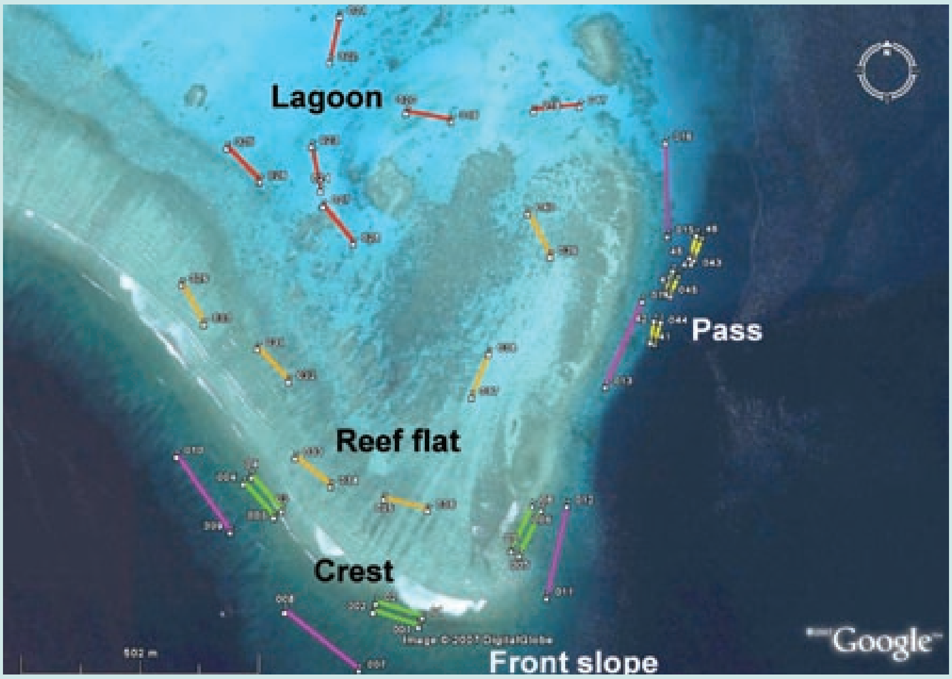

Above: aerial photo of one of the barrier reef study sites (southeast end of Récif Tetembia, Province Sud), showing the actual position of transects in the five habitats. Pink (long) transects (200 m) – Front slope. Green transects (100 m) – crest. Orange transects (100 m) – reef flat. Red transects (100 m) – lagoon. Yellow transects (50 m) – deep water in the barrier reef pass.
Source: Purcell, Gossuin and Agudo (2009a).

Above: weighing (left) and measuring (right) representative individual sea cucumbers collected on transects of the population surveys.
Source: S.W. Purcell.

6.1.3 Fishery-dependent stock surveys
Definition

A process of collecting and analysing data on fishing activities and catches of sea cucumbers in the fishery.

Fishery-dependent surveys collect information on what, when, where and how animals have been caught in the wild, so are therefore inseparably dependent on fishing. Most often, these surveys are based on data submitted by fishers (e.g. via logbooks) or data collected by fishery officers by observing or inspecting the sizes and types of sea cucumbers caught, processed or traded.

Uses

Data on fishing effort and catches will reveal a great deal about fishing activities as well as providing a surrogate measure of abundance of sea cucumbers in the wild. Managers are called upon to monitor fishing activities regularly and use fishery-dependent data to evaluate the performance of management measures (see Sections 3.1 and 3.4). When the fishing locations are stated, data from fishers or landing surveys can be used to compare the density of stocks among different fishing grounds. These data are used as surrogates of data from field population surveys (e.g. underwater visual censuses) to indicate stock composition and abundance because the data are much easier and cheaper to collect (see Section 4). Of course, one must be careful and cautious, about how fishery-dependent data are interpreted (see below).

Data on catches can be used to characterize the species composition of individual fisheries, to assess the level of utilization and fishing mortality of the different species, to calculate catch per unit of effort (see below) and to monitor quotas. Monitoring of catches over time can show historical trends in the fishery and indicate the abundance of the stock. Data on catches are extremely important in fisheries where quotas are used, because these allow managers to determine whether the quotas have been met, are being underutilized or have been exceeded.

The catch structure in the fishery can also be examined with catch data and compared over time or among locations. Catch structure refers to the size of individuals and species composition of each species in the catch. Shifts in the catch structure are strong signals of overfishing or potential non-sustainability in the fishery. Shifts in catch structure may reflect, for instance, a serial depletion process by which excessive fishing pressure is exerted on individual stocks (e.g. of high-value species) leading to a shift of fishing pressure to less-preferred species or size classes. Comparison of catch structure and sizes of sea cucumbers in catches with corresponding data from fishery-independent surveys (e.g. underwater visual census) over the same areas can reveal selectivity by fishers. These comparisons show fishery managers which species the fishers prefer to catch, compared to what is present in the wild and whether they are leaving small individuals or simply collecting all sizes available (Purcell, Gossuin and Agudo, 2009a).

Data on catch and fishing duration can be used to calculate catch-per-unit-effort (CPUE) (Hilborn and Walters, 1992; FAO, 1999). This ratio can be examined over time to reveal any trends in the efficiency of fishers to obtain their catch. Catch can be expressed as the number or weight of the entire catch, a selected subset of the catch, or a particular species in the catch. Effort usually refers to the time a fishing gear is deployed in the water, but on a coarser scale can also refer to the number of active fishing units in the fishery (e.g. number of vessels or fishers). Many aspects of the fishery can be monitored utilizing CPUE analysis, including trends in overall fishery catch rates, catch rates of target species, catch rates in specific geographic areas and seasons and catch rates of size classes. CPUE is a much more powerful tool than catch data alone.

Limitations

Data collected by researchers or catches at landing sites, processing stations or fishers' homes is easily obtained and the researcher can often control the accuracy of the measurements. However, data obtained from the logsheets or logbooks of fishers may be incomplete or incorrect. They may, for example, not declare all animals caught or not identify or separate some species correctly or may receive or buy sea cucumbers from children or other fishers and declare that it was caught by them over their fishing periods. These inaccuracies may lead to a false understanding of total catches in the fishery or CPUE.

Fishery-dependent data will often give a biased indication of the composition, sizes and abundance of wild stocks. Therefore, data must be interpreted with caution.

The reason is that fishers or fishing gear is probably selective towards certain species and sizes of individuals. It is therefore useful to compare catch data with fishery-independent data to better understand biases in the data.

