

Abstracts and publications on trochus and other molluscs

The remarkable population size of the endangered clam *Tridacna maxima* assessed in Fangatau Atoll (Eastern Tuamotu, French Polynesia) using in situ and remote sensing data

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Source: ICES Journal of Marine Science 62(6):1347–1048.

Several lagoons of the Eastern Tuamotu Atolls (French Polynesia) are characterized by enormous populations of the clam *Tridacna maxima*, a species considered as endangered in many locations worldwide. This unique resource is virtually intact, until recently being impacted only by local consumption. Increasing exports to Tahiti's market (up to 50 tonnes of wet matter y^{-1}), combined with the relatively small size of these lagoons ($<50 \text{ km}^2$), have raised significant concerns for agencies charged with management of lagoonal resources. In order to evaluate whether the current harvesting pressure threatens long-term sustainability of this resource, it is necessary to estimate the total number of individual clams present and also the fraction of that stock that is currently targeted by fishers, who generally collect clams in very shallow waters ($<1 \text{ m}$), walking on the reef edges. Here, we present results for a pilot study evaluating this resource at Fangatau Atoll. Using a combination of data collected *in situ* and three remotely sensed images with different spatial resolution (1.5, 5.6, and 30 m), we estimate that the shallowest lagoonal areas (4.05 km^2 at depth $<6 \text{ m}$) harbour five classes of benthic habitat with significantly different clam areal covers and densities. Considering the cover/density values for each habitat class, 23.65 ± 5.33 million clams (mean $\pm 95\%$ confidence interval) inhabit these 4.05 km^2 . Assuming that current harvesting techniques will be maintained in the future, the commercially available stock represents 44% of the population located on 1.18 km^2 of the shallow lagoon. A comparison of results from the three remote sensing platforms indicates that high resolution, broadband multispectral sensors (e.g. IKONOS, Quickbird) should provide the best existing platforms to conduct similar assessments elsewhere.

Stock enhancement programs in the United States affiliated Pacific Islands for economic development and food security

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Source: Journal of Shellfish Research 24(1):330–331. January 2005.

There is a strong desire by many of the Pacific Island governments to develop income-generating local industry based on available natural resources, and to restock reefs where natural marine populations have declined. Some nations in the United States affiliated Pacific Islands such as the Republic of the Marshall Islands (RMI), Federated States of Micronesia (FSM), and the Republic of Palau also face increasing economic pressure as funding from their respective Compacts of Free Association with the USA diminishes. Farming marine and freshwater aquaculture organisms has the potential to provide export products, alleviate social pressure on threatened food species, and provide import substitutes for the US affiliated Pacific Islands. The economy mainly relies on foreign aid. Presently, there is emphasis on the development of marine resources, mainly marine aquaculture or mariculture, to meet future economic needs, become self-sufficient, and develop food security for its fast-growing population. Pollution-free water and biodiverse fauna of finfish and shellfish, of which several are endemic to the region, bless all the US affiliated Pacific Islands. Because the land area is minute compared to the vast ocean exclusive eco-

conomic zones, it means that in all these nations the natural resources are primarily marine. The nations' abundant and extremely biodiverse coral reefs provide habitat for robust fish populations and other marine life that support subsistence and commercial fisheries. However due to overfishing and bad and destructive fishing practices, several species have become overexploited and need conservation. There is also a strong desire by the national governments to develop revenue-producing local industries based on available natural resources and to restock reefs where natural marine populations have declined. The national and local governments have also initiated marine protected areas (MPA) to revive the fisheries. In addition to this, there are several stock enhancement programs, especially in shellfish like ornamental shellfish like trochus, black pearls, and giant clams, being undertaken successfully to restock the depleted reefs and in the MPA. Preliminary results have shown that these stock enhancement programs have been successful mainly due to the community participation in these activities. The success and popularity of such measures have prompted the governments to look into stock enhancement programs through sea ranching of hatchery-produced fish fingerlings of food finfishes like groupers, snapper, and other food fishes and several rare and endemic ornamental fish and shellfish species for food security, stock replenishment, and enhancement, thus paving the way for future economic benefits and community self-sufficiency and self-reliance.

