harvest occurred from Rota during that period was unknown. During the German occupancy of the Marianas (1899–1914) it was noted by a German district officer of Guam that Carolinians from Saipan dove for trepang at Aguigan Island off Tinian Island and sold them to Japanese merchants (Amesbury et al. 1989).

A commercial sea cucumber fishery began in the Commonwealth of the Northern Mariana Islands (CNMI) on the island of Rota (14°10' N, 145°14' E) in October 1995 (Fig. 1). The CNMI Division of Fish and Wildlife (DFW) became aware of the fishery in December 1995 and initiated data collection in January 1996 that continued until the end of May 1996 when the company, based in Guam of Chuukese origin, ceased harvest in anticipation of moving operations to the island of Saipan. This paper documents and summarises the data submitted to DFW from the Rota fishery.

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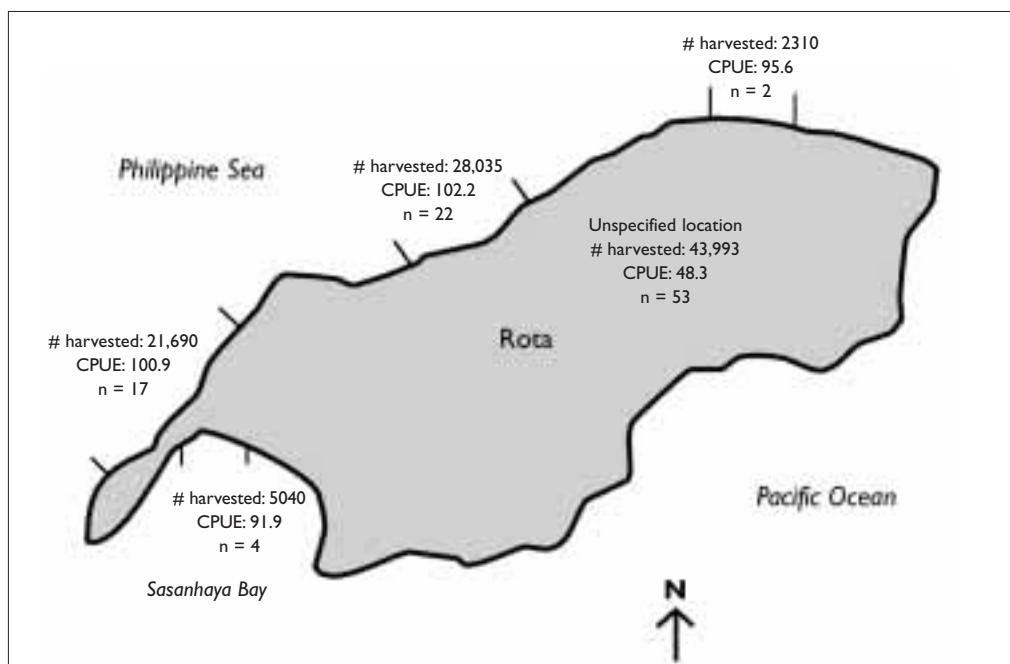


Figure 1. The island of Rota, Commonwealth of the Northern Mariana Islands.

Method

Data reporting

Beginning in January 1996 the harvest company was required to submit data to the DFW as an export permit condition. Data that were requested from the fishing company included the following:

- date of harvest
- location of harvest
- number of harvesters
- number of hours fished
- species harvested
- number harvested per species
- total live weight harvested per species
- total processed weight per species
- total weight exported
- gross and net revenues.

Data forms were created and provided to the company, along with the sea cucumber identification guide published by SPC (1994). A map was also provided to the company to document harvest locations.

Data collection took the form of requiring the company to submit these data statistics to the DFW office on Rota on a weekly basis. The data were then sent to Saipan where they were reviewed for completeness and stored in electronic format at the Saipan office.

The fishery

Harvest of sea cucumbers from the outer reef flat was completed by hand picking and placement in 6-gallon (22.7-litre) buckets, then transfer to a pickup truck for transportation to the processing facility. On the outer reef slope, sea cucumber harvest was accomplished by free diving, using a 14-foot (4.3-meter) outboard powered boat for transportation back to port. The use of scuba or hookah was prohibited by export permit condition. The harvest crew consisted of 3–5 Chuukese fishermen, plus a vessel operator when using the boat.

