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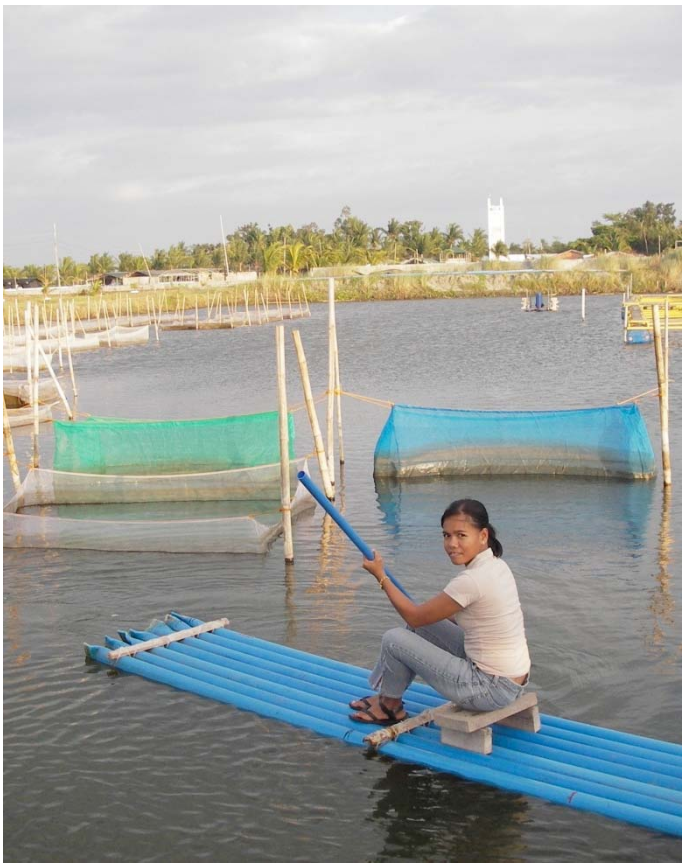

ACIAR-SPC Asia-Pacific Tropical Sea Cucumber Aquaculture Symposium

15-17 February 2011,
Noumea, New Caledonia

BOOK OF ABSTRACTS

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ACIAR-SPC Asia-Pacific Tropical Sea Cucumber Aquaculture Symposium

(15-17 February 2011, Noumea, New Caledonia)

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15.30	Break out groups to identify knowledge gaps for each major issue.	
16.30	Reconvene to collate these and prioritise as a group. Rank each issue.	
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16.00	***Symposium Closing***	

Regional Overviews

THE GLOBAL POTENTIAL OF SEA CUCUMBER AQUACULTURE

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Abstract

In 2003, the Food and Agriculture Organization, in response to a growing number of enquiries from its members, organized an international workshop on sea cucumber aquaculture and management. This gathering of experts clearly showed that sea cucumber fisheries, the over-exploitation of many species and the interest in farming these echinoderms for the lucrative Asian markets were no longer a limited to the Asia-Pacific region, but very much an issues that had spread to all continents. The growing demand for both temperate and tropical species of sea cucumbers as food items, predominantly among the Chinese, have pushed fishing communities in many countries to exploit their resources. This has led to the over-exploitation of many of the high-valued and traditionally demanded species and also the exploitation of species not usually demanded by the market. Consequently, an increasing number of countries have realized the need to regulate its fisheries by establishing management plans and regulatory measures to avoid the collection of undersized specimen and depletion of stock. These plans have had a mixed degree of success for a number of reasons and complications in managing this type of fishery.

In view of the declining resource, increasing attention has been channelled into farming sea cucumbers. In the case of the temperate *Apostichopus japonicus*, one of the major farmed and traded species in China, hatchery techniques have been well researched and developed and mass seed production is nowadays a reality. In the case of tropical species, seed production technology for one of the top species traded, i.e. *Holothuria scabra*, have been worked out but not widely available. The current interest in sea cucumber aquaculture is high, particularly in those countries that have the above sea cucumber species in their waters, but also for other species which are being investigated. The market for sea cucumber products is growing and it is likely that the largest market, China, will continue increasing its demand.

OVERVIEW OF SEA CUCUMBER AQUACULTURE AND STOCKING RESEARCH IN THE WESTERN PACIFIC REGION

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Abstract

Sea cucumber represents an important source of income to coastal communities in many parts of the Pacific Islands and in some communities it may be the only source of income. For most of the Pacific Island Countries and Territories (PICTs) sea cucumbers are harvested and processed into bêche-de-mer for the export market. Catches from Asia and Pacific regions are known to be the highest, with about 36 species harvested in the Pacific region.

The fast pace of development of sea cucumber fisheries to supply the growing international demand for bêche-de-mer is placing sea cucumber fisheries at risk. Throughout the Pacific, sea cucumber stocks are known to be under heavy fishing pressure, catches of small individuals and low value species are increasing. Management measures have generally failed to stop the decline and some PICTs have resorted to the extreme measure of fishing moratoria to encourage stock recovery. Concern about overexploitation has led to initiatives to promote sea ranching and restocking as an income generating activity and a means to rejuvenate wild stocks. Countries such as New Caledonia, Solomon Islands, Fiji, Marshall Islands and Kiribati have made progress with sea cucumber aquaculture of two tropical species, sandfish (*Holothuria scabra*) and white teatfish (*Holothuria fuscogilva*). Kiribati is the only PICT which has developed expertise in white teatfish aquaculture.

The western Pacific has a number of advantages in terms of sea cucumber culture. Systems of community managed marine areas have been used for other species such as clams. Harvesting of sea cucumber is by hand and does not require special expertise, capital or changes to traditional practices which means benefits flow directly to the village level. Existing aquaculture facilities can be adapted to sea cucumber aquaculture. However, there are also challenges faced with sea cucumber aquaculture and restocking. Availability of hatchery technology, expertise and resources is often limited, especially for small PICTs. Natural disasters, such as cyclones, occur in the region and pose a risk to released juveniles and adults. Land ownership issues may affect released juveniles or broodstock if release sites are open to fishing or under dispute. In the areas where populations are already depleted, sufficiently large wild broodstock may be hard to find. Large outdoor tanks are expensive and many PICTs do not have seawater ponds available for nursery. Shared hatchery facilities may assist countries with limited hatchery capacity, however translocating juveniles from one area or region or country to another can cause irreversible genetic problems.