Trochus resources: a new fishery for Tonga?

S. Malimali

Source: I. Novaczek (ed). 2005. Pacific voices: Equity and sustainability in Pacific Island fisheries. Suva: Institute of Pacific Studies, USP Fiji. 137–151.

Many Pacific island countries are exploring the potential of aquaculture for enhancing food security and marine exports. One of the most popular species for introduction has been the topshell, *Trochus niloticus* and, despite its experimental release in Tonga in 1992, information on the size of the stock and fishers' perceptions are limited. This study explores how fishers' activities, attitudes and livelihood options have influenced the trochus fishery establishment program in Kolonga village on Tongatapu. Observation, questionnaires, creel surveys and interviews were used for data collection over several months in 2003. The role of women in the fishery is a critical element, since day gleaning by women is the major fishing activity on the Kolonga reef. Day and night diving also occurs, but only by men. Females glean only for food, fishing 5–6 times per week. Trochus was found in only 8 of 79 catches inspected and had only been collected for home consumption. None of the fishers sold the shell, knew that the shell was marketable, knew that it had been introduced to Tonga, nor knew that harvesting it was banned. Trochus represented only 3% of the shells collected, but most fishers said they collected it. The basal diameter of trochus harvested from Kolonga ranged from 30 mm to 120 mm, with the majority being 50–90 mm. As the sexually mature size of male and female trochus is between 55 and 70 mm, some of the specimens observed were too small to have reproduced. Even small captures reduce the chance of a commercial fishery being established, and the trochus population could even become depleted to the point of local extinction. Recommendations for ensuring a viable trochus fishery in future include strengthening awareness programs, implementing community-based management measures and involving young people, women and elders (those most dependent upon reef gleaning) in local management systems.

Gender, generational perceptions and community fisheries management in Lelepa, North Efate, Vanuatu

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Source: I. Novaczek (ed). 2005. Pacific voices: Equity and sustainability in Pacific Island fisheries. Suva: Institute of Pacific Studies, USP Fiji. 186–208.

In recent decades there has been significant pressure on rural Vanuatu to join the cash economy. Communal sharing of resources has shifted to individual harvesting of marine resources for commercial gain, affecting gender roles, technologies used and fish stocks. The history of change in subsistence and small commercial fishing activities on Lelepa Island, north Efate, illustrates these developments. Researchers from the Vanuatu Cultural Centre collected data on traditional harvesting and management

practices in 1999–2001. For this case study additional research was conducted in 2003 using observation and semi-structured interviews. While marine products remain the primary source of protein on the island they have also contributed to cash incomes, creating a dilemma for the community. For example, traditionally only women collected trochus but as it became commercially valuable men started to harvest it also and demand outstripped supply. Trochus is now uncommon. The introduction of spear guns, nets, reels and motor boats meant that by the 1970s Lelepa's other marine resources were also in decline. Green snail may be locally extinct. Beche-de-mer was fished out in the late 1970s. Many big fish, especially wrasse and grouper, are also now rare. Despite this the bulk of fish caught still goes for sale in Port Vila. Foreign companies have paid large access fees to collect fish, live corals and juvenile giant clams for the aquarium trade, but no monitoring of their activities has been done and it has had a detrimental impact on the emerging ecotourism industry. The paramount chief of Lelepa responded to these pressures by introducing traditional harvest bans and a marine protected area in the early 1990s. This was not popular with many fishermen and meant the end of fishing for elderly women. By custom, women have little say in village decision-making, but they are expected to provide food for their families and they also play an unacknowledged role in educating children about the protected area. Some species are recovering but violation of the ban by some small chiefs has led to problems of compliance and enforcement. Finding the balance between subsistence needs, economic development and resource conservation in Lelepa is likely to remain difficult and contentious.