The catch was processed using the standard method outlined by SPC (1994). The sea cucumbers were gutted, boiled, smoked for 48 hours, sun-cured for 3–4 days, and then packaged for export.

Data quality

Managing the Rota fishery proved difficult, as no personnel could be dedicated to it on a daily basis. Problems with the submitted data were encountered in some of the data fields. These problems are outlined below.

Location of harvest

Nearly 55% of the harvest data did not specify harvest location, generalising location to ‘Rota.’

Although measures were taken to resolve the problem, enforcement was not sufficient to cause the company to alter this practice until late in the fishery, when the company began negotiations to move their operation to Saipan. Data for the months of October through December were only submitted as the monthly totals of dried weight exported.

Species harvested and number harvested per species

The sea cucumbers harvested in the submitted data were listed as 'potatoes (brown)' for every entry except twice in February 1996, when 'black teatfish' were additionally recorded. Observation of the species identified as 'potatoes (brown)' indicated that they were the surf redfish, *Actinopyga mauritiana*. Grouping all sea cucumbers under a general term such as 'potatoes (brown)' masked the presence of the black teatfish harvested, as company personnel admitted to catching black teatfish when encountered. Direct observation of landings and of the smokehouse facility on Rota indicated that black teatfish were being harvested, albeit in low numbers, but not recorded on the data sheets. The total number of sea cucumbers harvested per trip was usually submitted as a rounded estimate (e.g. '680,' '1050,' '960').

Results and discussion

The estimated total number of sea cucumbers harvested in Rota from January through May 1996 was 103,193, with an estimated total wet weight of 75,492 lbs or 34,242 kg. The average weight per 'potatoes (brown)' was estimated at 0.73 lbs or 331 g, while black teatfish were estimated to average 3.5 lbs or 1588 g. The estimated total dried weight harvested was 10,826 lbs or 4910 kg.

The dried product weight of the first shipment of sea cucumbers harvested from Rota was 2177.3 kg, which included October through the first week of December 1995. With an overall estimated mean dried weight per sea cucumber of 0.0476 kg, the estimated number of sea cucumbers harvested in Rota prior to implementation of the DFW data collection programme was about 45,757, bringing the overall total to 148,950.

Zoutendyk (1989) collected surf redfish in Cook Islands for trial processing and marketing and found outer reef flat specimens to average 280 g, while reef

slope specimens (1–3 meters depth) averaged 620 g. When compared to the average value of 331 g of Rota's 'potatoes (brown)', it suggests that the majority of 'potatoes (brown)' were probably surf redfish. Depth of harvest was provided for 78% of the harvest dates from Rota, in ranges such as 1–10 feet. It was therefore not possible to compare mean weights from different depths. If the data collected in Cook Islands by Zoutendyk (1989) were indicative of surf redfish size partitioning by habitat and depth, then the majority of surf redfish harvested in Rota were from the outer reef flat habitat. This would also be supported if the average weight were biased slightly upward due to the presence of unidentified black teatfish in some of the submitted harvest data.

Three export records from the Rota fishery were submitted to DFW as required under permit condition. These records documented that a total of over 6885 kg of sea cucumber were exported from the commercial port of Saipan to Hong Kong during 1995 and 1996 (Table 1).

Excluding the first shipment that was collected prior to company submittal of catch data, 4708 kg of sea cucumber from Rota were exported from the last two shipments, compared to the estimated dried harvest weight of 4910 kg for the similar time period submitted on the data forms. The difference may be explained by the time period of the last two shipments of sea cucumbers from Saipan, which also included sea cucumbers harvested on Rota during December 1995, prior to the January 1996 commencement of data collection.

The product recovery rate (percent of dried weight to initial weight as reported on the submitted data forms) for 'potatoes (brown)' from the Rota fishery was directly calculated as 14.34%. The average product recovery rate for the two documented harvests of black teatfish from the Rota fishery was 11.57%. The product recovery rate for surf redfish from other studies in the Pacific region varied from

Table 1. Exports of Rota harvested sea cucumbers from the port of Saipan.