This presentation will highlight developments in a number of Western PICTs who have been involved in sea cucumber aquaculture. It will also report on the capacity of other PICTs who have not made progress in this area but plan to do so.

OVERVIEW OF SEA CUCUMBER AQUACULTURE AND STOCKING RESEARCH IN THE SOUTH-EAST ASIAN REGION

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Abstract

South-east Asia has traditionally been the global centre of production of sea cucumbers for Chinese markets. While early research into culture methods took place outside this region (notably in the Pacific, India and China) recently investment in *H. scabra* culture in particular has lead to some significant advances within this region. The authors are aware of programs in five countries; Philippines, Vietnam, Thailand, Malaysia and Indonesia. Philippines and Vietnam have been at the forefront of recent efforts, with involvement from substantial national programs and local institutions as well as international donors and scientific organizations.

Efforts in the Philippines have focused on hatchery production, community-based sea ranching, and improving fishery governance. Notable outcomes include functional model ranching enterprises, progress with diverse culture methods suitable for a range of circumstances and increasing capacity for scaling out hatchery technology. Recently efforts on co-culture and pond-based production have been stepped up.

In Vietnam, efforts have concentrated on hatchery development and pond-based culture. Simplification of hatchery methods has lead to the ability to produce large numbers of juveniles year-round. This in turn has lead to a fledgling culture industry, with up to a dozen farmers across three provinces producing sea cucumbers in mono-culture or in rotational culture with shrimp.

Efforts in Malaysia, Thailand and Indonesia have been smaller and generally isolated to individual institutions or projects, without industry or community scale-out at this point. Constraints to future expansion of culture systems, and steps towards removing these will be outlined.

LARGE-SCALE PRODUCTION OF SANDFISH FOR POND CULTURE IN VIETNAM

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Abstract

In recent years, the farming of sandfish *Holothuria scabra* has been adopted by a number of farmers in South Central Vietnam. Hundreds of thousand hatchery-produced juvenile sandfish have been stocked in the region. Broodstock were collected from the wild in Khanh Hoa province. They were also chosen from commercial culture ponds at 40-500g. The broodstock are stored in a holding pond at a low density at below 200g m^{-2} without adding feed. There should be plenty of animals in the pond to substitute a group of 50 animals after breeding in the hatchery. The animals of average weight around 350g are transferred to conditioning tanks about 1 month prior to spawning. Indoor conditioning tanks are prepared with sandy substrate and sand-filtered water supply. Water exchange should be monitored and temperature held below 30 ^{o}C. The animals are fed with fine shrimp feed. Co-culture of sandfish broodstock with Babylon snails (*Babylonia areolata*) in tanks provides extra feed that contributes to growth. Simplified hatchery methods using cheap and basic equipment have been refined over the past decade and consistent batches of juveniles can now be produced at will, with around 50,000 competent juveniles produced from batches of 2 million eggs.

Sandfish are cultivated in 0.5 to 1.0 ha ponds with muddy sand or coral-sand substrate using simplified techniques and management methods developed locally. The pond should be drained to kill all predators. The stocking size is 2g-20g and stocking density 1 m-2. The water is changed by opening and closing sluice gates with the tide. Paddle wheels are used to mix pond water to prevent stratification in the rainy season. Water depth in ponds is maintained at 0.8-1.5m. Seaweed and predators should be removed regularly during the culture.

The results of model sandfish culture ponds in three provinces (Khanh Hoa, Phu Yen, Ninh Thuan) typically proved that sandfish pond culture can be profitable for farmers in these coastal areas. After 9-14 months, sandfish were harvested at 2.61- 2.7 tonnes ha-1. Survival rates were higher with larger initial sizes (80% for 2g, 85% for 10g and 87% for 20g). Sandfish produced from pond culture are usually sold to local dealers or buyers in Ho Chi Minh City. The constraints to commercial sandfish pond culture in Vietnam are no longer pond management and the low prices paid by the dealers, but rather density limits and culture duration.

IN VITRO FERTILIZATION OF SEA CUCUMBERS, A NEW METHOD TO BOOST AQUACULTURE PRODUCTION

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Abstract

The usual way to get larvae in sea cucumber aquaculture is to obtain eggs during the spawning period by means of thermal shocks. This method is usually efficient although laying often occur within few very short periods. It means that sea cucumber hatcheries are not fully used throughout a year which is a loss of benefit for aquaculture companies. For instance, in Madagascar, eggs are available through thermal shocks from December to February: it means that if the hatchery would rely on this method, it will be in activity no more than five months during a year. In Madagascar Holothurie S.A., larvae are obtained each month through in vitro fertilization what boosts the production and decreases the cost of the infrastructures needed for juvenile growth.

Oocyte maturation in sea cucumbers is stopped during the meiosis at prophase I. Maturation naturally concludes just before spawning leading to mature oocytes ready to be fertilized. The discovery of a new and highly effective oocyte maturation inducer allows the deblocking of meiosis and the fertilization of oocytes that are present at any time of the year. The oocyte maturation inducer is a molecule whose way of action on oocyte maturation is now understood. The maturation inducer effects on oocytes of various species, including the marketed species *Holothuria scabra* and *Holothuria fuscogilva*, were analysed and compared to that of the few oocyte maturation inducers described in literature. The new substance induces the maturation and fertilization of more than 90% of oocytes while other inducers [1-methyladenine, dithiothreitol (DTT), dimercapto-propanol (BAL) and L-cysteine] enable 28–90% of oocytes to mature. The use of the last inducers results in fertilization rates that never exceed 40%, and the obtained larvae present developmental abnormalities. The new substance action on *H. scabra* oocytes is efficient yearlong even outside the spawning period of *H. scabra*. It is effective on the oocytes of all aspidochirote species tested so far coming from various seas such as Mediterranean, Sea of Oman and the Mozambique Channel.