A decline in CPUE over a time period is usually a good indication that stocks are declining. However, the degree of confidence in CPUE as an index of abundance will vary according to the type of behavioral interactions between fish and fishers. For instance, Hilborn and Walters (1992) have categorized three possible relationships between CPUE and abundance:

1) *hyperstability*, where CPUE stays high as abundance declines. This can occur in fisheries where search for the target species is highly efficient, effort concentrates in areas of high abundance and the species remains concentrated as abundance declines;
2) *proportional*, where CPUE is roughly proportional to abundance. This occurs in situations where the species is homogeneously distributed in the fishing grounds and the process of searching is random; and
3) *hyperdepletion*, where CPUE drops faster than abundance declines. This condition is expected, for instance, when there are marked differences in the vulnerability of portions of the stock, such that there is a smaller but more vulnerable potion of the stock which is depleted and a less vulnerable but more abundant subset of the stock that remains underexploited (e.g. a large part of sea cucumber population in deeper waters not accessible to fishers).

Also, advancements in fishing gear, improvements in fishing abilities of fishers and captains, weather patterns, etc., can all influence CPUE trends. Interpretation of CPUE data, therefore, must be undertaken with knowledge of such potentially contributing factors.

How to implement

Data on catches and catch structure can be gathered in the following ways:

a) landing surveys conducted by researchers at boat ramps, ports or fishers' homes;
b) surveys conducted by researchers at processing stations;
c) logbooks or logsheets given to fishers, who record the data themselves and submit the forms on a regular basis; and
d) fishery observers/researchers who travel with fishers as observers on their boats.

Landing surveys and surveys of processed sea cucumbers will be the most reliable, since the researcher can correctly identify the species caught and accurately measure and weigh the animals (Figure 29). It can be difficult to arrange meetings with fishers in remote locations but this may be facilitated by researchers travelling with buyers to collect sea cucumbers from fishers (Purcell, Gossuin and Agudo, 2009a). The landing forms should include the locations fished (even a general region), time spent fishing, time spent travelling to the fishing sites, number of fishers, number and weights of each species caught (Appendices 1 and 2). The forms may include the prices paid or received (Appendix 1).

FIGURE 29
Researchers measuring and weighing dried sea cucumbers at an exporter's facility in Alotau, Milne Bay, Papua New Guinea. These fishery-dependent data are later used to help monitor the sizes and species caught in the fishery

PHOTO: J.P. KINCH

Logsheets or logbooks given to fishers should be supported by taxonomic identification tools to verify species identities (e.g. waterproof identification cards, Section 6.1.1). Fishers should be expected to record their catch within a short time, e.g. 12 h, after returning to shore. It may be a clause of their fishing permit that they submit the forms on a regular basis, e.g. after each landing or every three months. In recording their catches, it is important that the forms also ask fishers to account for any sea cucumbers or bycatch species discarded (see Appendix 3) or retained for personal consumption.

In trawl or dragnet fisheries, like the growing fishery for *Cucumaria frondosa* in Newfoundland and Labrador, Canada (Section 2.4), fishers may also be expected to record the geographic positions of the start and end points of each tow (see Appendix 3). In dive fisheries, as in the Seychelles, the fishing logsheets can include data fields for dive depth and fishing region (see *Examples and lessons learned*, Section 5.5). These types of data can then be used by the fishery manager to monitor where sea cucumbers have been collected and see if fishing depths or locations change over time.

When calculating CPUE, the units of effort to use will depend on the type of fishery and fishing gear. Effort can be expressed, for example, as the numbers of hours spent fishing, number of fishers, number of vessels, vessel-days or number of trawl-hours. For sea cucumber fisheries conducted by diving, the most useful effort unit would be the actual amount of dive time spent in the water, i.e. total person-hours diving.

Some measures should be put in place to validate the accuracy of data submitted by fishers. For example, fishery officers could make impromptu visits to fishers and weigh and check the species in their catch to see if these records correspond with the records in the fishers' logbooks. A collation of data on catches from logbooks could also be compared with data on exports for a given period.

EXAMPLES AND LESSONS LEARNED

New Caledonia, France

Landing surveys were conducted to examine the composition, body sizes, catch volume and fishing effort of fishing campaigns in New Caledonia (Purcell, Gossuin and Agudo, 2009a). Fishers or processors were visited in six study regions and measurements were taken on batches of harvested sea cucumbers. A data form was filled in by researchers, not the fishers (Appendix 2). The exact weight or estimated proportion of the catch made up of various species was recorded along with individual measurements of body lengths and weights of 20 random individuals of each species. The fishers were asked about the fishing locality, number of fishers, total time fishing, time spent fishing and travelling to sites. The weights of gutted, salted or dried sea cucumbers were later converted to estimates of whole body weight using conversion factors (Conand, 1989, 1990; Skewes *et al.*, 2004; Purcell, Gossuin and Agudo, 2009b).

An early lesson was that landing surveys at processing stations were easier to organize than at fishers' homes or at boat ramps. At best, fishers told of the fishing region rather than specific sites. A total of 17 species were recorded from 54 landings, representing 453 fisher-days of collecting sea cucumbers.

The size frequencies of sea cucumbers in the landings were compared directly with corresponding size frequency data from underwater visual censuses. This approach revealed selectivity towards larger individuals in some regions. The data from landings were also used to calculate CPUE of fishers in each study region, which was compared to CPUE data from sociological questionnaires. Purcell, Gossuin and Agudo (2009a) highlighted a few important lessons for fishery-dependent surveys:

1. Whole body weights converted from dried animals will be less biased if the animals are fully dried.
2. Size selectivity by fishers can be best seen by comparing landed sizes to measurements of animals taken by divers during field surveys. Therefore, both sets of data are recommended.

3. Estimates of CPUE based on sociological interviews may be inaccurate. Landing surveys are a better estimator of CPUE, since data on fishing times and catch can be recorded more accurately, but good replication of landing surveys is required.
4. Unless all landings are well documented, landing surveys cannot be a sole reference for judging the range of species exploited. This should be augmented with fisher interviews. Some species are harvested only occasionally by fishers and declared in interviews, but may be missed in landing surveys.
5. Perceptions by fishers of the average sizes of animals they captured did not always match the actual landing data. Monitoring programmes must also collect landing data to bring more realism into the understanding of sizes collected.

Source: S.W. Purcell.

Coral Sea Cucumber Fishery, Australia

The Australian Coral Sea Cucumber Fishery operates on remote, offshore, reefs east of the Great Barrier Reef. Owing to the cost of fishery-independent surveys, fishery logbook data is used to assess stock status. A Commonwealth Scientific and Industrial Research Organisation (CSIRO) study calculated CPUE for each species per day using data on hours fished and number of fishers for each operation (Hunter *et al.*, 2002). The average CPUE per trip, per vessel, was used for statistical comparisons and catch data from trips less than 3 days were pooled with data from the following trip. Logbook data which were not separated in these two modes (35% of records) had to be excluded from CPUE analyses because the two methods target different species and habitats.