Date to Saipan	Date to buyer	Destination	Shipment weight (kg)
10/12/95	16/12/95	Hong Kong	2,177.3
10/03/96	14/03/96	Hong Kong	1,562.6
1/06/96	23/06/96	Hong Kong	3,145.7
Total			6,885.6

5% to 10% (Table 2), while SPC (1994) listed the product recovery rate of the black teatfish as 8%. Inclusion of the black teatfish data lowered the overall average product recovery rate to 14.23%. Conand (1990) presented changes in length and weight for six species of sea cucumber during four stages of processing, 'initial condition,' 'after boiling,' 'smoking,' and 'dried product.' She attributed the variation of dried product weight from the various studies referred to a result of remaining moisture content. Data for the surf redfish were not presented, although data were presented for the deep-water redfish, *Actinopyga echinata*, a morphologically similar species that is replaced by the surf redfish on the outer reef flats (Rowe and Doty 1977, Kerr et al. 1993). Data presented by Conand (1990) for this species showed that the recovery rate following smoking was 16%, and following drying from 3–11%. The data from Rota suggested that 'dried weight' as submitted on the data forms could have been the weight following smoking.

Table 2. Comparisons of product recovery rates for the 'potatoes (brown)' from the Rota fishery and the surf redfish, *A. mauritiana*, from other studies.

Product recovery rate (%)	Source
14.34	Rota fishery data
7.0	Zoutendyk (1989)
5.0	Veikila and Viala (1990)
8–10	Din (1986)

Another possibility was that the sea cucumbers exported from Rota may have been of a low grade due to a high moisture content. The average price per kg as calculated from the submitted financial data was USD 7.74. By comparison, the reference price for 'Grade-A' surf redfish in Singapore in 1996 was USD 12.00–15.00, and 'Grade-A' black teatfish USD 20.00–25.00 (SPC 1997). Preston (1993) lists the mid-1990 export price of surf redfish at USD 7.00–8.00/kg and the black teatfish USD 11.00–12.00.

The mean catch per unit effort (CPUE) per month as the number of sea cucumbers harvested per collector-hour, and the number landed per month from the fishery, both calculated from submitted data, are illustrated in Fig. 2. Dalzell et al. (1996) listed CPUE as the number of pieces harvested per collector-hour for a variety of sea cucumber species, except the surf redfish. The black teatfish CPUE were very low, between 6.0 and 19.2, while mean values

for *A. miliaris* and *A. echinatus* ranged from 68.2 to 118.0. The daily CPUE in the Rota fishery varied from 34.0 to 133.6, with a mean of 72.2. Text in Fig. 1 shows the mean CPUE for harvest locations on Rota. Except for data from the unspecified harvest location, which had the lowest CPUE, the location specified CPUE data were from harvests during April and May 1996.

Both CPUE and landings increased during April and May, toward the end of the fishery, concurrent with the advent of spring doldrum conditions resulting in calmer seas that may have provided easier access to reef areas previously unexploited due to poor sea conditions. The geographic orientation of Rota does not provide for extensive lee aspects, resulting in significant surge in nearshore areas most of year, particularly during the months from September through December, when typhoon activity is at a peak in the Mariana Islands.

The lack of CPUE data from the early months of the fishery as well as the lack of location data for about 55% of the submitted data precluded any analysis of trends per area. The CPUE within the same month from unspecified locations were compared to those where location was specified in Fig. 3. The unspecified location CPUE were much lower than the specified location CPUE, even in months where both types were submitted, although the CPUE for specified location from February 1996 was comprised of only two harvests. The data in Fig. 3 would seem to support the premise that previously unexploited areas were accessed in April and May 1996. Despite the increase in CPUE over time the number of sea cucumbers harvested must have been significant to cause the company to shift operations to Saipan, indicating overexploitation. A post-harvest survey was not conducted due to limited human resources and the commencement of the Saipan fishery.

Callaghan (1995) presented an economic analysis for a hypothetical sea cucumber harvest in Micronesia by subsistence or artisanal fishermen, based on a harvest of 100 sea cucumbers sized 10 per kg dry weight, per eight hour fishing trip by two fishermen using a 16–18 foot outboard powered vessel. That analysis indicated that net revenue would fall as the size of sea cucumbers became smaller, with substantial net revenue occurring only in size categories of 10 and 20 per kg dry weight. It was found that harvests resulting in more than 30 sea cucumbers per kg dry weight were not economically viable.