Gender collaboration: a case study of local resource management in Safa'i village, Samoa

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Source: I. Novaczek (ed). 2005. Pacific voices: Equity and sustainability in Pacific Island fisheries. Suva: Institute of Pacific Studies, USP Fiji. 209–220.

Women in coastal communities across the Pacific have long been involved in many aspects of fisheries, but their role has often been undervalued or neglected in government plans and processes. This study explores gender roles in fisheries management and conservation in the village of Safa'i, a small, traditional community on the northern coast of Savai'i, the biggest island of Samoa. Safa'i has a population of around 250 and the village economy is based on subsistence and artisanal fishing and agriculture. Traditional fisheries management practices were based upon male chiefly authority and excluded women from consultation and decision-making. Problems occurred due to the lack of full community support and poor enforcement, exacerbated by population concentration in coastal areas. In 1995, the Samoan government introduced a fisheries extension program which gradually devolved powers and responsibilities for inshore fisheries management back to local communities. Safa'i joined this program in 2002. A cooperative management approach has established an institutional structure for the control of marine resources, enabling collaborative actions between the village leaders (matai) and the government. Shared decision-making involving both men and women was introduced and members of the Women's Committee were elected to sit on a Fisheries Management Advisory Committee. Consultation with women, matai and untitled men led to a fisheries management plan which has included: the creation of a marine protected area; bans on destructive fishing practices; enforcement of village rules and bylaws; restocking of reef and lagoon areas with giant clams and trochus; and workshops and training for villagers on fisheries management and conservation. Alternative activities such as penning fish for harvest and turtles for tourism and conservation have also been introduced. The plan is monitored and enforced by a committee consisting of men and women. Women's traditional fishing activities have been affected, as has their domestic routines, time allocation and family nutrition, but the changes will also benefit them. Safa'i has become very successful and the active collaboration of both women and men in fisheries management is seen as a key factor in achieving sustainable fisheries. Recommendations for further improvements made include: strengthening communications with village level women's committees and encouraging women's participation in workshops and training; using the women's committees to promote fisheries management; improving data on subsistence fisheries and women's involvement in fisheries; undertaking periodic reviews of fisheries management plans to determine the progress of women; and establishing a 'Women in Fisheries Association' in Samoa.

A 60-year isotopic record from a mid-Holocene fossil giant clam (*Tridacna gigas*) in the Ryukyu Islands: physiological and paleoclimatic implications

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Source: Palaeogeography, Palaeoclimatology, Palaeoecology 212(3–4):343–354. (Sep. 2004).

We have constructed a 60-year stable isotope record from a ^{14}C -dated fossil giant clam, *Tridacna gigas* (6216 years BP), at its northernmost latitudinal limit in the geological past, on Kume Island, Central Ryukyu Archipelago, Japan. Stable oxygen ($\delta^{18}\text{O}$) and carbon ($\delta^{13}\text{C}$) isotopic analyses are combined with observations of growth lines seen on the inner shell layer. Sixty pairs of summer/winter growth lines, which preserve daily growth increments were observed in the inner shell layer. Two growth phases, characterized by a growth curve and isotopic profiles, are clearly recognized throughout the growth history of this specimen. No significant shifts in average values of the two isotopic ratios were detected during its growth history, although the growth rate varied widely from 1 to 15 mm/year over 60 years, including after the onset of sexual maturity. Spectral analysis of the fossil *Tridacna* $\delta^{18}\text{O}$ time series implies that decadal variability observed in the North Pacific Ocean during the past hundred years also existed 6000 years ago. Our study implies that fossil giant clams are one of the best means of inferring isotopic records of annual to decadal climate variations. Giant clams have the advantages of a dense shell, high growth rate, long lifespan, and geographically and geologically broad distributions.