Fishers free diving mostly caught black teatfish (*Holothuria whitmaei*), surf redfish (*Actinopyga mauritiana*) and lollyfish (*H. atra*), whereas fishers using hookah targeted white teatfish (*H. fuscogilva*) and amberfish (*T. anax*). Prickly redfish (*Thelenota ananas*) were caught using both methods. From early 2000 to mid-2001, the CPUE for black teatfish declined from 12 kg h^{-1} to <4 kg h^{-1} on 3 out of 4 reefs. Estimates of CPUE were variable for white teatfish (10–60 kg h^{-1}), prickly redfish (<1–30 kg h^{-1}) and surf redfish (<1–16 kg h^{-1}), and, although CPUE declined on some reefs, it increased on others. The findings prompted the management agency to reduce the TACs for several species. The study cautions that CPUE estimates may be unreliable as proxy measures of abundance for lower-value species (when high-value species are still targeted by fishers) because they were collected opportunistically (Hunter *et al.*, 2002).

The logbook data provided by fishers was considered fairly accurate, owing to few fishing operations and productive relationships between fishers and the management agency. Bias could arise when (a) assessing stocks of individual species because multiple species were caught, (b) fishers shifted preferences for certain species, and (c) different fishing methods were used. Hunter *et al.* (2002) therefore give the following lessons for setting logbook requirements:

1. Catches from hookah and free diving sessions should be recorded separately
2. Effort should be recorded as fishing hours
3. The number of divers per dinghy should be recorded
4. Catches should be weighed for each fishing session on each trip
5. The species that fishers targeted each day should be recorded

In conclusion, CPUE data is difficult to interpret. Therefore, managers should use a precautionary approach when developing or adapting regulatory measures from these fishery-dependent data.

Source: *T. Skewes, CSIRO, Australia.*

Galápagos Islands, Ecuador

Monitoring became mandatory in the Galápagos Islands in 1998 for the sea cucumber fishery. Initially, on-board logbooks were issued but had little support from the fishers and the data they recorded was inconsistent with dockside landing surveys. Therefore, fisheries observers from the Charles Darwin Foundation (CDF) and the Galápagos National Park (GNP) collected the data, which comprised fishing site, fishing method, number of fishers, hours invested in fishing, total catch (in weight or in units) and species caught. Data were recorded at the wharf through interviews with the fishers. The body lengths and weights were recorded for about 40 percent of the catch. By the end of each fishing season, the data were analysed and the results provided to stakeholders before the next year's season.

The data revealed the most important fishing sites, catch per unit of effort (CPUE), number of active fishers and boats per season and body sizes. The fishery-dependent surveys helped to determine when to close fishing (and start the seasonal closure) and when the TAC was nearing fulfillment. Furthermore the measurements of sea cucumbers were used to show what percentage of individuals had been caught under the minimum legal size limit.

From 1998 until 2006, the fishery-dependent surveys were conducted jointly by CDF and GNP. However, due to the high costs of maintaining this programme, CDF eventually pulled out and currently is under the sole responsibility of the GNP. Unfortunately, since 2006 only the total catch has been calculated from the data and there has been limited human resources to analyse other important statistics, such as CPUE and visitation frequency at fishing sites, which is limiting the decision-making process.

In summary, the logsheets were abandoned because data from fishers were inaccurate and the monitoring programme was very costly and faced difficulties because it relied largely on private donations to cover field expenses of the observers. In future, monitoring programmes need to invest in training fishers on how to fill in the logbooks and provide incentives for recording accurately. Alternatively, the data can be collected by fishery observers but must be adequately funded through the government (e.g. through tax revenue from the fishing industry).

Source: V. Toral-Granda.

6.1.4 Socio-economic surveys

Definition

The collection of data on responses from fishers and other actors in the fishery, to questions about social and cultural factors that affect the exploitation of stocks.

The surveys would commonly entail questionnaire-based interviews with fishers, processors, exporters and other stakeholders of the fishery. The data should allow the fishery manager to identify, for instance, the actors in the fishery, what fishing methods are used, what time and resources are invested to collect the animals, how the sea cucumbers are processed and sold/traded, what income is gained from fishing and processing and selling, knowledge of regulations and what are the stakeholders views on management of the resource.

Uses

Socio-economic surveys provide a basis for understanding the relationship between fisheries stakeholders and fisheries resources, and a means to obtain stakeholders' views about the fishery (Kronen *et al*., 2007; De la Torre-Castro *et al*., 2007). Managers are called to gather and analyse data on social, economic and institutional factors of fisheries, or commission/facilitate such work and base management decisions on such factors (FAO, 1995; Section 3.1). Importantly, socio-economic surveys allow the manager to choose regulatory tools that will be accepted by the fishers and other stakeholders. Analyses of data of socio-economic indicators can also serve to evaluate the performance of management strategies adopted and enforced (see Section 3.4).

The surveys should also supply valuable information on the species collected, catch rates, fishing zones targeted and the gears used for fishing. This information can augment fishery-independent surveys – for example, by improving the understanding of stock distribution through fishers' accounts of where species have been collected

(Purcell, Gossuin and Agudo, 2009a). Questionnaires to fishers can reveal breaches of fishing regulations or illegal practices that cannot be shown through landing surveys or compliance reports (Kinch *et al*., 2007). Compared to underwater visual census of stocks, socio-economic surveys are relatively cost-effective.

FIGURE 30
A researcher recording responses of a Filipino fisher to socio-economic questions about income gained from fishing

PHOTO: R. GAMBOA

The surveys can also show the geographic differences in resource use and dependence within the fishery (Kronen *et al*., 2007; Kinch *et al*., 2008a). For example, fishing will represent a more important part of the incomes of fishers in some localities than others, or some species may be targeted in some localities but not elsewhere. Such information could be used for adapting management regulations differently to suit the needs and current practices of fishers among regions within a fishery.

Socio-economic surveys should help to identify alternative income streams to meet the livelihoods of fishers or processors (Figure 30). Where fishery closures or limited entry rules are to be imposed, managers are thus able to support, or plan for, alternative economic activities for the fishers.

Education and communication programmes should be designed through some baseline socio-economic surveys. They may, for example, help managers to understand how fishers become informed about fishery regulations and what forms of media are best for educating them.

Limitations

An initial limitation can be in the capacity of fishery departments to design and conduct socio-economic surveys in a structured way that gives quantitative data for evaluating trends within and among fisher groups (see Section 2.3). As for underwater resource surveys, expertise is needed to conduct surveys that will give reliable, unbiased data.

A more serious limitation relates to the ability to collect representative socio-economic data that is non-biased with respect to sampling. Whereas sites for underwater resource surveys are easy to encounter, workers commonly find difficulty in finding fishers to conduct interviews. They may be in remote communities (Section 2.3) or at sea when fishery workers want to interview them. Those fishing less often may therefore be surveyed more frequently and so biasing the results of data analyses. This problem compounds when data averages from social surveys are extrapolated, or scaled-up, to infer the resource use by whole communities.

