Woleai Islands (N=2,500) with the assistance and permission of local Island councils. The trochus were maintained in holding tanks aboard each vessel for transportation to planned reseeding sites. Some mortality occurred during transit, but in most cases losses were not significant.

It is estimated that 1,607 adult trochus were successfully planted on four atolls, with an average of 321 individuals at each site (range 103–500). Average direct cost for each planting was approximately US$5,000 per site or US$12.60 per seeded adult (excluding Eauripik where seeding was unlikely to be successful).

Monitoring will be required to determine both the relative and the economic success of the project. Data collected and reported here may assist in determining the economic and biological success of this type of development activity in the greater South Pacific region.

Trochus reseeding for the Yap State Marine Resources and Management Division, 1991–1992

Date seeded	Seedlings from	Island seeded	Number seeded	Mortality
21/11/91	Woleai	Elato	500	none
22/11/91	Woleai	Lamotrek	304	196
21/01/92	Ulithi	Sorol	500	none
22/08/92	Ulithi	Eauripik	103	397*
26/08/92	Woleai	Fachaulap	200	300*

* Note: High mortality, probably due to diesel fuel contamination of flushing water

Natural broodstock resources in Kosrae, Federated States of Micronesia

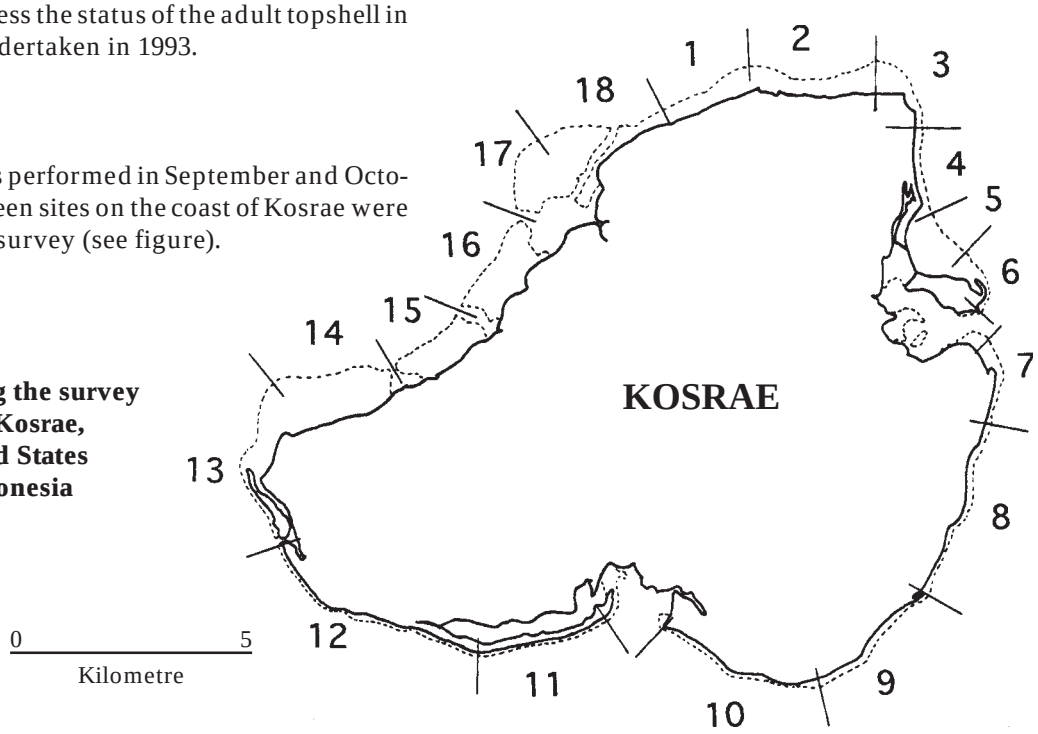
by Isao Tsutsui and Roland Sigrah, Marine Resources Division, Kosrae, FSM

T. niloticus have not been harvested in Kosrae since 1987 because stocks have been reduced by overfishing. Broodstock animals were distributed from a trochus sanctuary to other sites by the Kosrae State Marine Resources Division (KMRD) in 1988. A survey to assess the status of the adult topshell in Kosrae was undertaken in 1993.

Methods

The survey was performed in September and October 1993. Eighteen sites on the coast of Kosrae were chosen for the survey (see figure).

The fixed-time swimming method was used for the survey (Nash 1985). The survey was limited to water 1–7 m deep on the reef slopes. This covered the ranges of water commonly accessible to free-diving topshell fisherman (Heslinga et al. 1984).



Map showing the survey sites on Kosrae, Federated States of Micronesia

Several SCUBA divers carefully searched for live adult topshells (over 60 mm in diameter), and recorded the number of animals found in a given time interval. On average each diver searched approximately 7 m^2 per minute. The total area searched at each site was calculated by multiplying the number of minutes spent searching by 7 m^2 (area searched per minute):

Area searched at each site (m^2) = no. of minutes spent searching x 7 m^2 (area searched per minute)

Trochus densities at each survey site were calculated from the number of *T. niloticus* found divided by the total area searched:

Density of animals in each site (tr/m^2) = number of animals found ÷ area searched

The physical dimensions of each site were measured. The depths (from 1 to 7 m) were measured directly underwater at each site. The horizontal lengths of the reefs were taken from the Kosrae Coastal Resources Atlas (Manoa Mapworks 1987). The area of each was then calculated as follows:

Estimated site area (m^2) = water depth from 1 to 7 m x horizontal length of the reef (m)

The biomass of topshells at each survey site was calculated by multiplying the density value at that site by the estimated site area:

Biomass of topshells = density of animals at each site (tr/m^2) x estimated site area (m^2)

The diameter of topshells collected and water depths were also recorded.

