Development and application of sea cucumber fishery regulations in French Polynesia

Arsène Stein[1]

1. The sea cucumber fishery situation in French Polynesia before 2008

In French Polynesia, the trade in sea cucumbers (locally called *rori*) began in the 19th century as a supplement to the trade in pearl oyster shells (nacre or mother-of-pearl). In 1848, sea cucumbers were harvested from 11 atolls in the Tuamotu Islands (Lucett 1851). Official annual statistics on dried sea cucumber exports are not available before the 1930s, but do indicate exports of 59,400 kg in 1931; 36,800 kg in 1932; 7,380 kg in 1933; 1,700 kg in 1934; and 9,800 kg in 1935, probably from the Tuamotus. A long period follows during which statistics on dried seafood products were recorded only for certain years; these figures indicate up to several tonnes, but it is not possible to distinguish between the proportions of fish and sea cucumber.

Some sea cucumber species are also eaten by a portion of the local population, but harvests remain small in comparison to those of other seafood products such as molluscs, shellfish and especially finfish. The inhabitants of three of the Austral Islands – Rimatara, Rurutu and Rapa – are known to be particularly fond of sea cucumbers such as *Actinopyga mauritiana, Holothuria atra*, *H. cinerascens, H. leucospilota* and *Stichopus horrens*, which they eat both raw and cooked. Polynesians of Asian origin are also keen on teatfish (*H. fuscogilva* and *H. whitmaei*), which they eat cooked.

Because of sea cucumbers' high commercial value, several initiatives were launched by the Fisheries Department in French Polynesia to develop the teatfish fishery so as to create a means for livelihood in rural areas. In the late 1970s and early 1980s, the Fisheries Department carried out teatfish processing trials on Tahiti and Moorea (using artisanal smokehouses) to determine whether there was potential for further development. The trials did not last long, however, because of very low harvest quantities.

Between 1984 and 1986, the Fisheries Department implemented a seafood product processing programme on Apataki Atoll, where the potential for teatfish was considered to be better. Raw materials were provided by Fisheries Department staff initially, and later by the island's fishers, to supply an experimental smokehouse. Fishers were paid per sea cucumber and encouraged to use 'torpedo spears' or 'dri-bombs', accessories recommended at the time to facilitate deep-water sea cucumber fishing. This programme led to the production of 786 kg of beche-de-mer (also called trepang) over three years, all of which was sold to several Chinese restaurants in Tahiti at an average price of XPF (CPF francs)[2] 1,141 per kilo (kg^{-1}). This was a considerable amount for that time as in comparison, salted or dried fish produced at the same location sold at XPF 228 kg^{-1}. Despite the favourable purchase prices proposed, fishers from Apataki did not develop this business for themselves, and the experimental programme came to an end.

In 1998, a private company established a processing centre on Fakarava Atoll in the Tuamotus. It was equipped for processing approximately 10 tonnes (t) of finished products per month but ceased activity several months later, after having processed just 1 t of finished products in total.

The above background makes it possible to state that, overall, French Polynesia's sea cucumber stocks were hardly exploited between 1940 and 2008, with the exception of Rimatara and Rurutu Islands in the Australs where subsistence fishing is deeply rooted, and Tahiti, where many people from those two islands live.

2. Commercial fishing from 2008 onwards and the problems that arose

Commercial sea cucumber fishing in French Polynesia started in earnest in 2008, when a local operator who had learned the trade in New Caledonia opened a business. That initiative led to other new operators setting up businesses. Between 2008 and 2011, exports grew exponentially, with 3 t exported in 2008, 28 t in 2009, 56 t in 2010 and 125 t in 2011. In 2012, total exports increased slightly,– despite a fishing season limited to 10 months – to 132 t, some 6.8 t of which was exported in 2013. This residual amount exported in 2013 can be explained by the fact that commercial fishing ended on 1 November 2012 when the sea cucumber fishing regulations came into effect, and a six-month period was established for selling residual stocks.

[1] Project leader, Department of Marine Resources, French Polynesia. Arsene.stein@drm.gov.pf

[2] XPF 100 = USD 0.95 (16 January 2019)

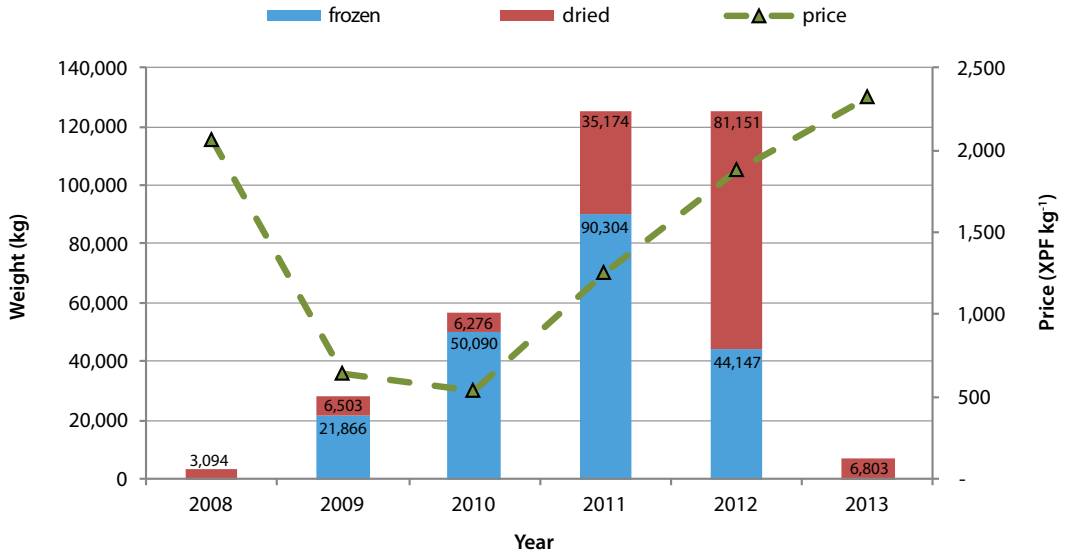

Figure 1. Sea cucumber exports by product type (unit = kg) and average per kilo prices.