Unlike sea cucumbers on the sea bed, fishers can give false information (even unintentionally) or be reluctant to divulge information. This may be related to the style of the interviewer, and experience is required to know when interview responses may be misleading. A survey method called "triangulation"[1] can help to reduce falsity in socio-economic data. Many fishers are reluctant to divulge how much they catch or where they fish.

[1] *Triangulation* is a method in which different approaches are used to help validate data on the same issue/question. In the case of a socio-economic study, data could be collected from questionnaire-based interviews and fishery-dependent surveys to answer the same question. For example, fishers could be asked about the average length of sea cucumbers they collect and their responses could be validated by taking independent measurements of animals in their catch over replicate fishing trips. In the same sense, triangulation could consist of asking interview questions from different perspectives to obtain, and validate, certain data.

How to implement

Firstly, define the purpose of the survey and what information is required (De la Torre-Castro *et al.*, 2007). While the fishery manager may want certain information from fishers (e.g. on catch rates, species and sites fished), other stakeholders will need data on different variables (e.g. trade routes and the state of product sold). It is also important to define the actors in the fishery prior to designing and conducting surveys. Ideally, the socio-economic surveys should cover a wide breadth of stakeholders, not just fishers. Some preliminary work is therefore needed to list the fishers, processors and exporters and how they can be contacted. A process can then be determined to representatively sample the fishers where they are numerous.

FIGURE 31
Household socio-economic and semi-structured interviews conducted at Iabam Island, Milne Bay Province, Papua New Guinea to determine marine resource dependency, particulalry sea cucumbers

PHOTO: J.P. KINCH

The questions and data variables for the socio-economic surveys should then be designed. This may be easiest by adapting an existing survey questionnaire for sea cucumber fisheries (e.g. Kinch *et al.*, 2007; Kronen *et al.*, 2007; Purcell, Gossuin and Agudo, 2009a). The manager should consult with other stakeholders, like trade officers and conservation agencies, to know what questions should be posed in interviews. Consideration needs to be given to whether the results should reflect fishers, or other actors, collectively, or whole communities. Social surveys may target fishers only, or be posed at households, or both (Figure 31). Household surveys should be used where there is subsistence fishing and many family members may be involved in fishing (see Kinch *et al.*, 2007), and inappropriate where there are relatively few actors in the fishery and all sea cucumbers are sold for export. The questionnaires for households will differ from those for individual fishers, as will questionnaires for processors or exporters.

There should be a pre-determined design for sampling fishers or households, e.g. systematic or randomised, such that the samples (i.e. completed questionnaires) are representative of the entire pool of potential respondents. The same approach would apply to "selecting" communities, if a proportion of them are to be sampled and if the data are scaled up to regions or a whole country. Consider the limitations of extrapolating data from non-probability sampling techniques, e.g. "convenience" sampling or "snowball" sampling, if these are used. Kronen *et al.* (2007) outline the most common random sampling designs for socio-economic surveys:

- *simple random sampling* – when the entire population is relatively uniform,
- *stratified random sampling* – where there are sub-groups of households or fishers in the population with different characteristics, and
- *multistage random sampling* – where sampling is structured hierarchically, e.g. samples within villages and villages within provinces.

Questionnaires should be structured to furnish quantitative data – this means scoring responses so that they can be converted to counts, rank responses or binomial (e.g. yes or no) data. This will permit calculation of response averages and enable statistical analyses. Avoid questions that ask for volumes, percentages, or averages (e.g. "What is your average cost per fishing trip?"), because small-scale fishers, or those with a basic school education, will often have difficulty answering them, for a variety of reasons (Kinch *et al.*, 2007). Visual aids and field identification guides will help to avoid ambiguity with terms and species (Kronen *et al.*, 2007)

FIGURE 32

Using size cards of sea cucumber body lengths during socio-economic interviews of sea cucumber fishers at Andra, Papua New Guinea (left) and Abaiang, Kiribati (right)

PHOTOS: M. KRONEN, SPC PROCFISHIC

(Figure 32; Section 6.1.1). Care should be taken to choose questions wisely to acquire the key data without demanding too much time of the respondents, e.g. approximately 30–45 minutes. The fishery technicians should be appropriate trained in conducting the surveys, or partner institutions can be consulted to help in this task.

Some investment should be placed in communication with fishers about the socio-economic survey programme. Raising awareness will help to uncover all the actors for designing the sampling. As for resource surveys, it will probably be unfeasible to interview all fishers, so some prior rules should be set to allow representative sampling.

Following interview-based surveys, the data should be entered into a database and analysed. Managers may wish to firstly examine simple calculations of the data, separated by fisher groups, locations, gender or age of the respondents. Finally, the information should be validated and used for management purposes. Respondents will also want to see that the results are disseminated and used in the management of the resource.

EXAMPLES AND LESSONS LEARNED

Papua New Guinea

Relatively little research has been conducted on the sea cucumber fishery in Papua New Guinea, despite its economic importance for the nation and to coastal and island fishers, their families and their communities. In recognition of this shortcoming, the National Fisheries Authority (NFA) conducted socio-economic studies of the beche-de-mer fishery in the Western, Central and Manus Provinces in 2006–2007. The surveys aimed to describe the fishery operation to enable the NFA to refine the fisheries management. In particular, the fishery needed better compliance by fishers and companies, stronger benefits to coastal and island fishers and communities; and a more robust assurance of sustainability of sea cucumber resources.

The NFA has also conducted general socio-economic fisheries surveys in the Morobe, New Ireland and Milne Bay Provinces in 2005–2007, as part of its Coastal Fisheries Management and Development Program. These surveys were undertaken to provide basic information on the relative importance of fisheries to the livelihoods of people. They were also designed to provide information on the types and quantities of marine organisms being harvested in each province with a view to assessing the status of the resources and to identify threats and opportunities for the future.

Source: J.P. Kinch.

New Caledonia, France

In a recent project to assess two sea cucumber fisheries in New Caledonia, socio-economic surveys were conducted using questionnaire-based interviews (Purcell, Gossuin and Agudo, 2009a). The questionnaires were structured to provide quantitative data for analyses; i.e. responses as ticks to multiple choice responses or as numbers. Responses were recorded by a sociologist.

The fisher interviews took 30–40 minutes to pose questions within the themes of the type and places of fishing, the catch, the average fishing effort (duration), processing of sea cucumbers by the fishers, economic importance, historical context, and their knowledge and desires about fishery management regulations. Cards with drawings of various sized sea cucumbers allowed fishers to choose drawings for questions regarding the size of sea cucumbers they collected rather than guessing metric lengths and weights. Colour identification cards helped to associate local names of sea cucumbers to scientific names. Many of the interviews were held in conjunction with separate surveys of their landed catch, or by accompanying processors to a sale point to meet the fishers. Interviews were held with the fishers and do not reflect households.