EVALUATION OF NUTRITIONAL CONDITION OF JUVENILE SANDFISH, HOLOTHURIA SCABRA

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Abstract

It is important to accurately evaluate the well-being or nutritional condition of organisms for monitoring the wild stock conditions and improvement of aquaculture techniques; however, reliable nutritional condition indices have not been established for sea cucumbers. In this study, the effects of starvation on condition factor (body volume / body weight), coelomic fluid constituent (protein, carbohydrate and cholesterol) concentrations and coelomic fluid density were analyzed in an attempt to establish a method to determine nutritional condition in juvenile sandfish, *Holothuria scabra*. Body length, width and weight of juveniles produced at sea cucumber hatchery of Aquaculture Department, Southeast Asian Fisheries Development Center (SEAFDEC/AQD) were measured after anaesthetization with 2% menthol. Coelomic fluid protein level was analyzed by the BCA method. Carbohydrate level was analyzed by the phenol - sulfuric acid method. Cholesterol level was analyzed by the Zak method. Coelomic fluid volume and coelomic fluid weight were measured. Starvation caused a concomitant decrease in body length, width and weight, resulting in constant condition factor, indicating that condition factor cannot be used as a nutritional condition index. Coelomic fluid constituent levels could be measured with a small amount of samples (i.e. 10 - 20 μl). Although no clear pattern was observed in coelomic fluid protein and cholesterol levels during the starvation trial, carbohydrate level increased. Coelomic fluid density also increased during starvation. These results suggest that coelomic fluid density and carbohydrate level may be used as an index for nutritional condition of sandfish without sacrificing the animal.

*OCEAN NURSERY SYSTEMS FOR SCALING-UP JUVENILE SANDFISH (*HOLOTHURIA SCABRA*) PRODUCTION- ENSURING OPPORTUNITIES FOR SMALL FISHERS*

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Abstract

Cost-effective production of juveniles to release size (>3g) is a primary objective in the culture of *Holothuria scabra*. Ocean nursery systems were developed to address space limitations in a small hatchery set-up and shorten the rearing period in the hatchery. Growth and survival of first stage juveniles (>4 mm) in two ocean nursery systems: floating hapas and bottom set hapa cages were compared with those reared in hapa nets in a marine pond. The effects of sand conditioning on juvenile quality were also investigated. Juveniles were in good condition, and survival was not significantly different among the different nursery systems. However, growth in pond hapa nets was significantly higher. Nonetheless, the estimated cost of producing juveniles in the floating hapa system was only about half (0.22USD per juvenile) compared to those reared in the other systems. Moreover, local community partners easily maintained the floating hapas and reared the juveniles to release size. Growth of sand-conditioned juveniles was higher than unconditioned ones in hatchery tanks and significantly more conditioned juveniles buried within the first hour of release in the field. From floating hapas, juveniles can be conditioned in sea pens for at least a week prior to release. However, whether this intermediate rearing procedure will be practical with large numbers of juveniles needs to be considered. Results show that ocean nursery systems are simple and viable alternative systems for scaling-up juvenile sandfish production compared to hapas in marine ponds which might not be accessible to small fishers.

SMALL-SCALE HATCHERIES AND SIMPLE TECHNOLOGIES FOR SANDFISH PRODUCTION

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Abstract

The on-going production of sandfish in Davao City, Philippines is a demonstration of collaborative efforts and localizing the technology. Two business groups offered work spaces inside their pond properties at no cost. The $30m^2$ and the $80m^2$ structures in Alsons and Highponds, respectively, are made of light materials. The fiberglass and the marine plywood tanks as well as the hapa nets are all made locally. The water channel inside Alsons serves two other purposes: as a natural conditioning area for the broodstock and a hapa nursery for juveniles. Broodstock can be kept for weeks in the channel with zero mortality even without maintenance. In the hapas, juveniles can grow to 5-10 g in 1-2 months at an average survival of 84%. Instead of 2-3 algae species for larval food, only *Chaetoceros calcitrans* is given until the early juvenile stage. To further cut on maintenance cost, a weekly stock of *C. calcitrans* is bought from Alsons and scaled up using recycled 250L PVC barrels. Bloodworms are kept off by covering the tanks with black cloth. Each hatchery has a capacity of 480,000 fertilized eggs and a performance average of 1.9% survival to 3-5mm juveniles. The hatcheries can be expanded to address the demand for volume if production is aimed towards commercialization.

SANDFISH PRODUCTION AND DEVELOPMENT OF SEA RANCHING IN NORTHERN AUSTRALIA

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Abstract

The Northern Territory's 'Trepang Fishery' extends across approximately two-thirds of the NTs coastline, with the principle target species being the sandfish (*Holothuria scabra*). Tasmanian Seafoods P/L has been involved in the trepang fishery for almost 20 years, and is currently the sole licence owner for sea cucumber fishing in the Northern Territory.

In 2004 Tasmanian Seafoods P/L began investigating the potential of sandfish propagation and juvenile production, with a view to enhance the existing fishery. Initially a pilot hatchery was set up at the Northern Territory Governments 'Darwin Aquaculture Centre' (DAC), since then the hatchery has expanded significantly at the DAC, and the project now includes 8 ha of earthen ponds.

In developing the sea ranching component of the project, Tasmanians Seafoods has sought to create working relationships with remote Indigenous communities which are nearby recognised fishing grounds, and establish joint ventures for the harvesting of the 'released' sea cucumber. The development of sea ranching has also required ongoing negotiations with Northern Territory Government Fisheries Department to develop appropriate policies and management arrangements to conform with the Northern Territory's Fisheries Act 1995.

This paper will review the projects progress to date and provide an overview of current systems and facilities in place for sea cucumber production.

HATCHERY EXPERIENCE AND USEFUL LESSONS FROM ISOSTICHOPUS FUSCUS *IN ECUADOR AND MEXICO*

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Abstract

This contribution summarises lessons learned from captive breeding of the sea cucumber *Isostichopus fuscus* in land-based installations on the coast of Ecuador and Mexico. This species has been intensively fished in Mexico, along mainland Ecuador and around the Galapagos Islands. Management efforts have traditionally been challenged by local socio-economic conditions. Populations of *I. fuscus* have thus been severely depleted over the past decades, generating interest in aquaculture and restocking. Spawning, fertilization, larval rearing, disease control and juvenile growth have been documented in two privately-owned hatcheries. Data from monthly trials conducted in Ecuador over three years indicate that, under optimal conditions, juveniles can be grown to a size of ~8 cm in length in 3.5 months. Survival is typically between 30 and 50 %. Furthermore, preliminary tests have shown that the growth of juvenile sea cucumbers in old shrimp ponds is feasible. In Mexico, successful spawnings were restricted to fall months when cultures of larvae and early juveniles yielded growth rates similar to those recorded in Ecuador. Further growth of juveniles in shrimp ponds was impeded by infections leading to high mortality rates, whereas juveniles grown in cages in the ocean exhibited high rates of growth and survival. Overall, studies demonstrate that, with proper disease control, millions of juvenile *I. fuscus* can be reared in captivity annually, thus providing an alternative to fisheries or a way to maintain sustainable harvests and eventually contribute to the restoration of natural populations.