The fishery in Rota was conducted by an outside commercial venture comprised of fishermen with harvest experience from other parts of Micronesia. If the size categories from Callaghan (1995) are applied to these data it can be observed in Fig. 4 that

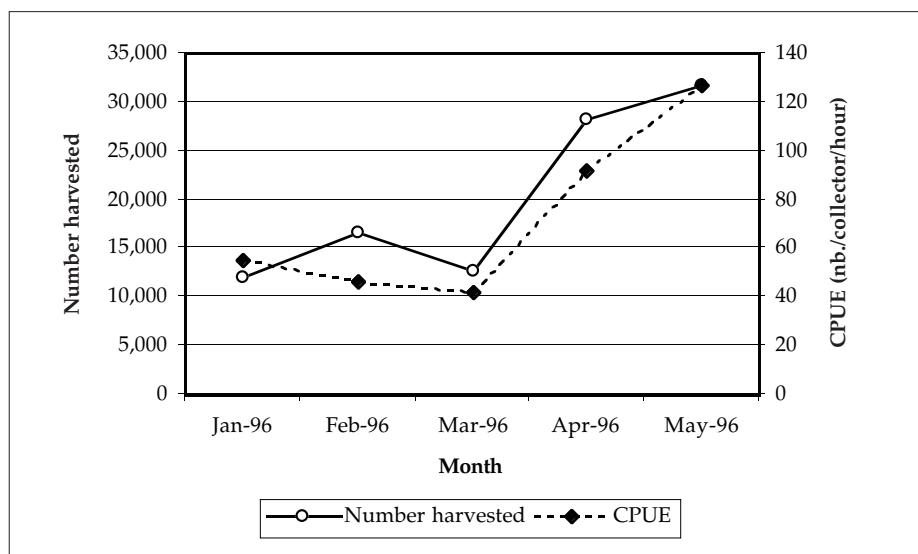


Figure 2. Total number of sea cucumbers harvested and CPUE for the Rota fishery.

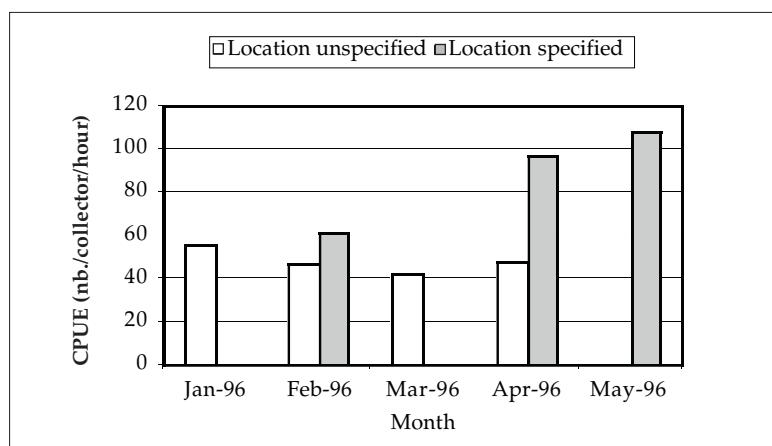


Figure 3. Comparison of CPUE for unspecified harvest location versus specified harvest location.

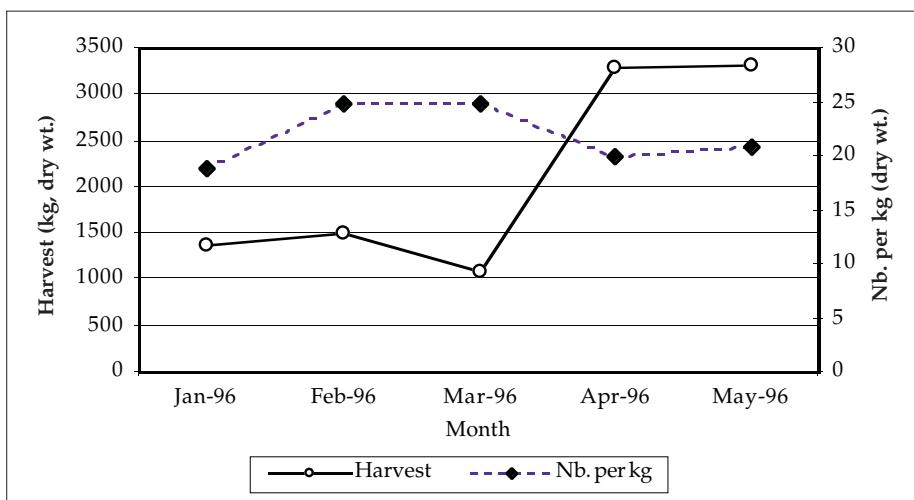


Figure 4. Total dry weight of sea cucumber harvest and mean number of individuals per kilogram of dry weight.

the 30 individuals per kg dry weight cut-off point was never attained in the Rota fishery. The highest number recorded was 25 per kg dry weight for the months of February and March 1996. During those months the lowest CPUE values were also documented (Fig. 2). Although harvest location information was not available for February and March 1996, based on data in Figs. 2–4 it appeared that some areas on Rota were probably overexploited, and previously unexploited areas were harvested during April and May 1996.