PHOTO: S.W. PURCELL

Above: a biologist/sociologist at a processing station in New Caledonia, where sea cucumbers and *Trochus* topshell are being dried on mesh racks after boiling.

Interviews were also held with most of the fishery's processors (i.e. someone who regularly buys sea cucumbers – whole, gutted, salted or dried). Keeping processors informed on the project's progress was a key for gaining their cooperation. Meetings with fishers in some of the distant and isolated areas were possible thanks to this collaboration. These 20-minute interviews covered themes such as their experience in the industry, zones and problems in the purchase of sea cucumbers, species bought and prices, export context and export prices, and their desires about fishery management regulations.

Comparisons of interview responses with landing surveys showed that the perceptions by fishers of the sizes of animals they captured did not always closely match the sizes of animals in their landings. The lesson here is that monitoring programmes must also collect landing data to bring more realism into the understanding of sizes collected.

The study also showed that fishers listed a larger number of species that they collect than was recorded in landings. This is mostly attributed to the fact that landing surveys will rarely be able to represent catches at all times of the year at all sites. In addition, the interviews indicated a broader distribution of one species than shown by underwater visual census. The lesson is that fisher interviews can supply valuable information for understanding fishing impacts and building species inventories.
Source: S.W. Purcell.

Western Indian Ocean
The regional WIOMSA/MASMA interdisciplinary project on sea cucumbers (2006–2008) (Conand and Muthiga, 2007) consisted of integrated socio-economic and ecological studies in five countries of the Western Indian Ocean (WIO) with contrasting conditions in their ecology and fisheries: from unexploited stocks in La Reunion to severe overexploitation in Madagascar; from small-scale fisheries in Kenya to industrial fisheries in the Seychelles. The methods used included structured questionnaires, semi-structured interviews and network analysis. Based on the results of these studies a conceptual model of the sea cucumber fishery dynamics was proposed (De la Torre-Castro *et al.*, 2007). It encompasses multiple levels and takes into account the main features of the fishery, such as fishing and collecting grounds, resource users and other stakeholders involved in the fishery (e.g. fishers, middlemen and exporters), the links between stakeholders, villages and countries and the associated management initiatives at different levels. The holistic outlook of the model, that takes into consideration both social and ecological interactions, may be instrumental in supporting a regional management strategy for sea cucumbers.
Source: C. Conand.

6.1.5 Price monitoring

Definition

Regular examination over time of the prices of sea cucumbers and beche-de-mer along the marketing chains: i.e. from fishers, collectors, exporters and consumers.

Uses

Price monitoring can provide managers with an understanding of the social aspects in the fisher communities. For example, whether fishers are receiving a fair share of the export value of the sea cucumbers they catch and sell (e.g. Kinch *et al.*, 2008b). Likewise, this information gives alternative data (e.g. compared to socio-economic surveys) on the income generated by the fishery and the economic importance to various actors.

By monitoring export prices through time, the market force can be better understood (see Sections 2.2 and 2.4). For example, the manager can receive delayed feedback about changes in the overseas demand for all, or certain, species over time. Such information can help to plan ahead for adapting management to avoid rapid overfishing due to increased demand of certain species. Similarly, monitoring of retail prices in Asian markets may open opportunities for fishers that are not apparent (Figure 33).

Monitoring along the whole "market chain", from fisher to exporter, allows government agencies to verify or set appropriate taxes and duties.

Limitations

It may be difficult to force agents to provide reliable information on prices of sea cucumbers sold or exported. In some fisheries, trade confidentiality is a right of fishing companies. The remoteness of some fishers or buyers may make it difficult to gather price data.

FIGURE 33

Tropical sea cucumbers, as beche-de-mer, displayed at various prices in a dried seafood markets in Taipei, Taiwan Province of China (left) and at a wholesaler in Canton (Guangzhou), China (right)

PHOTOS: J. AKAMINE

There may be seasonal variation in the demand for certain sea cucumber products. Further, custom officers may lack the training to identify species and grades of sea cucumbers to attribute the export prices.

Data from overseas markets are not very easy to interpret, due to misreporting, underreporting and the re-export of traded beche-de-mer. For example, it has been estimated that underreporting of traded beche-de-mer in China, Hong Kong SAR, can bias the trade data by about 49 percent (Clarke, 2004).

How to implement

The manager must have a basic knowledge of the relationships between sellers, exporters and importers along the market chain. This may involve foreign financiers to fishing companies or exporters.

Managers should also seek to involve the trade ministry and customs departments in country to support or conduct monitoring of export prices of sea cucumbers. It would be useful to form a relationship with these groups to meet periodically to examine price data and the implications for actors in the fishery.

It is necessary to have a process by which price data from the international market can be obtained regularly. This could be facilitated through collaboration with international agencies involved in monitoring the trade of beche-de-mer (e.g. INFOFISH – www.infofish.org). They will be in a position to provide data and contacts for monitoring overseas market prices. The manager should be clear about whether the data refers to smoked, dried or salted sea cucumber products and that the species names correspond exactly to local species.

It may be advantageous to develop industry bodies, such as Management Advisory Councils (MACs) for the sea cucumber industry in country. They should be kept updated with summaries of price monitoring so they can participate in adaptive management.

EXAMPLES AND LESSONS LEARNED

The Philippines

Despite being one of the top exporters of beche-de-mer, the Philippines has not established any standardized national or local price monitoring scheme. The local middlemen dictate the price to fishers and their re-sale prices are dictated by the Manila exporters or their overseas partners. Most recently, the proliferation of non-Filipino direct exporters (such as Koreans and Japanese) has contributed to the increase in both demand and price. This has also posed stiff competition among local traders. In any case, the local fishers are the real financial loosers.

The absence of a price monitoring scheme in some fisheries is aggravated by the lack of a formal marketing system. There may be no receipts for the sales of sea cucumbers and no formal contracts between fishers and buyers for credit assistance – these business dealings can be based simply on trust and loyalty. As a result it is rather difficult for managers to reliably estimate, or validate, the overall value of exported beche-de-mer. An illustration of this problem is shown through a comparison of the import statistics in Singapore and the export data posted in national related agencies. The comparison indicates that export quantities reported from the Philippine fisheries agencies (based on formal sale records) are significantly less than the quantities actually exported from that country. In this case, correct export records through a more robust sale and trade reporting scheme could possibly elevate the importance of beche-de-mer from the eighth to forth most economically important marine export commodity in the Philippines.

Among the recommendations at the National Forum in Sea Cucumber Fisheries Management held in Dagupan, Pangasinan, in 2007 are: a) to set a national standard for sea cucumber products; b) perform a market study to generate a real picture of the industry; and c) conduct trainings on post-harvest processing for fishers to improve the quality of their products.
Source: R. Gamboa.