DAY 2 (Wednesday Feb 16)

Sandfish Sea Ranching and Farming

PRINCIPLES AND SCIENCE OF STOCKING SEA CUCUMBERS INTO THE SEA

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Abstract

In order to achieve success in stocking, the goals must be clearly stated. The scale, methodology, management and timeframes of the interventions can then be matched to the original goals. Stock enhancement, restocking and sea ranching will involve different stocking strategies. The risks of losing genetic integrity of local stocks is real, so juvenile sea cucumbers produced from adults from one locality should not be translocated to another. Cultured juveniles are easily marked by immersion in a fluorochrome and seawater solution, providing a long-term, unequivocal, means of distinguishing hatchery-produced animals from wild conspecifics. Open sea pens are an experimental tool to provide better estimates of early stocking success. Stratified visual surveys can be used once the sea cucumbers reach sub-adult size. Proponents of sea cucumber stocking should be conservative and realistic about the expected returns; one in five to ten released juvenile sea cucumbers surviving to market size is a benchmark. Investors should expect rigorous evidence of the likely returns from sea ranching sea cucumbers, and managers should carefully examine costs and benefits of restocking. Clear goals, use of existing technology, and realistic expectations in sea ranching and restocking of sea cucumbers will provide the foundation for success.

POND GROW-OUT TRIALS FOR SANDFISH IN NEW CALEDONIA

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Abstract

Sandfish has a high commercial value on the international market once processed by boiling and drying, into beche de mer. The price of beche de mer depends on its quality and size; and currently varies from USD 21-47 per kg in New Caledonia. Over the past 10 years, exports of beche de mer from New Caledonia have ranged from 40 to 80 tonnes (ISEE, Institut de la Statistique et des Etudes Economiques de Nouvelle-Calédonie).

The main focus of the research by the WorldFish Center in New Caledonia was the release of juveniles in enclosures in the wild to determine the optimum size and density of juveniles for restocking and stock enhancement. However, some of the cultured juvenile sandfish produced in New Caledonia were distributed into earthen ponds to assess the potential for farming the species. This study reports on pond culture grow-out of sandfish from small juveniles to market size of 500 to 800 g.

ABILITY OF THE SANDFISH, HOLOTHURIA SCABRA*, TO UTILIZE ORGANIC MATTER IN THE BLACK TIGER SHRIMP POND*

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Abstract

A great proportion of shrimp aquaculture in Southeast Asian countries has switched its target species from black tiger shrimp, *Penaeus monodon*, to *P. vannamei*, which is an exotic species originally imported from Latin America, due to frequent viral disease outbreaks. One of the causes of disease outbreaks is thought to be poor water and sediment conditions in the shrimp pond, which aggravate disease symptom. To establish co-culture methods of black tiger shrimp and sandfish, *Holothuria scabra*, for possible mitigation of shrimp pond eutrophication and prevention of disease outbreaks, basic laboratory experiments were conducted at Aquaculture Department, Southeast Asian Fisheries Development Center (SEAFDEC/AQD) in Iloilo, Philippines. A feeding trial of juvenile sandfish showed that sandfish do not grow well with fresh shrimp feed without sand substrate at the bottom of the rearing tank. A feeding trial with and without sand substrate with *Navicula ramossisima* (a benthic diatom) as food showed that the substrates enhance the growth of sandfish. Addition of ground bivalve shells to the substrates as a source of calcium carbonate also improved the growth rate. A feeding trial using shrimp tank detritus, shrimp faeces and *N. ramossisima* as food sources showed that sandfish grew fastest with the faeces followed by detritus and *N. ramossisima*. Acid-volatile sulfur levels in the sediments were reduced by bioturbation of sandfish. This suggests that sandfish are suitable for co-culture with black tiger shrimp. An example of an outdoor shrimp pond co-culture trial based on this information will be presented.

POND FARMING AND CO-CULTURE OPTIONS IN VIETNAM

Dave Mills[1]* and Nguyen Dinh Quang Duy[2]

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Abstract

Enthusiasm among shrimp farmers along the central coast of Vietnam for growing sandfish (*Holothuria scabra*) is increasing; however returns are constrained primarily by density dependent growth limitations and duration of culture. Both density constraints and issues with culture duration can be addressed in-part through advanced-stage pond-nursery systems, which have proven very successful. Farmers are given an option of buying ca. 2g individuals for VND1000, or 20 to 30g individuals for VND3000. These larger juveniles can be grown at high density in the best quality coastal ponds though the wet season, giving farmers a 'head start' and allowing them to produce market-sized individuals (350-400g) before the onset of the next wet season.

Co-culture and rotational culture are popular concepts, which potentially allow farmers to diversify production and thereby moderate the high risk associated with shrimp culture. Several farmers are already growing sandfish in rotation with white shrimp (*Litopenaeus vannamei*) and while they were keen to look at co-culture, were not prepared to take the financial risk to experiment with this option. In response, we initiated a replicated trial at the National Seed Production Centre, Vanninh. Fifteen ponds of ca. 500m^2 were set up to compare productivity and pond condition under co-culture and rotational culture regimes. Ponds were seeded with advanced juvenile sandfish (30-60g) and shrimp post-larvae, potentially allowing shrimp and sandfish to be harvested together. While early results were promising, even fairly small shrimp caused damage to sandfish, eventually resulting in total mortality in all co-culture ponds. The trial is now continuing, having been re-structured to look at the bio-remediation capacity of shrimp in rotational culture systems.

*ESTABLISHMENT AND MANAGEMENT OF COMMUNAL SANDFISH (*HOLOTHURIA SCABRA*): SEA RANCHING IN THE PHILIPPINES*

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Abstract

Sea ranching of sandfish is being piloted as a means to enhance the recovery of depleted natural stocks and provide a supplemental source of income for fishers. Participatory and adaptive approaches were employed in the establishment and management of the sea ranch to ensure that benefits accrue to both the "right holders" and other community members. Three pilot sea ranching sites have been established in north-western Luzon. The sites are managed by members of a local association of small fishers with the support of the municipal government who granted limited exclusive use rights. The sea ranch is delineated into two major use zones; the 1-hectare release and nursery area, and the 4-hectare reserve area where traditional fishing activities are allowed except harvesting of sea cucumbers. Multiple releases were made depending on juvenile production. Within a year, an effective spawning population has been established. Growth rate was fastest during the first six months with the modal weight reaching size at sexual maturity. After 18 months, the maximum size attained by the first batch of juveniles (in 100 m^2 monitoring pens) was ~700 g. Estimated survival of released sandfish ranged from 20- 40%. After 18 months the estimated density of mature sandfish was about 590 individuals ha^{-1} and standing stock in the sea ranch was 1,169 kg wet weight. Periodic selective harvesting of animals >320 g improves potential economic and ecological returns. Among the major threats to sustainability are periodic poaching and storms which reduce harvestable biomass.