Despite the lack of access to operators' statistics on the quantities, species concerned and islands of origin, an analysis of export statistics made it possible to clearly distinguish between two types of products, divided by a price threshold at about XPF 800 kg^{-1}:

- Expensive products, with a price of one to several thousand CFP francs (XPF). These were mainly dried products, usually exported by air. The three species with higher intrinsic value (*Holothuria fuscogilva, H. whitmaei* and *Thelenota ananas*) were generally processed in this form. These products were shipped almost exclusively to Hong Kong.
- 'Cheap' products, ranging in price from XFP 300 to 700 kg^{-1}, consisting of raw or semi-cooked products or of less valuable species, such as *Actinopyga mauritiana* and *Bohadschia argus*. These products were exported frozen, by ship, to destinations such as Taiwan and Vietnam.

2.1 Highlights of the 2008–2012 period

In 2008, the sole sea cucumber operator targeted only the two or three species with the greatest market value and exported 3 t of dried products harvested from several lagoons in the Society and Tuamotu islands. As the operator had no competition, the prices he offered to fishers for fresh products were rather low – all the more so because the exporter took care of processing them himself to ensure optimal quality of the exported products. This may explain the relatively low average price declared at the time of export of around XPF 2,000 kg^{-1}.

In 2009, at least two other exporters started up businesses, one of which dealt in low-value sea cucumber species, which were exported frozen. The production of dried products doubled to 6 t, and the production of frozen products climbed sharply to 22 t. The average value of dried products decreased to XPF 1,700 kg^{-1}, while that of frozen products was limited to XPF 335 kg^{-1}. Because frozen products predominated, the average value of exported products dropped to XPF 636 kg^{-1}. At least six of the Tuamotu Islands were fished for the production of dried sea cucumber products, while most frozen products (*A. mauritiana*) came from Tahaa and Tahiti.

The 2009 scenario repeated itself in 2010, but was characterised by a much greater harvest of species of lesser value, and exports that were dominated by frozen products. Overall production doubled, with an estimated 50 t out of 56 t of sea cucumbers being exported frozen at an average price of XPF 372 kg^{-1}. The quantity of dried sea cucumbers remained stable, however, at 6 t, with slightly improved prices compared to 2009 due to an increase in the number of exporters (to nine) and the beginning of competition. The growing dominance of frozen products brought down the average value of exported products to XPF 540 kg^{-1}. That year, harvesting took place in at least 13 Tuamotuan atolls. Frozen products continued to come mainly from the Society Islands of Tahaa, Raiatea, Huahine, Moorea and Tahiti. 2010 was marked by the efforts of the municipality of Moorea, which already had a maritime area management plan, to set up a regulatory framework for sea cucumber fishing, which led to a charter being established in 2011.

In 2011, overall production doubled once again, in particular because of very strong development in sea cucumber fisheries in Tahiti and Moorea, chiefly for *B. argus*. Production of frozen products reached 90 t for an average value of XPF 700 kg^{-1}. Meanwhile, the quantity of dried products grew six-fold and their overall average value climbed to nearly 2,700 kg^{-1}, while the overall average value of exported

products reached XPF 1,250 kg^{-1}. The increase in price can be explained mainly by heightened competition between buyers who competed for the products on the ground and offered fishers prices that were closer to values on the international market. That year, sea cucumber fishing took place on at least 20 atolls in the Tuamotu Islands. On some atolls, such as Faaite, Fakarava, Arutua, Rangiroa, Kauehi and Amanu, teatfish stocks were considered to have already been heavily impacted. On Bora Bora, the municipality blocked a project by an operator from Tahaa who wished to fish in Bora Bora's lagoon.

2012 was marked by some stagnation in activity, independently of the close of the harvest season on 1 November 2012, when the new regulations came into force. With products exported in 2013 included, overall tonnage reached 132 t, consisting of 88 t of dried products and only 44 t of frozen products. The average value of the products increased from 2011, except for frozen products: XPF 600 kg^{-1} for frozen products and XPF 2,500 kg^{-1} for dried products, amounting to an overall average price of XPF 1,900 kg^{-1}.

In Tahiti, a significant reduction in activity for frozen products was observed as early as March, apparently linked to a problem marketing this type of product and price levels that could no longer be maintained. In November 2012, several dozen tonnes of sea cucumbers were still stored in a freezer because they could not be exported as is. Quantities of dried products, on the other hand, more than doubled compared to 2011, due to their being made up mainly of more poorly rated species, such as *B. argus*. There were 15 registered exporters in 2012, some of whom had only just started out in the business. In the Tuamotu Islands, at least 30 atolls were being fished, sometimes only on an occasional basis. Harvesting also spread that year to a few islands in more distant islands, such as Ua Pou and Tahuata in the Marquesas, and Raivavae and Tubuai in the Austral Islands. Finally, 2012 was marked by positions taken by two municipalities: Rangiroa in the Tuamotu Islands issued a ban on commercial sea cucumber fishing in all of its islands, and the Gambier Islands decided not to allow sea cucumber fishing in its lagoons.

2.2 Problems begin to arise

Problems first began in 2010 and increased gradually until the regulations came into force in November 2012. The main grievances registered by the Fisheries Department are detailed below.

Product wastage

This major problem can be broken down into several types.

1. Harvested products were destroyed due to the overly poor quality obtained during processing. These events were more common among new fishers and processors and/or new buyers.
2. One buyer rose up against the practice of traders who bought sea cucumbers whole from fishers, saying that this hindered the renewal of wild populations that would reproduce naturally if their gonads were put back into the ocean after evisceration.
3. The harvest of several species was called into question because of the very low added value of the finished product, or because the species was of minor importance.
4. Most wastage resulted from harvesting a large number of very small sea cucumbers, which dragged down the value of all export catches and threatened certain sea cucumber populations in several lagoons. This problem, which was heightened by night-time fishing, was especially prevalent in the Society Islands.