Conclusion

The data resulting from the Rota fishery indicated that the company initially had harvest success at the commencement of the fishery followed by a drop in harvest rates, due to a probable combination of seasonal conditions and over-exploitation of accessible areas. With the seasonal advent of calmer seas previously unexploited areas were targeted, resulting in high harvest rates.

The lack of any catch data from the first three months of the fishery, as well as the lack of harvest location data in nearly 55% of the reported data, hampered a more coherent analysis.

The economic model produced by Callaghan (1995) suggested an economic size limit on harvest, although the level of economic viability of a sea cucumber fishery would be related to the value of the species exploited.

In many cases throughout Micronesia local natural resource agencies lack the resources to effectively manage sea cucumber fisheries, and, as was the case of the Rota fishery, may even be unaware of its existence until it has already commenced, thereby eliminating any pre-harvest surveys that would allow rational harvest quotas to be set.

The only redeeming factor to arise from the Rota fishery was that, due to the regulations governing the CNMI DFW, any company desiring to export any marine product from the CNMI has to obtain an export permit from the DFW, to which data reporting conditions can be attached. Without such an option, it has become increasingly difficult to obtain harvest data.

In areas where no such laws exist, the situation becomes a relative impossibility. It is therefore in the best interests of natural resource agencies worldwide to assess their respective sea cucumber resources regardless of their harvest status. Assessment and establishment of rational harvest quotas ensures not only sustainable harvests, but also long-term biological sustainability of the species of economic importance.

In 1993, Richmond (1995) guided a workshop titled 'A Regional Management Plan for a Sustainable Sea Cucumber Fishery for Micronesia' at the University of Guam Marine Laboratory. The goals of the workshop were to develop a sea cucumber fishery management plan for Micronesia and to promote regional cooperation and coordination of research efforts. Although the difficulty of managing sea cucumber fisheries was illustrated in the Rota fishery, the guidelines generated by that workshop, as well as the support of numerous workshop participants, proved instrumental in obtaining the data summarised in this paper.

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Spawning and larval rearing of sea cucumber *Holothuria (Theelothuria) spinifera* Theel

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Introduction

In India, the beche-de-mer industry mainly depends on *Holothuria scabra*, commonly called sandfish, a highly valued and widely distributed species. In addition to this, another species, *H. spinifera*, commonly known as brown sandfish, is also fished in large quantities and widely processed along the Gulf of Mannar and the Palk Bay, on the south-east coast of India. The animal is brown on the upper surface and lighter on the lower surface, with sharp projections all over the body (Fig. 1a). Being a highly burrowing species, it is found on clean sand in slightly deeper waters (James 2001). This species, locally called *Cheena attai* (or *Raja attai*), was once rated high in the market and was in good demand in China. At present, the market value is moderate, the freshly caught specimens are priced at Rs. 10–15/piece and the processed ones (Fig. 1b) fetch Rs. 500–1000/kg depending on the size.

H. spinifera is fished throughout the year, usually by trawlers that form the major part of the sea cucumber fishery. It is also caught as a by-catch of *thallumadi*, a local fishing gear, and by skin diving during peak seasons. James et al. (1997) reported an estimated landing of 460 tonnes by a trawl net, modified to collect chanks locally known as *chanku madi*, during 1994–95 along the Rameswaram coast of the Palk Bay area. Sea cucumber caught in trawlers command a lesser price than those collected by skin diving, due to quality difference. Moreover, *H. spinifera* is very sensitive in nature and even a slight disturbance leads the animal to eviscerate, usually the gut along with the right respiratory tree and sometimes the gonad also. Hence, the specimens collected through skin diving were used as broodstock. Considering their commercial value, attempts were initiated for the hatchery production of seed. The hatchery technology for *H. scabra* has been developed by James et al. (1988). This paper presents the results of the

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