MALDIVES SEA CUCUMBER FARMING EXPERIENCE

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Abstract

With the recent technological developments and the increasingly intensive interest in tropical sea cucumber farming, it is an opportune time to review the existing strategies of the Maldives first successful commercial hatchery. This may help to understand the potential strategies followed in successful hatchery and grow out operations. This paper attempts to analyze the strategies used in the production and grow out of the commercially important sea cucumber *Holothuria scabra*, and their effects on the local communities and the environment in the Maldives. The commercially important sea cucumber *Holothuria scabra* has being aquacultured in Maldives since 1996. Hatchery production techniques consistently produce high quality juveniles. When the juveniles reach 2 to 3 cm in size, they are transferred to nearby company owned atoll lagoons for further growth. The sea cucumber grow out period varies between 12 to 18 months in these waters. In addition to the company's own sea cucumber grow out operation, considerable quantities of juveniles are grown by contract growers/villagers from the nearby islands. Sea cucumber grow out period varies between 12 to 18 month in the lagoons. When full grown (350 – 425 gram) the local growers sell the cucumbers back to the company and are paid a management fee according to the duration of care and quantity of the product. This strategy of engaging the participation of the local community and village groups is one of the reasons for the ongoing success of sea cucumber culture in Maldives. Sea cucumber hatchery production is a profitable operation in Maldives even though the cost of production per unit of juvenile is higher due to remote location and associated higher energy cost and transportation.

*SANDFISH (*DAIRO*) PRODUCTION AND SEA RANCHING TRIAL IN A FIJIAN* QOLIQOLI

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Abstract

Since 2008, there has been ongoing sea cucumber aquaculture technology transfer carried out in Fiji under the auspices of an Australian Centre for International Agricultural Research (ACIAR) project. The high-value commercial species sandfish (*Holothuria scabra)* known locally as *dairo*, is both an export product and local delicacy in Fiji. It has been over-exploited in many parts of the country. Between 2008 and 2010, sandfish production technology was transferred to the government and private sector at J Hunter Pearls, a commercial blacklip pearl oyster hatchery at Savusavu on the island of Vanua Levu. In May 2009, about 500 juvenile sandfish of 1-10 g size produced from the training runs were released into a local village *qoliqoli* (traditionally managed fishing area) at Natuvu. They were released into four 100 m^2 sea pens and monitored regularly for survival and growth. Survival after six months was around 28% overall (23% for juveniles of 1-3 g and 33% for 3-10 g). Data collection was terminated after nine months when a cyclone damaged the hatchery and release pens. Average sandfish weight was 165±5 g and 167±6 g for small and large sandfish, respectively, at nine months after release (Feb 2010).

Engagement from the local community was strong, village members assisted in all aspects of the release study and imposed management measures in their *qoliqoli* (traditional fishing grounds).

In late 2010, similar technology transfer was carried out at the Fiji Fisheries government shrimp hatchery at Galoa, Viti Levu. In November 2010, successful spawning resulted in the stocking of larval rearing tanks with one million eggs. After one month, approximately 5,000 small juveniles were ongrown in 1 mm mesh bag nets in a pond adjacent to the hatchery. They had reached approx. 0.6 g in mid January 2011 but subsequently died as a result of equipment failure and poor husbandry practices.

Sandfish aquaculture in Fiji has proved to be achievable and has potential for success. Sea ranching appears to have capacity to deliver benefits directly to local communities. Efforts so far, however, have been constrained by cyclonic weather events, divided priorities (commercial versus research interests), lack of government resources (in particular, the lack of microalgae production capacity) and staffing issues.

DEVELOPMENT OF SEA CUCUMBER FARMING AS AN ALTERNATIVE LIVELIHOOD IN SOUTHWEST MADAGASCAR

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Abstract

In South West Madagascar, anthropogenic and environmental factors, including climate change, population growth and overfishing, are adversely affecting marine resources. Coupled with the aridity of the region, alternatives to fishing for the indigenous Vezo fishing communities are limited. Since 2007, NGO Blue Ventures (BV) has been pioneering sea cucumber farming as an alternative livelihood strategy for communities. After preliminary trials demonstrated the feasibility of rearing juvenile *Holothuria scabra* in sea pens, funding was obtained in 2008 for BV and partner NGO Trans'Mad to scale up the project to 40 families in seven villages. Simple sea pens, measuring between 625 and 900 m^2, were constructed in nearshore seagrass beds and stocked with batches of 300-450 hatchery-reared juveniles (15 g) at three to four month intervals. Sea cucumbers reached a minimum size of 300 g between five and 12 months later. Although preliminary trials yielded high survival rates (80%), on scaling the project a number of factors increased mortality rates, including sub-optimal transportation and stocking conditions and high levels of predation. The adoption of strategies to improve survival post-release, including allowing juveniles a period of repose and acclimation prior to stocking, the use of covered enclosures to protect newly released juveniles, targeted predator control and improved transportation techniques, led to survival rates of >80% three months post release. However, theft of market-sized sea cucumbers was prevalent throughout the project and although anti-poaching mechanisms were implemented, theft remains a major threat to the success of village-based sea cucumber farming in this region.