Poaching

Scuba diving for sea cucumber fishing is illegal in French Polynesia, but it was reported in several islands of the Tuamotus, which is not surprising given that many pearl oyster farms are equipped with scuba gear.

Use of new technologies

The use, or suspicion of use, of ROVs (remotely operated vehicles) or of camera-aided systems for detecting sea cucumbers in deep waters were reported, leading to the fear that their use might become widespread for deep-sea resources.

Harvesting by outside fishers

Many fishers or inhabitants complained that fishers from other municipalities or islands were operating in their geographical areas.

Impression of a 'slaughter'

Some individuals expressed – directly to the Fisheries Department, in the media, or through social networks – their protests against the 'pillage' or 'slaughter' of sea cucumbers. Pictures of bags filled with sea cucumbers or pickup trucks filled with bags of sea cucumbers made them fear that sea cucumbers would be eradicated.

3 Proposed corrective measures

The author participated in the technical workshop on sea cucumber fisheries held in November 2011 in Nadi, Fiji, organised jointly by the United Nations Food and Agriculture Organization, the Australian Centre for International Agricultural Research, and Southern Cross University in Australia. The problems identified and the lessons learned from the workshop helped design regulations adapted to French Polynesia's geographical situation. The aim of the

regulatory measures was to provide a framework for the sea cucumber fishery, which is economically significant in the islands, so as to eliminate the main problems reported and involve fishers and communities in the daily management of sea cucumber fishing (Table 1).

It should be pointed out that these regulations were not developed via a participatory approach with the fishers. Rather they were based on the experience the Fisheries Department had gained in organising community trochus harvest operations, by incorporating information provided by certain sea cucumber buyers, and feedback concerning problems encountered on the ground.

3.1 - Product traceability

The overall goal was, if not to prevent, then at least to limit fraud among both fishers and traders. The solution was to impose traceability requirements on harvested products, with ongoing monitoring by the Fisheries Department.

This traceability is monitored on the ground by the management committee, which stamps the shipping sheets for each sales transaction between a fisher and trader. The Fisheries Department receives this sheet and enters it into a database, which allows the Fisheries Department to check the origin of the products before approving the trader's export application.

The Pacific Community (SPC) helped the Fisheries Department a great deal in designing and developing the web application used by the department to manage sea cucumber traceability. This application is also accessible, with the use of a password, to the management committees and sea cucumber traders (Fig. 2).

- A management committee can always access the data relating to fishing seasons (period of open season, numerical quotas by species, numerical residual quota by species, list of fishers, contact details of the sea cucumber traders), thus enabling it to verify, if necessary, local management data.

Table 1. List of problems and possible and/or proposed solutions.

No.	Problem to be solved	Possible solution
1	No information on species or island of origin	Set up a procedure requiring that the island of origin and the species involved be reported
2	Imprecise nature of quantities given by weight	Give quantities and quotas in numbers
3	Very low-value species are being fished	Ban commercial harvest of such species
4	Species considered to be rare or at least very uncommon are being fished	Ban commercial harvest of such species
5	Specimens that are too small are being harvested	Introduce minimum size limits – live weight – for each species Ban night fishing
6	A wide variety of processing methods are used	Introduce minimum size limits – dry weight – for each species
7	ROVs and dri-bombs are being used	Make harvesting by hand mandatory
8	Fishers coming from outside the municipality or island	Set up a list of fishers who have been approved by each management committee[3]

No.	Legislators' aim	Solution proposed
1	Apply the main administrative requirements to traders rather than to fishers	No permits required for fishers but authorisation to engage in trade should be required
2	Involve local communities	Create a management committee made up solely of local stakeholders The management committee should manage the practical and regulatory aspects on a daily basis
3	Get the best possible prices for fishers	Encourage fishers to take advantage of processing's added-value Promote competition between buyers Encourage the harvesting of the largest specimens
4	Maintain free but supervised trade	Introduce a purchase declaration procedure Introduce trader licensing Provide traders with training on regulations
5	Limit quantities harvested for each species	Introduce per-species quotas
6	Introduce additional precautionary measures	Set up fishing reserves Set up a no-harvest period for each species

[3] Management committees are described in detail in section 3.2 'Decentralisation', on next page.

Apataki 2014

- Date d'ouverture : 05/05/2014
- Date de fermeture : 31/10/2014

Lieu de pêche	Espèce	Quota (nombre)	Quantité pêchée	Quota consommé	Quantité expédiée	Stock ouverture	Quota consommé (1)
Apataki	Rori titi blanc	2000	1881	94 %	1921	0	96 %
Apataki	Rori marron de récif	4000	459	11 %	264	0	7 %
Apataki	Rori titi noir	400	258	64 %	310	0	78 %
Apataki	Rori ananas	4000	47	1 %	38	0	1 %
Apataki	Rori vermicelle	8000	893	11 %	943	0	12 %

(1) Le quota consommé pour l'expédition est calculé à partir de la quantité expédiée moins le stock à l'ouverture

Figure 2. Example of a table taken from the web application, which is available to management committees and traders.

- Sea cucumber traders have ongoing access to the open and residual quotas by species, for each lagoon open to fishing, and the contact details of the management committees. This allows them to know where and what type of product it is still possible to buy. Traders can also use this application to fill in and send their export forms to the Fisheries Department in order to get the export certificate that Customs requires.

Sea cucumber trade licences

The licencing procedure for sea cucumber traders makes it possible to identify all of the entities authorised to engage in the purchase and sale of sea cucumbers. Licences are issued by the Minister of Fisheries for a period of two years, and may be revoked in the event of non-compliance with their responsibilities.

Licencing subjects beneficiaries to mandatory reporting requirements for all of the important data on each species sold, such as quantities, weight, type of packaging (frozen, dried, fresh) and island of origin.

For sea cucumber exports, a declaration must be submitted to the Fisheries Department for each operation, including all details relative to the species, number, weight, island of origin and destination. For local sales, a simple monthly report is required.