PHOTO: R. GAMBOA, UPMIN

Above: Sea cucumbers processed at the household are stored until the next visit of the middleman (with notebook) who dictates the grade and price.

Asian markets

The Asian centre for sea cucumber trade is China, Hong Kong SAR. In 2006, the region reportedly imported 4 180 tonnes of sea cucumber from 54 countries and regions. However, Hong Kong residents consume only a small part of the imports as most is re-exported mainly to mainland China. For example, in the same year, China, Hong Kong SAR re-exported 3 564 tonnes of sea cucumber to 13 countries and regions (of which about 87 percent was re-exported to China and 6 percent to Taiwan Province of China).

The area of the Hong Kong Island called Nam Pak Hong is where most of the imported sea cucumbers are traded. From there, products are ship to Guangzhou in Guangdong Province (China). Merchants in Guangzhou play an important role in distributing beche-de-mer throughout the country although more recently there are increasing traders now based in cities of Dalian and Qingdao in northern China.

Customers in northern China generally prefer the spiky sea cucumber known as "cishen", while un-spiky holothurians or "guangshen" are preferred in southern China. The Japanese *A. japonicus* is a typical cishen and is currently the most valuable traded sea cucumber species. Fifty dried sea cucumber pieces making up one "jin" (or 600 g) is the standard business transaction volume. Trade is also carried out by "picul" (or 60 kilograms) which is equivalent to 100 jin units. In mainland China one jin equals to 500 grams.

Sea cucumbers smaller than the standard size (i.e. 12 g) are traded at lower prices. Large specimens are more expensive and fetch better prices. Currently, the average price of *A. japonicus* based on trade statistics, is about JPY48 000/kg (2009 prices). However, products from Hokkaido, Japan, famous for its spikes and thick body walls is said to reach a market value of JPY80 000/kg. Retail prices are also differentiated by production site and size of the traded product.

Source: J. Akamine.

6.2 INSTITUTIONAL REQUIREMENTS

6.2.1 Support institutional arrangements for local-scale management

Definition

Aid to the development systems (formal or non-formal) for fishers or fisher groups to take joint, or full, authority in developing and implementing resource management.

The support could be through community organizations, co-operatives, or customary/community groups. Here, "local-scale management" means management decisions and actions conducted by community groups or fishing groups rather than centralised government agencies.

The establishment of institutions for resource management by fisher groups is part of co-management and community-based management and encouraged within an ecosystem approach to fisheries (Section 3.3). Broadly, *co-management* involves the participation of fisher groups or fishing communities with management agencies in the decisions and operation of resource management. In *community-based management* the authority to manage the resource is devolved to the fishing communities, including decision-making, monitoring and enforcement.

Uses

Hilborn (2004) argued that it is not the shortcomings of single-species management that has failed in collapsed or overexploited fisheries, but institutions using top-down (or "centralised") control. Improvements in the sustainability of marine resources through community-involved institutions of fisheries management arise, to a large extent, through better compliance and accountability (Shepherd *et al*., 2004). This is because the management decisions and outcomes are vested with fishers or fishing communities who value the long-term benefits of a sustainable resource. If governance structures are adequate and the appropriate incentives are in place, community management of resources is analogous to putting the farmer in charge of the farm (Hilborn, Oresanz and Parma, 2005). Co-management and community-based management arrangements will be particularly useful in small-scale fisheries where top-down, centralised systems have proved ineffective (Ostrom, 1990; Berkes *et al*., 2001).

Enforcement can improve with locally-management institutions (Shepherd *et al*., 2004). Self regulation by fishing groups and co-management can help to reduce the burden of conflict management that generally resides with management agencies. More direct and well-established modes of resolving conflicts will probably exist within communities compared to those between fishers and centralised management agencies. Owing also to pre-established relationships, co-management and community-based management schemes can foster better consensus building than ad hoc formulation of advisory groups. Appropriate management measures can be proposed that align with community aspirations and customs, and can be enforced with penalties that suit local customs.

A further benefit of devolving the management of resources to fisher groups is improvement in communication among the actors in the fishery. Support may be required from fisheries agencies so that fishers in fragmented fisheries can meet regularly. Within communities, fishery regulations can be better understood since they are developed through wide participation.

Limitations

Co-management and community-based management are not without their shortcomings. There is no guarantee that the group/community will act in its self-interest or that the management decisions will lead to good outcomes. Decision-makers within communities or fisher groups may lack the understanding of biological processes to aptly manage the resource compared to a trained fishery manager. In addition to capacity constraints, communities may lack the financial resources for proper monitoring or surveillance. Moreover, vested personal interests in the community may derail appropriate management strategies for personal gain or assign fishing rights inequitably.

Exclusive rights and devolved management can fail when there is a mismatch between the spatial scales of the management units and the scales at which stock-recruitment processes operate (Hilborn, Parrish and Litle, 2005). For example, the fishing practices in one community may affect the recruitment and sustainability of sea cucumber stocks in a neighbouring community. This may certainly be the case for many sea cucumber stocks that exist as metapopulations of numerous populations connected via larval dispersal. Co-management systems may therefore be more suitable for sea cucumber fisheries, whereby some coordination by centralised fisheries agencies ensures connectivity of populations with a metapopulation.

How to implement

Assess existing institutions in place (including leadership and governance structures). If deemed appropriate then assist in the formalization of the local-level institution. The appropriateness of the existing institutions should be clear if the management decisions are respected by fishers and foster good stewardship of the resources. This will generally mean some level of industry participation in decision-making (Parma, Hilborn and Oresanz, 2006).

The different types of fisher's organizations or stakeholders need to be listed and a plan drawn to show how they are structured or linked within the current management institution. Managers should seek to map out, for example in a flowchart, the decision-making process currently used in the fishery, or other similar fisheries. The stakeholders include more than just the fishers and fishing communities, e.g. conservation agencies, fisheries scientists, fishery managers and field workers. What are the inputs from the different stakeholder groups in decision-making and who has the decision-making authority?

As discussed in Section 6.1.5, the market chain structure should be well understood and preferably illustrated schematically for others to easily understand. How are sea cucumbers sold and exported from the country? Centralized processors and exporters should naturally be an element of participatory types of management, since their compliance is also needed.

Likewise, the legal frameworks need to be described. These would include processes by which management decisions are placed into law or customary regulatory systems, overarching national or international regulations (i.e. national constitutions and international treaties and conventions like CITES), and the process by which offenders are prosecuted for breaching fishery regulations.

Consider the spatial scale at which ecological processes operate in the sea cucumber populations within the fishery and try to match these with the spatial jurisdictions of management institutions. Management measures applied to sedentary animals (like sea cucumbers) near one community may likely, through larval dispersal, have a profound affect on populations managed by a second community. Since individual sea cucumber populations (e.g. on separate reefs) are probably interconnected within a larger "metapopulation" (e.g. the collective populations of one species within an entire reef lagoon), management should ideally operate at the local scale and involve coordination of management institutions at the larger (metapopulation) scale (Hilborn, Oresanz and Parma, 2005; Orensanz *et al*., 2005).