SEA RANCHING IN AN INDIGENOUS COMMUNITY WITHIN A WELL REGULATED FISHERY (AUSTRALIA)

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Abstract

The sandfish (*Holothuria scabra*) fishery in the Northern Territory is one of a relatively small number of viable sea cucumber wild fisheries remaining globally. This is largely due to a set of well-managed regulatory controls that ensure its sustainability, together with a relatively low occurrence of illegal take through poaching. As a consequence, stocks remain healthy, both in terms of biomass and genetic integrity. In the Northern Territory the export of sea cucumber product is conducted by a single company who has established fishing and processing operations and strong supply chains to markets throughout China. This well-established and functional wild fishery provides a solid foundation for the development of sea cucumber aquaculture in the Northern Territory with its undeveloped coastline predominately (85%) owned by Indigenous people who aspire to use their coastal resources for sustainable activities. Recent land claims have extended ownership of their traditional country to include the intertidal zone. Northern Territory fishery regulations require proponents to undertake a 3-year pilot trial to assess social and economic viability after which an aquaculture licence may be granted. Potential environment risks (in particular disease and genetic risks) are managed through appropriate mitigation measures. The Northern Territory government and the private sector are currently conducting a number of such pilot trials in collaboration with Indigenous communities. ACIAR is funding the NT Fisheries led trial on Goulburn Island, located off the western coast of Arnhem Land. A significant additional component of this work undertaken by the Territory government is to overcome social barriers to Indigenous engagement in ranching enterprises through appropriate communication and training strategies. Future expansion of ranching in the Territory will require careful assessment of site suitability and community capacity.

MARINE TENURE AND THE ROLE OF MPAS FOR SANDFISH GROW-OUT IN THE PACIFIC

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Abstract

Many Pacific Island countries are reigniting long used customary marine resource management systems and traditional tenure through the Locally Managed Marine Area (LMMA) approach. The customary tenure system varies, some recognized in national law, while in others their recognition is informal. These practices include seasonal bans on harvesting, temporary closed (no-take) areas, and restrictions being placed on certain times, places, species or classes of persons. The LMMA demonstrates shared vision of stakeholders that promotes for the success of the adaptive management. This is evidenced by healthy ecosystems and communities, abundant marine and fish stocks, sustainable fisheries utilisation, protected marine biodiversity, sustainable development in coastal communities, an understanding of what communities are doing and can do in managing marine areas, and an understanding of ecological and socioeconomic responses to LMMA and coastal management implementation. The LMMA approach helps to ensure that benefits from marine conservation efforts will accrue to the local community, generally in an equitable manner benefiting them spiritually, culturally, communally, socially and economically. A Fijian LMMA site in the Verata district revealed that since 1997 there has been a twenty-fold increase in clam density in the tabu areas, a 200−300 per cent increase in harvest in adjacent areas, a tripling of fish catches, and a 35−45 per cent increase in household income. Similar trends have also been observed in the other tabu areas across Fiji with a range of potential marine commodities such as giant clam, sea weed and coral transplanting. Currently there are more than 200 traditionally imposed LMMAs, including tabu areas, and these continue to grow.

In Fiji, a LMMA *qoliqoli* site trialed sea ranching of sandfish in their closed area. The entire process was governed by customary institutions and laws that incorporate local socioeconomic considerations and provided more diverse and culturally appropriate approaches to enforcement, compliance, monitoring and restitution. The effectiveness of traditional practices is a reflection of the strength and the viability of the customary law regime. There may also be issues regarding enforcement, the viability of a closed area in the long term, and the roles taken by governments, communities and traditional leaders. Traditional practices are generally accompanied by strategies and resources to support sustainable use, viable livelihoods and equitable sharing of benefits.

*SANDFISH (*HOLOTHURIA SCABRA*) FISHERIES IN THE PACIFIC: PRESENT STATUS, MANAGEMENT OVERVIEW AND OUTLOOK FOR REHABILITATION*

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Abstract

Customary marine tenure practiced in the Pacific Islands is an effective vehicle for sustainable management of sea cucumber resource. However, progress in community based marine resources management in the last decade has done little to reverse the declining trend in sea cucumber fisheries. Continued extraction by a combination of commercial activity and subsistence fishing threaten the sustainability of sandfish recruitment and with it, broodstock and the habitat needed for the development of sandfish aquaculture.

Here we review the status of sandfish (*Holothuria scabra*) stocks from a range of Pacific Island countries some of which have had moratorium on exports for up to 11 years and the impact of the subsistence use of sandfish. We look at sandfish stocks and provide stock status information and management status based on surveys conducted by SPC in the 17 island countries. We use snapshot data to compare presence and abundance, density and size distribution of stocks across sites in seven countries studied from 2002 to 2009. Surveys show that *H. scabra* was present in 41% of countries and at 23% of sites assessed, with the current status reflect the differing fishing regimes in place. At sites where sandfish were present, shallow water transects assessments revealed stocks were mostly depleted with 81% of sites below mean density of 1200 cucumbers ha-1 (mean density of sandfish in best habitat assessed by SPC), with reduced mean and maximum lengths (healthy stocks had mean lengths at approx 23cm, Lmax 32cm).

Although both customary marine tenure and fisheries regulations seek to manage the sandfish resource, there are limitations to the scope of both social and government law in the context of controlling fishing of sea cucumbers. In the case of social law, the commercial nature of these fisheries is relatively difficult to control, witnessed by the differing range and level of adherence to social controls across the Pacific. Equally, Fisheries regulations are only effective when Fisheries agencies have the resources to implement comprehensive controls, which are difficult to implement across the scales that the fishery operates, and inoperable for subsistence fishing.

While there are some well managed fisheries and prospects for recovery in fisheries that are under pressure, difficulties in enforcing commercial fishing and export controls, in addition to the unlimited exemption on subsistence use is proving unsustainable for this fragile resource. The spectre of habitat change as a result of the loss of these grazers and bio-turbators presents a potential additional problem to recovery of these inshore environments.

Pacific Island peoples therefore face a challenge to reverse current trends and ensure sustainable management of their sandfish resource. At present aquaculture offers both a hope and in some cases a further pressure to a stressed social and ecological system. While aquaculture is being trialed in the region with some success, the introduction of relatively new ideas and technology is also resulting in direct (broodstock) and indirect (trial harvests and clearing to prepare ground for seed) depletion of wild stocks.

In this presentation, along with current status results, I will suggest areas where Regional, National and Local management regimes can be further aligned and supported to assist and facilitate community and government education and management initiatives.

Post-Harvest Value Adding, Marketing & Supply Chain, Socio-Economics

MARKETING SEA CUCUMBER IN SOUTHEAST ASIA: CHALLENGES AND OPPORTUNITIES

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Abstract

Sea cucumbers are fished worldwide, particularly in tropical regions. More than 50 species are commercially exploited – the most prized species being the white teatfish (*Holothuria fuscogilva*) and the sandfish (*Holothuria scabra)*.