Because sea cucumber traders must store and handle products that arrive from the outer islands before sorting or finishing up their processing prior to reshipment for export, they must get health permits and follow the current rules on the inspection of foodstuffs of animal origin in French Polynesia.

Specific case of processors

Processors are the individuals who process the fishers' fresh products before sales to a buyer. In most of the islands, fishers are also processors so that they can take full advantage of the added value that comes from processing their products. Fishers who do not know how, or who do not want, to process their products can make an agreement with a processor to be able to then sell those products to a sea cucumber trader. As a result, some people can work in processing without being fishers and get paid for their work. However, processors strictly speaking do not have the right to sell processed products that are not their own to a sea cucumber trader. As the sea cucumbers are intended for human consumption, processors may be required to obtain a health permit for their processing business. Up to now, health permits have not been made mandatory in the islands, but processors have been provided with a guide to good hygienic practices for processing their products, so that they can prepare for the day when such permits become mandatory.

3.2 Decentralisation

Fishing is organised according to geographical units (islands) or administrative units (municipalities) so as to control the number of participants and provide a concrete solution to the problem of intrusion by people from outside the area concerned.

Management committee

Each geographical unit can set up its own management committee, which may, for example, correspond to a municipality or to one or several islands close to the same municipality, as is often the case in the Tuamotus.

The management committee is chaired by a sea cucumber fisher and is formed by other fishers and representatives of other business sectors operating within the geographical unit, such as finfish fisheries, pearl oyster farming, tourism, and civil society groups that are involved in environmental protection. Municipal employees, who must not be elected officials, have also been included in the committee so that

they can provide logistical and/or administrative support to the committee. Mayors and local officials are not allowed to serve on management committees in order to limit their sphere of influence as to how the management committee operates, especially with regard to drawing up the list of fishers.

The management committee also plays a decisive role on the ground by:

- establishing the initial list of fishers and sending it to the Fisheries Department;
- providing information on any changes to the list of fishers;
- distributing fishing quotas to each fisher and ensuring the fisher is in compliance with them;
- carrying out possible redistribution of fishing quotas in order to optimise the use of the quotas granted;
- ensuring compliance with the general regulations and the rules agreed on at the local level;
- distributing fishing logsheets and shipping sheets to fishers;
- checking the accuracy of the information given on shipping sheets and validating any product movement out of its geographical unit; and
- ensuring that harvests come to a halt at the end of the season.

List of authorised fishers

Only persons registered on a list that has been validated and sent to the Fisheries Department by a duly constituted management committee are authorised to harvest sea cucumbers commercially in a defined geographical zone. These fishers may only sell their catch to an approved sea cucumber trader of their choice. This implies, in theory at least, that sea cucumber traders cannot buy products from someone who is not registered on any of the fisher lists validated by a management committee.

Monitoring agreement

Through a special agreement signed with the Fisheries Department, the management committee undertakes to enforce the fishing rules on the ground and can make specific proposals that then become the community rules for the fishers concerned if they are incorporated into the agreement. Such proposals may, for example, restrict harvests to certain days of the week, or even limit the number of fishing hours or require that sea cucumbers undergo a certain type of processing before they can be shipped to Tahiti. These locally applied rules may not depart from the general regulations, but they make it possible to vary certain practices that most fishers want. For example, ever since the season opened in 2014, all management committees have decided to ship only processed products to Tahiti.

3.3 Management measures

Subsistence fishing

Because sea cucumbers are part of the diet of some local people, sea cucumber fishing strictly for home consumption, without trade, continues to be allowed for all species. However, the rules on regulated species must be followed, especially in terms of minimum sizes and closed harvest seasons.

Authorised species

Out of the approximately 15 species of sea cucumbers that inhabit the lagoons of French Polynesia, only 5 species are authorised for commercial fishing. These five species have both large enough stocks to be harvested and fetch worthwhile export prices. They are: two teatfish species, *Holothuria fuscogilva* and *H. whitmaei*, *Thelenota ananas*, *Actinopyga mauritiana* and *Bohadscia argus*. *Holothuria atra* is excluded due to its very low purchase price, despite the fact that its stocks are by far the largest. *Thelenota anax* is also excluded because while it obtains relatively good prices, its stocks are low overall, although somewhat more numerous populations exist in certain lagoons.

Minimum sizes

Minimum size limits have been established for each sea cucumber species. The objective of this is, of course, to protect small sea cucumbers, but also to fight waste and to obtain the best export prices.

When a sea cucumber is processed (dried), it shrinks in length and diameter (and in weight), and the level of this change depends on the processing protocol required by the buyer. Setting minimum sizes for dry products encourages processors to use only those protocols that allow them to get dried sea cucumbers of a legal size from fresh sea cucumbers of a legal size. This measure is also in the interest of processors (and fishers), who must select the protocols that, for sea cucumbers of similar quality, lead to more lucrative finished products so as to benefit from their added value.

For example, when sampling was carried out in 2012 on *B. argus*, the number of dried sea cucumbers required to get 1 kg of product was six large ones or up to 62 very small ones. Further, with processing of similar quality, not only does harvesting small sea cucumbers risk compromising the entire value chain in the end, but the per-kilo price offered for small sea cucumbers is also much lower than the price for large specimens. Thus there is a dual benefit to only targeting large sea cucumbers.

The values of the minimum sizes are largely modelled on those that were in force in 2012 in New Caledonia, both

Table 2. Minimum sizes and closed seasons in French Polynesia.

Scientific name	Common local name	Common English name	Minimum live size (cm)	Minimum dried size (cm)	Prohibited months
Holothuria fuscogilva	*Rori* titi blanc	White teatfish	35	15	Nov, Dec, Jan
Holothuria whitmaei	*Rori* titi noir	Black teatfish	30	15	Jun, Jul, Aug
Thelenota ananas	*Rori euata*	Prickly redfish	45	20	Nov, Dec, Jan
Actinopyga mauritiana	*Rori papao*	Surf redfish	20	10	Nov, Dec, Jan
Bohadschia argus	*Rori ruahine*	Leopardfish	40	15	Nov, Dec, Jan
Other species			15	10	

for live and dry weights. However, as New Caledonia does not have minimum sizes set for *B. argus*, sampling was done with two exporters to determine the values.