Determine if there is a need for a local-level institution to take authority for, or participate in, the decision-making processes and day to day management of the fishery. Co-management systems may prove more effective than community-based management systems because they allow for fisheries authorities to dictate some regulations that would be best harmonized among various fisher groups, e.g. the setting of minimum legal size limits and reporting requirements. Co-management also plans for scientific information from fisheries managers to be a compulsory part of decision-making. Meet with the fishers and fishing communities to see how best these institutions can be formed.

Seek legal help to delegate authority of some management decisions to local-level institutions (i.e. to fishing cooperatives or fishing communities) and clearly define which decisions they have authority over and which ones they do not.

Similarly, arrange to devolve other management activities, like surveillance and enforcement, and internalize "externalities", such as monitoring and research (Parma, Hilborn and Oresanz, 2006). Local-level management institutions should be required to develop a management plan associated to their fishing grounds, which would include monitoring, evaluation and enforcement (Hilborn, 2004). The fishers, or fishing communities, will be in a position to determine appropriate expenditure on research and enforcement (Hilborn, Oresanz and Parma, 2005). Some simple monitoring may be undertaken by fishing communities, but government fishery agencies may need to retain this role, perhaps through an industry levy to recover costs (FAO, 1995; Hilborn, 2004). Fisheries agencies should still allocate funding to support meetings and operationalise management decisions made by local-level institutions, and engage with scientists and NGOs to assist with information and training – this can be one of their roles in co-management.

Work with fisher groups and communities to foster collaboration and open communication. Forming fishers' cooperatives may, for example, be a better vehicle for gaining market access and product labelling than government-run programmes.

EXAMPLES AND LESSONS LEARNED

Galápagos Islands, Ecuador

In the Galápagos Islands, a Special Law in 1998 establishes a participatory management system for the Galápagos Marine Reserve (GMR). This administration system involves both, local and national management of the Marine Reserve. Locally, through the Participatory Management Board (PMB), a forum represented by five stakeholders: Artisanal Fisheries Cooperatives, Naturalist Guides, Chamber of Tourism of Galápagos, Scientific Sector (currently the Charles Darwin Foundation) and the Galápagos National Park Service (GNPS). These stakeholder groups participate actively in development of management measures for the GMR and all decision-making is based on consensus. The resolutions taken by the PMB are presented to a national forum, called the Inter-Institutional Management Authority (IMA), which makes a final decision through a vote system.

While the Galápagos has a complex institutional arrangement for participatory management, it has not been a single solution to the problem of overexploitation and significant challenges remain for the management of Galápagos' sea cucumber resource. The sea cucumber *Isostichopus fuscus* is showing severe signs of overexploitation and conflicts between the fishing sector and the scientists and conservation managers. Therefore, although participatory management has allowed fishers and other stakeholders to become a part of the management process, the lesson is that several other factors must be addressed for this management system to be successful:

- The participatory management process may take some years to work effectively and must be funded adequately.
- The decision-making process needs to be explicitly bound to follow the best scientific advice available and in accord with resolutions from meetings among stakeholder groups.
- The management process should be divorced from government politics. That is, the management process should be designed such that changes in a nation's political parties do not undermine the management decisions or implementation.
- The Marine Park Authority or fishery agency should be given a legal authority to enforce the management regulations. Enforcement should not rest with agencies that are unable to conduct routine and impromptu inspections of fishing vessels or landing and processing stations.
- Members of the stakeholder groups should be designated to serve on the management committees for a lengthy period (e.g. 2 years) to maintain consistency in representation at meetings and knowledge about past and future directions.

Source: P.C. Martínez.

Papua New Guinea

The National Fisheries Authority (NFA) through the Coastal Fisheries Management and Development Project (CFMDP) recently attempted to accommodate changes to the 1998 *Fisheries Management Act* that would support local-level fisheries management. Under the proposed changes, the rights of the customary owners of fisheries resources and fishing rights would be fully recognized within three nautical miles of the baseline. The regulations also attempted to provide authority for customary owners in all transactions affecting the resource or the area in which their rights operate, including any relevant fishery management plans developed by them, and designated community-based fisheries management areas, as long as they were consistent with and not in conflict with existing national management plans. Technical assistance, if required would have been provided by the NFA, provincial or local level governments, or competent non-governmental organizations.
Source: J.P. Kinch.

New Caledonia, France

In 2007, the fishery service of the Northern Province cooperated with one community (Tribu Boyenne) to have some authority to manage the sea cucumbers on reefs in their [de-facto] jurisdiction, through a process of co-management. The fishers must still abide by the provincial fishery regulations (e.g. size limits, prohibition of SCUBA or hookah and night diving). On the other hand, it is the community that decides when certain fishing grounds can be open to fishing sea cucumbers and when they are closed to fishing. The community also appoints persons to help with periodic population surveys on the reefs to determine if densities and body size have reached pre-determined levels to warrant opening the fishing closure. This is done in cooperation with technicians from the Provincial Fishery Service. In addition, the community is also encouraged by the Fishery Service to undertake some simplified visual censuses to estimate sea cucumber densities on the reef to monitor their recovery after fishing episodes.
Source: S.W. Purcell.

6.2.2 Establish management advisory committees

Definition

Support to enable the formation of multidisciplinary bodies of stakeholders that provide information and advice on the best practices for the management of the fishery.

Some of the members of management advisory committees (MACs) may be directly involved in the fishery whereas others are not. They can include fishing cooperative representatives, fishery managers, scientists, local representatives, decision-making authorities and social workers.

Uses

One use of MACs is to bring a wider range of views and aspirations into the decision-making process. In this sense, they also provide integrated information on technical aspects, such as marketing, population dynamics and socio-economic drivers, to enable management decisions with a holistic view on the fishery. They are also a vehicle for bringing forward advice on the feasibility of management options and monitoring of the fishery. Through the process of open discussion, progress can be made towards overcoming mistrust that may exist between fishers and fishery managers and researchers.

Consultative Committees (CCs) are similar to MACs and tend to be used for smaller or developing fisheries (Smith, Sainsbury and Stevens, 1999). MACs and CCs provide a forum for assessing the potential consequences, costs and practicality of various scenarios of management regulations through "risk analysis" or "management strategy evaluation" (Smith, Sainsbury and Stevens, 1999). Risks may come in the form of uncertainty about: (1) sea cucumber stocks and the environment; and (2) dynamics and feedbacks that determine the future stock levels, including human factors (Grafton *et al*., 2007). Through such processes, key uncertainties can be brought to the fore and group members are able to agree upon performance criteria by which the management scenarios can be judged. Setting clear performance criteria at the onset allows for a more objective process of adaptive management later on.