Stichopus hermanni and *Sticophus horrens* are also high-value species preferred especially in the Korean market. In Southeast Asia, the important sources of sea cucumber are Indonesia, Philippines, Vietnam, Thailand and Malaysia. Singapore and Hong Kong (a transshipment point to China) are among the major export markets. The product is popular among oriental consumers owing to its alleged effect of improving vigor and curing a number of ailments.

Supply of sea cucumber in Southeast Asia is evidently on the downtrend owing to years of overfishing. Sea cucumber may be an incidental catch (e.g. Philippines) or a targeted species (e.g. Vietnam). Significant volume is being produced from sea ranching and pond culture, but this is not enough to offset the rapidly declining collection from the wild. This and the continuously increasing demand for this product have kept sea cucumber prices at attractive levels.

Nevertheless, the high prices could hardly translate to significant income for coastal households as individual catch remains small and fishing effort per unit catch increases. The market offers high premium for well dried, good quality sea cucumber. However, primary processing which is the sole determinant of product quality remains mostly at the village level employing traditional practices. The nature of fishery itself characterised by small volume of catch per day leads to diseconomy of size and constrains large GMP and HACCP compliant processing facilities from engaging in the business. The market also operates in the absence of officially formulated grades and standards which could guide transactions along the value chains.

The marketing system for sea cucumber in Southeast Asia is generally inefficient. Marketing channels are multi-layered, information asymmetry encourages the proliferation of redundant players in the distribution system and high transaction cost keeps the overall marketing margin high but the price received by divers/collectors low. Unlocking the full potential of the sea cucumber industry calls for a set of well conceived strategies that would sustain supply from the wild, increase the supply from aquaculture, improve primary processing and address the inefficiencies in the distribution system, among others.

UNDERSTANDING THE "BECHE DE MER" VALUE CHAIN (FIJI AND TONGA)

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Abstract

The Pacific Agribusiness Research for Development Initiative (PARDI) is a partnership involving the Secretariat of Pacific Community (SPC), the University of the South Pacific (USP) and a consortium of Australian Universities, funded by the Australian Centre for International Agricultural Research (ACIAR).

One of PARDI's aims is to create sustainable livelihood development outcomes for the fisheries/aquaculture sector in the South Pacific by undertaking supply chain and market-driven strategies to identify the researchable constraints currently impeding tangible economic development, and then undertake research-based projects to develop the appropriate technologies, products and/or skill based solutions. Adelaide University Value Chain group has been established to support PARDI projects in the Pacific and works closely with James Cook and Southern Cross University marine component leaders and scientists.

The sea cucumber industry is one of the sectors that has been identified as a contributor to community livelihoods in Tonga and Fiji and is currently being evaluated to improve our understanding of the industry. This presentation aims to offer a process that will identify projects that can potentially improve the livelihoods of communities in Tonga and Fiji reliant on the harvesting of sea cucumber.

Design/methodology/approach

- Review secondary research and literature that has been currently undertaken in the Asia Pacific to identify gaps in our understanding of the whole value chain.
- Analyse and map the existing value chain from harvesting processing export distribution to consumption.
- Identify key partners and stakeholders (public & private) willing to co invest and contribute to the research process and who have a willingness to participate in the implementation of change and improvements.
- Identify researchable constraints that limit the ability of these market chains to be more market responsive, equitable and ultimately more sustainable.

Findings – Our search of existing literature and publications (currently work in progress) has identified chains that are fragmented and potentially unsustainable due to a long history of overexploitation. There appears little collaboration and flow of information between participants. Communities whose livelihoods partly depend on the harvesting and processing of sea cucumber have little understanding of customer and consumer requirements and are at the mercy of middlemen and traders.

Researchers have already identified that there is considerable waste and non conformance to export specification during the harvesting and processing stages of beche de mer. As processed and dried product is not consumed locally but exported (generally to Chinese consumers in Asia) the secrecy around the structure of the distribution channels makes it difficult to collect consumer information that will encourage changes to practices and improvements of returns to participating communities.

Conformance to rules, regulations and practices due to remoteness can be difficult to measure and enforce. The level of unofficial black market trading and export is unclear. Education, training and tools to facilitate the proper selection and collection of sea cucumbers in the wild by fishers have been identified as future enablers.

Tonga has just experienced 2 years of catches that have exceeded quotas and processors in Fiji have concerns about the long term viability of the industry as catches decline and fears that the depletion of stocks in Tonga will lead to a flood of new traders setting up to harvest and process in Fiji.

Practical implications – The benefits for doing further analysis in unlocking the true state and economic benefits of the beche de mer chains in Fiji and Tonga may be important in determining improvement projects for future interventions.

The active engagement of chain participants NGOs and government agencies concerned about the environmental sustainability of the species in the wild may lead to new measures and facilitate investment in sea ranching.

PROCESSING CULTURED TROPICAL SEA CUCUMBERS INTO EXPORT PRODUCT: ISSUES AND OPPORTUNITIES

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Abstract

Sea cucumbers cultured in ponds or in the sea are potentially lucrative commodities but their export value can be gained or lost through the processing used. The gutting, water temperature, cooking times, handling and drying techniques should all be carefully controlled in order to achieve the highest grade possible for export. Farmed sea cucumbers may have thinner body wall than wild animals but have the advantage of being of consistent size, can be processed immediately after being removed from the water, and can be processed in bulk. Processors must understand the preferences of overseas importers, as the desired processing approaches may vary. The use of fuel for boiling sea cucumber to make beche de mer can be an ecological concern. Body organs and muscle bands may offer new products for value-adding of cultured sea cucumbers. Likewise, markets are more open to fresh and canned product. Training for, and providing guides to, processors in best methodologies and new market opportunities present fruitful scope for improving the cost-effectiveness of farming and ranching tropical sea cucumbers.

ECOLOGICAL AND SOCIAL CONSIDERATIONS FOR AN EXPANDING SEA CUCUMBER FARMING INDUSTRY

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Abstract

Sandfish is high valued and in strong demand on the international market, which makes it a promising candidate for aquaculture. It feeds low in the food chain and occurs naturally in dense populations, properties indicating its suitability for farming. Sandfish farming is being promoted as a suitable livelihood alternative for coastal communities, and especially for those involved in fishing for sea cucumbers - a fishery that needs to be reduced to avoid further collapse of many tropical sea cucumber stocks. In this context, a number of farming activities are currently underway globally, and with the decline of the wild fishery and with political agendas to find new income alternatives for coastal populations, the interest for the activity will probably increase. However, proper in-depth analysis of the social and ecological consequences from introduction of the activity is lacking. In Zanzibar, Tanzania, 74 sea cucumber fishers were asked if they would like to farm sea cucumbers. Circa 64 % of the respondents (mostly men) were positive to farming. However, their comments in regard to the activity highlighted that *i)* they are concerned about the personal risks involved in an investment, and that *ii)* farming was perceived as an addition to catch from the wild fishery.