At the request of traders, the minimum size limit of *A. mauritiana* was modified in January 2014, from 25 cm to 20 cm fresh weight and 12 cm to 10 cm dry weight. This measure made it possible to indirectly determine, for all species of sea cucumbers, a range of dry weight sizes, ranging from 10 cm to 20 cm, using intervals of 5 cm that are easier for fishers to remember (Table 2).

Sea cucumber traders made two further demands, one in 2015 and one in 2017, to decrease the minimum length of *Thelenota ananas* from 20 cm to 15 cm dry weight. Those demands have not been accepted to date, as the sample data taken in 2012 from two major exporters are compatible with a minimum length of 20 cm. One of the exporters, whose products came from the Society Islands, recorded lengths of 10 cm to 22 cm, with a mean length of 15.6 cm, but 96% of the catches were less than 20 cm long. The other exporter, whose products came from the Tuamotus, recorded lengths of between 14 cm and 31 cm, with a mean of 21 cm, with 55% of catches over 20 cm long. The sample data show that the minimum length of 20 cm dry weight is achievable if large individuals are harvested and that a species-specific processing method is used that does not result in excessive shrinkage. Processors were, therefore, encouraged to find processing methods that ensured a minimum length of 20 cm because it is, in principle, hard to accept that it takes more than three individuals weighing 3 kg to 5 kg each fresh to obtain 1 kg of dried sea cucumber (beche-de-mer).

Reserves

When the harvest or fishing season begins, an area covering, at the very least, one-third of the surface of each biotope in which the target species live must be declared a reserve. In practice, because harvesting usually involves all five authorised species, at least one-third of the area, comprising the lagoon, reef crest and outer reef slope, is closed to fishing (see Fig. 3). The area is not marked in any way; the limits indicated on a map correspond to recognizable points suggested by the fishers and are easily identifiable by them; for example, a *motu* (small island), point or channel. The reserve's location can be modified at the start of the following harvest or fishing season.

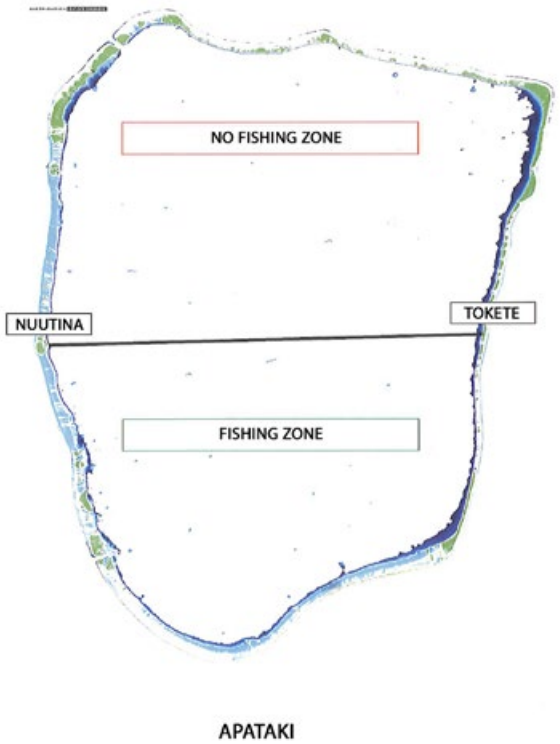

Figure 3. Example of the geographic division for Apataki Atoll (reef surface area = 735 km^2).

The municipality of Fakarava, which comprises seven atolls, is a special case because it forms a biosphere reserve where sea cucumber harvesting is only authorised in zones where all human activities are authorised (called transition zones). Taiaro Atoll is a no-take reserve, but open harvest seasons did take place in the municipality's six other atolls between 2014 and 2017.

Closed seasons

Each commercially harvested species is subject to a three-month mandatory closed season. The season corresponds to the biological cycle of the species determined outside of French Polynesia (i.e. the Southern Hemisphere summer), except in the case of *H. whitmaei* (black teatfish), for which it is the Southern Hemisphere winter. The three-month break serves to separate successive harvests or fishing seasons.

In addition, harvesting is only authorised during daylight hours, from 0600 to 1800. The aim is, above all, to ensure fishers are not tempted to harvest small specimens, which are much more accessible at night. It also serves to limit the risk of diving accidents and makes it easier to monitor catch compliance.

Only harvesting by hand is authorised

Only the harvesting or collecting of sea cucumbers by hand is authorised; this eliminates certain practices deemed to be harmful, such as 'torpedo spears' or 'dri-bombs' (Fig. 4), and to dispel fears – founded or not – about the use of various mechanical harvesting devices. In 2014, one management committee requested that the ban on torpedo spears or dri-bombs be lifted for reasons related to diving safety. The request was not approved and the management committee did not appeal it because fishers were able to take advantage of the vertical movements of teatfish during certain lunar phases. It would seem that the fishers on this management committee are now against authorising the use of torpedo spears. There is still reason to suspect that the technique continues to be used in certain sparsely inhabited islands.

Quotas

Quotas are set by species for a given lagoon, and it is up to the management committee to allocate them to registered fishers; as a rule, the quotas are evenly distributed among all fishers. For that reason, the Fisheries Department monitors only the overall quotas set for a specific lagoon and not the individual quotas attributed to each fisher. Should the quota for a species be reached before the end of the season, the harvesting of that species is closed, regardless of whether some fishers fished more than their individual quota while others didn't reach theirs . In such cases, responsibility lies with the management committee, which is supposed to take the situation into account the next time authorisation to harvest is requested.

Figure 4. Examples of 'torpedo spears' or 'dri-bombs' made of concrete set in tin cans.

The system for setting quotas is normally the trickiest aspect of regulations as it must be based on a robust methodology. Section 3.4 below considers this in detail.

The flow of products, from a lagoon that is open for harvesting to the final purchaser, is shown in Figure 5.