An operational advantage of advisory committees is subsequent compliance by fishers and other stakeholders for that matter. Because the management decisions, or at least recommendations, are formed through mutual agreement of the committee members, MACs gain broader acceptance and ownership of management decisions than top-down systems (Smith, Sainsbury and Stevens, 1999).

Limitations

Unless they are carefully composed, advisory bodies may not be in the best interests for the long-term sustainability of the resource or detached from the reality facing fishers and their aspirations. Members may have vested interests or the committees may be inappropriately biased towards one stakeholder group (e.g. composed of too many scientists). Advisory committees may simply lack the required expertise for certain roles, e.g. experienced social scientists or fisheries biologists.

Owing, in part, to the multisector nature of advisory committees, it may be difficult to reach consensus about management decisions. In fact, it may be equally difficult to reach consensus among scientists or fishery managers. Disputes, or differences of opinion, can stall the decision-making process. Full consultation with industry and other interest groups through MACs can often be time-consuming (Smith, Sainsbury and Stevens, 1999). In this respect, MACs should be formed by stakeholders that are prepared to negotiate to achieve acceptable compromises where necessary.

While advisory committees may easily reach consensus, they are, after all, bodies to provide advice and usually lack the authority for decision-making. The advantage of the committees may be lost where advice is not taken by decision-makers, and this can undermine motivations for involvement.

How to implement

If MACs or CCs do not currently exist, managers should firstly develop a list of credible and skilled stakeholders and experts and decide on the make-up of the committee. Members should have seniority and standing in each field of expertise and, preferable, an intimate knowledge of the fishery. Participants include fisheries scientists, conservation biologists, economists, sociologists and industry representatives. A chairperson should be assigned, which could be a fishery manager, scientist or an independent facilitator for neutrality. Other members should be assigned, perhaps through a rapid consultative process. Committees should best comprise a relatively small number of selected key experts and industry representatives, e.g. 5–10 members.

Define and decide on committee purpose, objectives and protocols (e.g. establish meeting schedules). It may be useful to develop a series of broad management objectives and a code of practice, and get the MAC or CC members to sign their acceptance of the code formally (Smith, Sainsbury and Stevens, 1999). The code could include principles of confidentiality, a willingness to negotiate and seek compromises with other group members and a declaration that their involvement will exclude personal agendas and other subjectivities.

Notify stakeholders of intending meeting dates, to enable adequate preparation of stakeholder concerns. Disseminate the contact details of all representatives. Develop a process by which the key concerns and decisions from meetings can be disseminated to other stakeholders. The manager may need to develop a summary of the state of the fishery, to brief the MAC members prior to meetings. Likewise, the legal framework for decisions and the existing legislation related to the fishery should be summarized for MACs.

Ensure that MACs have adequate funding. Ideally, MACs or CCs should be fully funded from the industry via taxes or levies on transactions of sea cucumber harvests. There may need to be some incentives for members to attend and plan for involvement in advisory committees.

EXAMPLES AND LESSONS LEARNED

Japan

Sea cucumber fisheries are managed by different prefectures, managed by a fishery cooperative association under the authority of the prefectural governor. Each fishery cooperative association has to obey the Fishery Adjustment Regulation issued by the Sea-area Fishery Adjustment Commission (SFAC) of each prefecture. Various regulations (e.g. fishing gears, fishing zones, closing periods and size limits) are specified for each species by each SFAC. The SFAC is generally composed of fifteen commissioners; nine of whom are elected fishermen and six others (four fishery scientist and two members of the public) appointed by the governor. The SFACs play an advisory role in the fisheries and all matters handled by the administrative agency with regard to fishery regulations. Fishery rights and permits are not processed until advice is received from the SFAC, which has the authority to decide on the arbitration, instruction and authorization of permits, etc.
Source: J. Akamine.

Great Barrier Reef, Australia

On the Great Barrier Reef, the Harvest Fisheries Management Advisory Committee (Harvest MAC) provides advice on the management of Queensland harvest and developmental fisheries to the state's Department of Primary Industries and Fishery (DPI&F). The committee includes representatives from industry, DPI&F, the Great Barrier Reef Marine

Park Authority (GBRMPA), Queensland Park and Wildlife Service (QPWS), Queensland Boating and Fisheries Patrol (QBFP), recreational fishers, scientists and a permanent observer from the Department of Environment and Heritage (DEH). The Harvest MAC meets twice a year to discuss recent developments in the fishery and data collected, and to consider the adequacy of management arrangements. At the request of the Harvest MAC, a beche-de-mer working group is occasionally held to discuss a particular issues relating to the sea cucumber fishery. The working group generally consists of a scientist, the DPI&F fishery manager and representatives from industry (e.g. fishers), GBRMPA, QPWS, QBFP and DEH.
Source: S. Uthicke.

Papua New Guinea
Under the 2001 *National Beche-de-mer Management Plan* (NBMP), a National Management Advisory Committee (NMAC) was formed in 2002 to provide advice to the Managing Director on the management of the sea cucumber fishery. The NMAC is responsible for proposing TACs, closed seasons, reporting, restrictions and trade regulations. It includes stakeholders across Papua New Guinea to provide advice on management measures and revisions to the management plan, deemed necessary through consultation with relevant stakeholders.

The NBMP also allows for the formation of Provincial Management Advisory Committees (PMACs) in all coastal provinces. These are established to advise the NMAC on province-specific management. The PMACs may, in consultation with their respective provincial government, develop a plan for any additional management controls that are needed for their sea cucumber fishery. The National Fisheries Board can then endorse these plans if they are consistent with the NBMP. The participation of the NMAC and PMACs is indicated below:

NMAC membership	PMAC membership
2 NFA representatives	1 Provincial administration representative
1 Fisheries scientist	1 District administrator
2 Customary fisher representatives	3 Customary fisher representatives
2 Company representatives	2 Company representatives
1 NGO representative	1 NFA representative
1 Representative from the 4 Region Fisheries Secretariats	1 Provincial fisheries officer
	1 NGO representative

Source: J.P. Kinch.

Western Indian Ocean
During the developing stage of the sea cucumber fishery in the Seychelles the management followed a top-down approach where the Fisheries Authority took the decisions (Aumeeruddy and Conand, 2008). Now there is an Advisory Management Committee composed of representatives from different government departments, boat owners, divers, processors and one NGO.

In Madagascar various actions have been taken during the last two decades to involve different participants of this fishing sector, including fishers, exporters, managers and scientists (Rasolofonirina, 2007; Conand, 2004, 2008). The National Association of Sea Cucumber Producers (Organisation nationale des exploitants des trépangs et holothuries – ONETH) was created in 1996 through a pilot operation. ONETH encountered several problems at its inception but it is now an active association.
Source: C. Conand.