Dimethylsulfoniopropionate in six species of giant clams and the evolution of dimethylsulfide after death

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Source: Third International Symposium on Biological and Environmental Chemistry of DMS (P) and Related Compounds, Rimouski, Quebec, Canada 26–28 September 2002. Canadian Journal of Fisheries and Aquatic Sciences 61(5):758–764.

Substantial accumulation of dimethylsulfoniopropionate (DMSP) is documented in tissues of all six of the common species of giant clams (Tridacnidae). Results include measures of DMSP concentrations in siphonal mantle, byssal mantle, adductor muscle, and gill tissues obtained by gas chromatography of alkalized extracts plus evidence of DMSP from mass spectrometry. Formation of dimethylsulfide (DMS) by tissues after death is documented. The tridacnid clams maintain symbiotic associations with populations of dinoflagellates, which live in the enlarged siphonal mantle. It was postulated that because of their association with dinoflagellates, the clams would chronically accumulate DMSP to high concentrations. The results show that DMSP occurs at over 30 nmol degree kg^{-1} in many tissues of tridacnid clams, meaning that these clams accumulate DMSP to the highest documented tissue concentrations in the animal kingdom. DMSP at such concentrations could affect multiple properties and functions. Of particular interest for this research was to assess whether postmortem breakdown of DMSP is responsible for the rapid development of potent off-odors and off-tastes that have blocked the commercial success of giant clam aquaculture. High concentrations of DMS produced in the day after death probably account for the peculiar perishability of giant clam tissues.

Effects of copper and decreased salinity on survival rate and development of *Tridacna gigas* larvae

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Source: Marine Environmental Research 58(2–5):793–797. (August–December 2004).

Giant clams (Family: Tridacnidae) are endangered species distributed in the Indo-Pacific region. In this study, survival rate and development of *Tridacna gigas* larvae were studied for three days in ambient water (32 psu), copper ($2.5 \mu\text{g Cu}^{2+} \text{ L}^{-1}$), reduced salinities (25 and 20 psu) and the combination of copper and 25 psu salinity. No significant differences were found in larval development between treatments. The survival rates decreased considerably with reduced salinities although the combination of copper and reduced salinity gave synergistic effects. As a consequence, this could limit population growth of giant

clams in coastal areas and could also explain the absence of larval settlement on reefs close to harbours or river mouths. More research is needed to understand the basic requirements and stress tolerance in giant clam larvae for reef restoration and other management actions to be successful.

Successful seeding of hatchery-produced juvenile greenlip abalone to restore wild stocks

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Source: Fisheries Research 78: 179–185. (2006)

Seeding of hatchery-produced abalone has the potential to enhance or maintain wild populations and ensure the viability of fishing grounds, but survival of outplanted juveniles has been poor in many previous seeding experiments. In our study hatchery produced *Haliotis laevis*, age 18 months with a mean size of 28 ± 3 mm, were released at eight sites in South Australia. Because a pilot study showed significant increases in survival 2 months after release in reefs with two layers of boulders compared to a single layer, six reefs were established at each site, each with two boulder layers and approximately 6 m² in area. Juveniles were anaesthetised prior to individual tagging and then given 5 days to recover on settlement plates within cages. The cages were transported in cool boxes, opened and placed between boulder layers by divers within 6 h of leaving the hatchery. Six months after seeding almost all juveniles were in cryptic positions between boulders, but 9 months after seeding 17% of abalone were emergent at 56 ± 7 mm. Estimated minimum survival after 9 months was poor at two sites (0 and 23%) but at six sites survival ranged from 47 to 57%. Empty shell collections accounted for 10% of seeded juveniles during this period. A second seeding a year later at one site resulted in similar survival after 3 months. These results compare very favourably with previous seeding experiments, particularly considering the range of sites seeded and the number of reefs within each site. This was probably due to careful site selection, careful handling of seeded juveniles and the provision of a suitable, cryptic environment to reduce mortality. Poor survival at two sites appeared to be due to the presence of large numbers of predators soon after seeding.

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