The indicated risk-awareness poses the question on what business model a sandfish enterprise should operate to reduce risk for communities with few income alternatives. The response that farming is an addition, not a replacement, to the fishery emphasises that aquaculture may not have a positive effect on the fishery. On the contrary it might undermine management efforts to have farmed sandfish exports where catch under legislation may be included. There are also potential ecological impacts such as compromising genetic integrity, changes in benthic community structure and altering of the physical habitat to accommodate grow out. These and other effects will of course depend on the scale of the activity, but there is currently little knowledge about ecological effects of sandfish aquaculture, and how this will affect ecosystem goods and services that coastal communities rely on for livelihoods. This emphasises the importance of a social-ecological systems approach when initiating and managing sandfish farming. It is also important to learn from past sandfish farming initiatives, as well as from introduction of other aquaculture species that has resulted in development of standards.

SEA CUCUMBER MARKETS IN THE WORLD: HONG KONG, GUANGZHOU AND NEW YORK

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Abstract

Hong Kong, Guangzhou and New York are the most important markets in the sea cucumber industry. Dried sea cucumber are brought from all over the world to be bought and sold in Hong Kong. Traders and wholesalers are located along Nam Pak Hong Street in the Sheung Wan Area in the north-west of Hong Kong Island. Hong Kong and Guangzhou in Guangdong Province, China, have been tightly connected since the birth of Hong Kong in the 19th Century. Through this channel, most of the dried marine products imported into Hong Kong are re-exported to Guangdong, from which they are traded throughout China. Wholesalers gather along Yat Tak Lou (Yi De Lu) Street in Guangzhou. This presentation will explore the historical development of the sea cucumber market in China, with special reference to regional differences. A recent development in the New York market is also explained in relation to the trade of the Galapagos sea cucumber, *Isostichopus fuscus*. The presentation will explore the characteristics of these three intertwined markets and will point out that resource management plans need to take market preference into consideration.

In 2007, Hong Kong imported 5,296 metric tons of dried sea cucumber: Papua New Guinea exported the most to Hong Kong, 704t, of dried sea cucumber, Indonesia's 653t comes in second, and Japan's 585t is third in order of volume. According to the Monthly Statistics of Hong Kong, Hong Kong re-exported 4,149 tons of dried sea cucumber to 13 countries and regions in 2007. Among them, China imported 3,576 tons (86 percent of the total re-export volume from Hong Kong).

About 50 species, out of 1,200 species total, are currently commercially traded in the world. Sea cucumber can be classified by its form in two categories: *ci-shen* "spiky" and *guang-shen* "shiny". The spikes actually refer to the parapodia on a sea cucumber's back and sides that harden when dried.

The most common *ci-shen* species is *Apostichopus japonicus*, and can be found in the Bohai Sea and along the Korean, Japanese and Russian maritime coasts. The species shows regional variation in sharpness of its spikes, with the Hokkaido variety demonstrating the sharpest spikes. Several of the *ci-shen* sea cucumber species that are internationally traded have temperate seas as their natural habitat, while *guang-shen* sea cucumbers, the rest of the commercially traded species, are typically found in tropical sea environments. Some types of tropical sea cucumber found in the Pacific Ocean and around Southeast Asia, such as *Thelenota ananas* and *Stichopus chloronotus*, are also classified as *ci-shen*. *Isostichopus fuscus*, a species that is harvested around the Galapagos Islands and in other locations, is also considered *ci-shen*.

The differences in form of sea cucumber species also play an important role in sea cucumber foodwise. Chinese cooking is largely divided into Beijing, Shanghai, Sichuan and Cantonese cuisine, and regional differences are most pronounced between Beijing and Cantonese cuisine. Traditionally, in Beijing cuisine, *ci-shen* sea cucumbers are preferred, while the Cantonese prefer *guang-shen* species. While geographic location plays a part in the preference for the temperate *A. japonicus* in the north and the tropical *H. fuscogilva* or *H. scabra* in the south, cooking styles also explain the difference. Pekinese prefer to serve food in small dishes, while the Cantonese use a large serving dish placed in the center of a round table, which explains the higher demand for small *ci-shen* species in Pekinese cuisine and large *guang-shen* species in Cantonese cuisine.

To my understanding, the New York market prefers *ci-shen*, especially *I. fuscus*. The species began to be commercially harvested in the late 1980s and became a very particular species in symbolizing globalization of the sea cucumber industry and sea cucumber conservation such as CITES. This presentation presumes that the New York market would have played an important role in the exploitation of *I. fuscus* in Central and South American countries such as Mexico and Ecuador. This is another reason why it is necessary to investigate the market preference and feed the result back to the resource management planning.

APPLYING DECISION TOOLS TO IMPROVE MANAGEMENT AND PROFITABILITY OF SANDFISH INDUSTRIES IN THE ASIA-PACIFIC

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Abstract

Economic decision tools aim to assist farmers and potential investors understand the economic requirements, costs and benefits, and risks involved in production. Existing and future farmers can develop farm models based upon experience and apply it to decision-making and management. Through the development of economic decision tools farmers can assess impacts such as disease, climate and market prices (known as externalities) that may influence profitability. They can also assess changes in profitability caused by changes in the cost of feed, labour, electricity, packaging and transport. Additionally, the decision tools can evaluate the economic effects of improvements in yield, future development plans, or a change in production efficiency.

Culture or ranching of sandfish is a relatively new income-generating activity (as compared to traditional wild harvest) now being practiced in a range of countries as an alternative to other income sources. Many people are interested in moving toward more sustainable methods of sandfish production but do not have enough information to decide whether they are worth investing in. They need a way to compare these new activities with the other, more-familiar activities.

The primary focus of this talk and the associated workshop is to look at the possibility of sandfish culture and ranching operations as alternatives to more traditional pursuits. The workshop aims to provide a mechanism for discussion and a path for future development.

Notes on Workshop

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