Results and discussion

The results are shown in the table below. The density of *T. niloticus* on Kosrae was 0 to 0.129 tr / m^2. The trochus sanctuary had the highest value in the site surveyed. This indicates that the regulation creating a trochus sanctuary on Kosrae is well worthwhile.

In Palau, Heslinga (1984) reported a density of 4 tr / m^2 on the Idekelules Reef. On Yap, densities of 2 to 33 tr / m^2 were reported (Fagolimul 1987). In the Cook Islands, densities of 1 to 25 tr / m^2 were reported, with a maximum density of 66tr / m^2. The topshell density at Kosrae was considerably lower than the densities in the other Pacific Island countries. The environment at Kosrae appears to be suitable for *T.niloticus* to propagate.

Density and biomass of *Trochus niloticus* at 18 locations on Kosrae in 1993

Site	Total survey time (min.)	Number of topshells found	Topshells density (tr/m^2)	Estimated site area (m^2)	Estimated biomass
1	60	8	0.019	334,400	6,370
2	60	16	0.038	180,000	6,857
3	60	5	0.012	241,500	2,875
4	60	2	0.005	132,300	630
5	60	3	0.007	81,270	581
6	60	6	0.014	423,150	6,045
7	60	5	0.012	114,000	1,375
8	60	0	0.000	258,020	0
9	60	0	0.000	197,470	0
10	60	2	0.005	135,750	646
11	75	6	0.014	339,010	4,843
12	60	0	0.000	454,020	0
13	60	18	0.043	260,010	11,143
14	60	4	0.010	220,400	2,112
15	60	24	0.057	223,290	12,759
16*	60	54	0.129	191,100	24,570
17	60	4	0.010	182,700	1,740
18	60	26	0.062	328,250	20,320
Total					**102,866**

* present trochus sanctuary site

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Trochus niloticus propagation project in Kosrae, Federated States of Micronesia

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The topshell, *Trochus niloticus* L, is one of the commercially important gastropods in the tropical regions. Its natural range is limited to a region from Ryukyu, through the Philippines, Indonesia, to Fiji, Vanuatu and northern Australia. However, its geographical range has been greatly enlarged by artificial distributions:

Five hundred topshell were introduced successfully from Pohnpei to Kosrae in 1959. Since then, the topshell population has propagated and become a common element of the reefs of Kosrae.

As the commercial value of *T. niloticus* has increased recently, it has become a significant source of supplementary income for the people of Kosrae. This trend is also apparent in the other states of FSM and other Pacific countries.

The resulting increased fishing pressure on the natural population of the topshell has caused numbers to decline (Heslinga & Hilmann, 1981).

Conservation and population management and / or release of artificially raised seeds appear to be efficient methods of preserving the topshell resources and enabling them to recover.

The *T. niloticus* propagation project, which is jointly administered by the Kosrae State Marine Resources Division (KMRD) and the FSM National Aquaculture Center (NAC), started in March 1992.

The final goal of this project is to allow recruitment and to releasing artificially produced seed to augment the natural increase. The project has three phases as follows:

1. Development of seed production techniques;

2. Development of re-seeding techniques;

3. Seed production, re-seeding and conservation.

During 1992–1994, the project dedicated its attention to the development of seed production techniques suited to Kosrae's economy, environment, culture and customs. Cost-efficient methods were developed to allow the project to function in the present economic situation.

1. Efficient spawning induction in Kosrae

Static-water stimulus was used for all spawning inductions of *T. niloticus*. The animals were kept in a small tank of static sea water filtered through one-micron mesh with strong aeration, for approximately 24 hours. After this spawning stimulus, all the animals were placed in the spawning tank with continuous filtered sea-water flow.

Nineteen spawning experiments were performed, and 66–90 percent of the broodstock were induced to spawn by this method. In Japan, ultraviolet (UV) is used to induce spawning of this species. However, this method is very expensive (Isa, 1991). Additionally, induced rates were almost identical to our result. In Fiji, warm-water stimulus is applied to broodstock. The sea water is warmed by direct heat via sunlight. However, this method is not suitable for Kosrae due to its frequent rainfall. The static-water stimulus is easier, cheaper and the most efficient method of inducing *T. niloticus* to spawn in Kosrae.

2. Hatchery and nursery operations

2.1 Fertilisation and hatchery operation

Each individual was sexed while gametes were being released. Males and females were placed in separate filtered sea-water tanks for collection of gametes. Artificial fertilisation was performed immediately after the eggs had been collected.

The fertilised eggs were placed in 40–50 litre hatchery tanks and reared in 1 micron filtered sea-water.