In regulatory terms, two successive pieces of legislation were approved.

1. A resolution by the French Polynesia Assembly, which closed commercial sea cucumber harvesting throughout the territory, introduced sea cucumber trader licensing, and established the general framework of management and conservation measures – this legislation came into force on 1 November 2012.

2. An implementing order issued by the French Polynesia Council of Ministers established management committees and their terms of reference, and stipulated the procedure for opening commercial harvest seasons and the parameters for authorised species, from mandatory sizes to closed seasons. This legislation came into force on 2 May 2013.

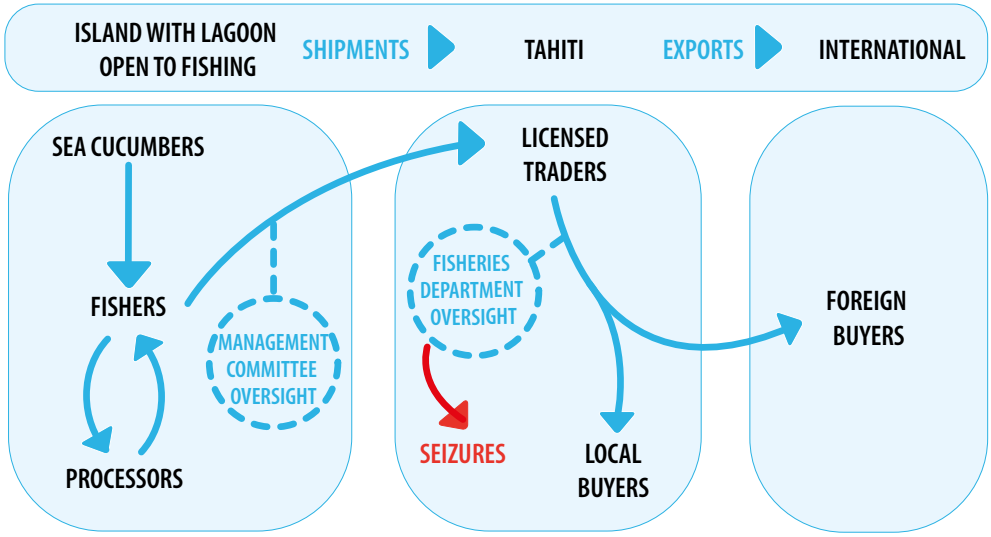

Figure 5. Sea cucumber flow diagram from harvest to export

3.4 Focus on how initial and final quotas were set and subsequent changes

Principle

In the absence of detailed knowledge about the five sea cucumber species involved, the recommended system consists of conducting stock surveys for each species in every lagoon to be harvested. These costly operations usually have to be repeated at the start of each season so as to gauge the impact of the preceding harvest and the numbers of new specimens available for harvest.

The Fisheries Department did not, however, have any statistics on the harvests in each lagoon between 2008 and 2012. It did, however, have some information on the stocks of certain species on certain islands and the intensity of the harvest of certain species on several islands, bearing in mind that stocks and species distribution can vary widely from one lagoon to another.

The Fisheries Department also had access to the following data or information: lagoon surface areas, relative preponderance of species in some lagoons, dry and fresh weight conversion rates, and average number of fresh specimens required to get 1 kg of dry weight.

Studies conducted in the late 1990s in Tahiti and Rangiroa (SNC Pae Tai – Pae Uta Etudes Environnement 1997) have provided estimates of potential harvests for certain species: 4.1 kg ha^{-1} $year^{-1}$ for *H. fuscogilva* and *H. whitmaei* combined for Tahiti, and 70.6 kg ha^{-1} and 4.1 kg ha^{-1} $year^{-1}$ for *B. argus* for Tahiti and Rangiroa, respectively.

Those existing data were used to establish a method for setting quotas for the Tuamotus, which remain the main targets of harvesting campaigns. That approach can be criticised from a scientific point of view, but it has the merit of enabling immediate harvesting while limiting risks – due to the regulatory management measures – and of adapting catch sizes at each new open season in light of results of previous harvests. It has another significant advantage – the acquisition, at little cost, of information about the various sea cucumber populations in the lagoons harvested.

The baseline used to calculate the initial quotas for the atolls is based on a hypothetical harvest of 1.0 kg of sea cucumbers (all species) live weight per hectare of reef surface; the equivalent of 0.1 kg of dried beche-de-mer per hectare. Those are very reasonable amounts when compared to the recommended harvest levels of teatfish or leopard fish (aka tigerfish) for Tahiti or Rangiroa in the late 1990s (SNC Pae Tai – Pae Uta Etudes Environnement 1997).

The surface area considered concerns all sectors of the reef, from the lagoon to the outer slope. Those data are available in the atlas of coral reefs of French Polynesia (Andréfouët et al. 2005). Conventional distribution in terms of the weighted abundance for each species is based on the results of studies previously conducted in French Polynesia (SNC Pae Tai – Pae Uta Etudes Environnement 1997, Biodax Consulting 1998).

The factor for converting the weight into number of specimens varies depending on the species and corresponds to the mean number of specimens meeting the minimum size requirement needed to get one kilo of dried products. Table 3 sums up the different ratios assigned to each species.

The outcome can be weighted, depending on the estimated intensity of harvests before 2013, from 0.5 for lagoons

considered to have been heavily harvested with regard to at least one species, to 1.0 for lagoons considered to have only been lightly harvested, if at all.

The initial quota (Q) – in numbers for each species (sp) in a given lagoon – is set using the following formula:

$$Qsp = S * R * Asp * Csp * P$$

Where:

- *Qsp is the initial quota of specimens for the species concerned*
- *S is the reef surface area in hectares*
- *R is the total authorised dry weight per hectare = 0.1 kg*
- *Asp is the distribution rate for the species*
- *Csp is the weight/number conversion factor for the species*
- *P is the weighting factor based on the intensity of previous harvests*

The final quotas are then set by comparing the initial quotas to the quotas requested by the management committee; the quotas are levelled out, which generally lowers them.

Two numerical examples

The first example concerns Fakarava, a large atoll with a reef surface area of 1,243 km^2. The quotas in number of specimens for each species for the first year of harvesting in 2014 received a weighting of 60% because of the high pre-2013 harvest estimates for *H. fuscogilva* and *H. whitmaei* (Table 4).

The final dry weight quota recommended for all species combined was estimated at 6 tonnes maximum, whereas the management committee had requested a quota of 50 tonnes. In reality, only 17% of the quota granted was filled on Fakarava in 2014 (Table 5).

Table 3. Ratios used to determine quotas.

Species	Dry weight/ live weight conversion rate	*Asp* live weight in kg per lagoon hectare	*Csp* Number of specimens for 1.0 kg (dry)	Mean live weight considered (kg)	Ratio of maximum number of specimens per lagoon hectare
Bohadschia argus	0.1	0.4	4	2.50	0.160
Actinopyga mauritiana	0.1	0.1	10	1.00	0.100
Thelenota ananas	0.1	0.25	3	3.33	0.075
Holothuria fuscogilva	0.1	0.2	2	5.00	0.040
Holothuria whitmaei	0.1	0.05	2	5.00	0.010

Table 4. Sea cucumber quotas for Fakarava Atoll in 2014.

Species	*Asp*	*Csp*	Weighting	Initial quota calculated in numbers	Quota requested by management committee	Additional information	Final suggested quota in numbers
Bohadschia argus	0.4	4	0.6	11,933	50 tonnes dry weight without specifying per-species quantities or numbers	Little information	10,000
Actinopyga mauritiana	0.1	10	0.6	7,458		Little information	5,000
Thelenota ananas	0.25	3	0.6	5,594		Little information	5,000
Holothuria fuscogilva	0.2	2	0.6	2,983		Abundance before 2013 but high harvests in the northern pass zone	3,000
Holothuria whitmaei	0.05	2	0.6	746		Little information	500
Total or mean	**1**	**3.85**	**0.6**	**28,714**			**23,500**

Table 5. Actual harvests from Fakarava Atoll in 2014.

Species	Quota requested by management committee	Final quota suggested	Actual harvests (numbers)	Actual harvests (kg)	Quota use rate in numbers (%)	Overall use rate of initially requested quota (%)
Bohadschia argus	50 tonnes dry weight without specifying per-species quantities or numbers	10,000	587	121	5.9%	2.1%
Actinopyga mauritiana		5,000	975	116	19.5%	
Thelenota ananas		5,000	72	19	1.4%	
Holothuria fuscogilva		3,000	2,356	797	78.5%	
Holothuria whitmaei		500	*	-	0.0%	
Total		**23,500**	**3,990**	**1 053**	**17.0%**	

* According to this table, *Holothuria whitmaei* was not harvested at all; harvest data for subsequent years showed that the species, in fact, accounts for about 2% of all teatfish.

The second example concerns the much smaller Aratika Atoll, which has a reef surface area of 171 km^2. The method for calculating the quotas of specimens for each species was thoroughly revised for this island, which had been spared harvesting before 2013, to take into account additional information and the fact that the harvest area was limited to the reef crest and the outer slope (Table 6).

The results indicate that:

- the *B. argus* quota was substantially reduced because the reef crest and outer reef slope of the atolls are far removed from this species' preferred biotope;
- the *T. ananas* quota was considerably increased, following the information obtained from an exploratory campaign carried out in 2012 by the Khaleb Bin Sultan Living Ocean Foundation, which showed that this species was actually abundant on the outer reef slope; and
- the *A. mauritiana* quota was increased on an exceptional basis and rounded up to the nearest thousand to offset (to some extent) the low quota allocated for *B. argus*.

The theoretical dry weight quota was estimated at about 1700 kg. In reality, only 20% of the total quota was filled on Aratika (Table 7).

Table 6. Quotas for Aratika Atoll in 2014.

Species	*Asp*	*Csp*	Weighting	Initial quota calculated in numbers	Quota requested by management committee	Additional information	Final suggested quota in numbers
Bohadschia argus	0.4	4	1	2,736		No information on the species; fishing grounds limited to the reef crest and outer reef slope	600
Actinopyga mauritiana	0.1	10	1	1,710		No information on the species; fishing grounds limited to the reef crest and outer reef slope	2,000
Thelenota ananas	0.25	3	1	1,283	No specified quota	High abundance on outer reef slope	2,000
Holothuria fuscogilva	0.2	2	1	684		No information on the species; fishing grounds limited to the reef crest and outer reef slope	600
Holothuria whitmaei	0.05	2	1	171		No information on the species; fishing grounds limited to the reef crest and outer reef slope	100
Total	**1**	**3.85**	**1**	**6,584**			**5,300**

Table 7. Actual harvests in Aratika in 2014.

Species	Quota requested by management committee	Final quota suggested	Actual harvests (numbers)	Actual harvests (kg)	Quota use rate in numbers (%)	Use rate of initially requested quota (%)
Bohadschia argus	No specified quota	600	597	121	99.5%	Not calculated
Actinopyga mauritiana		2,000	462	47	23.1%	
Thelenota ananas		2,000	8	3	0.4%	
Holothuria fuscogilva		600	7	4	1.2%	
Holothuria whitmaei		100	-	-	0.0%	
Total		5,300	1,074	175	20.3%	

Surprisingly, the predominant species in the catches was *B. argus*, with the supposedly most abundant species – *A. mauritiana* and *T. ananas* – accounting for very little. As the preferred biotope of *B. argus* tends to be the inner lagoon, where harvesting was prohibited, it is likely that there was some illegal harvesting.

Quota changes

The big advantage of this method is that it uses data from a past harvest or fishing season to adapt certain suggested quotas for the next. Tables 8a and 8b, illustrates how quotas were adapted over three years, taking into account the results of the previous harvest and the quotas requested.

Table 8a. Adjustments in quotas (in numbers) for Fakarava Atoll from 2015 to 2017.

Island	Species	2014				2015				2016				2017			
		Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)
Fakarava	*Bohadschia argus*	50 tonnes	10,000	587	5.9%	7,000	5,000	55	1.1%	5,000	3,000	662	22.1%	5,000	3,000	2,363	78.8%
	Actinopyga mauritiana		5,000	975	19.5%	5,000	2,000	149	7.5%	3,000	2,000	171	8.6%	3,000	2,000	464	23.2%
	Thelenota ananas		5,000	72	1.4%	5,000	1,000	30	3.0%	1,500	500	32	6.4%	500	500	61	12.2%
	Holothuria fuscogilva		3,000	2,356	78.5%	6,000	3,000	3 000	100.0%	6,000	4,000	4,000	100.0%	6,000	4 000	3,151	78.8%
	Holothuria whitmaei		500	0	0.0%	500	100	56	56.0%	200	200	200	100.0%	1,000	200	71	35.5%
	Total		23,500	3,990	17.0%	23,500	11,100	3,290	29.6%	15,700	9,700	5,065	52.2%	15,500	9,700	6,110	63.0%

Table 8b. Adjustments in quotas (in numbers) for Aratika Atoll from 2015 to 2017.

Island	Species	2014				2015				2016				2017			
		Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)	Management committee quota request	Quota set by Fisheries Department	Actual harvest	Use rate (%)
Aratika	*Bohadschia argus*	No specified quota	600	597	99.5%	10 tonnes	2,000	42	2.1%	5 tonnes	2,000	5	0.3%	Management Committee did not function No fishing season opened			
	Actinopyga mauritiana		2,000	462	23.1%		1,000	123	12.3%		1,000	46	4.6%				
	Thelenota ananas		2,000	8	0.4%		500	0	0.0%		500		0.0%				
	Holothuria fuscogilva		600	7	1.2%		300	3	1.0%		300		0.0%				
	Holothuria whitmaei		100	0	0.0%		100	0	0.0%		100		0.0%				
	Total		5,300	1,074	20.3%		3,900	168	4.3%		3,900	51	1.3%				

4. Outcomes and analysis of harvest from 2014 to 2017

4.1 Production

The gross weights of products shipped from the outer islands to Tahiti are given in decreasing order in Table 9.

Eight atolls shipped more than one tonne of products to Tahiti, all of large dimensions. Two teatfish – *H. fuscogilva* and *H. whitmaei* – accounted for two-thirds of this output, leopardfish (*B. argus*) accounted for one-quarter, and the two other species combined accounted for under 10%.

Table 10 lists the principal characteristics of the harvests or fishing seasons in the different islands of French Polynesia from 2014 to 2017, with the quantities shipped to Tahiti and verified by the local management committees.

Table 10, on pages 54 and 55, shows that certain lagoons that were open to fishing were not exploited. This was because the management committee that had been set up was either uninvolved or even incompetent. In other cases, the islands are either uninhabited or only visited at certain times of the year, which may be outside of the sea cucumber fishing season. In addition, the lagoons of the Society Islands were not opened in 2014 because they were deemed to have been overfished before 2013. Lastly, a few lagoons in the Tuamotu Islands, because of their crucial importance in providing the pearl industry with pearl oyster spat, would have been turned down by the Fisheries Department had they asked for authorisation to harvest sea cucumbers.

The length of the harvest season also varied widely, from one to seven months, although it could last a maximum of nine months. There were two main reasons for this: 1) late requests for authorisation by the management committee, which itself was formed late; and 2) late issue of the authorisation by the competent authority, owing to the high turnover in the ministers in charge of marine resources between the introduction of the regulations in November 2012 and November 2017.

The true quantities harvested are unknown, as they correspond to the sum of the amounts shipped to Tahiti and an unknown and unreported amount corresponding, at the very least, to those dried products that did not meet the

Table 9. Quantities (in kg) shipped from the outer islands to Tahiti from 2014 to 2017 shown by species.

no	Island	Number of open seasons	*Bohadschia argus*	*Actinopyga mauritiana*	*Thelenota ananas*	*Holothuria fuscogilva*	*Holothuria whitmaei*	Overall total
1	Fakarava	4	667.9	191.5	56.2	5,346.1	131.4	6,393.0
2	Apataki	4	145.0	18.6	12.4	4,295.0	650.4	5,121.4
3	Kaukura	3	1,553.9	523.7	4.6	1,836.2	353.1	4,271.5
4	Toau	4	300.7	9.0	75.5	2,338.7	130.2	2,854.0
5	Makemo	4	1,156.5	214.1	6.0	128.3		1,504.9
6	Raraka	2	114.3	20.4	49.4	916.8	239.9	1,340.8
7	Raroia	2	1,267.6	7.0	15.0	4.0		1,293.6
8	Kauehi	3	251.7	19.6	14.4	626.0	96.0	1,007.7
9	North Marutea	2	314.0	139.0	10.0	94.0		557.0
10	Tahanea	1	190.5	36.1	9.7	10.9		247.2
11	Manihi	1	106.0	10.0		110.0		226.0
12	Faaite	4	81.1	81.4		53.6	0.5	216.6
13	Tahaa	2	24.9	14.9	19.4	135.3	12.5	207.0
14	Aratika	3	125.7	65.0	3.0	5.0		198.7
15	Niau	2		69.0	12.0			81.0
16	Vahitahi	2		1.7				1.7
Overall total		**43**	**6,299.7**	**1,421.1**	**287.5**	**15,899.9**	**1 614.0**	**25,522.1**
%			**24.7%**	**5.6%**	**1.1%**	**62.3%**	**6.3%**	

minimum size requirement and so, could not be sold. No one knows what happens to these products, but it seems likely that in islands where the management committees are less aware of the issues, the products were returned to the fishers instead of being seized and destroyed. Once they have been returned to the fishers, the fishers could then either eat them or even ship them to Tahiti, where they may or may not have been offered for sale. If they were placed on the market, the sale price was obviously well below that used for the same species on the legal market because of their small size. What's more, in these sparsely populated islands, it is hard to sell products illegally without it becoming known, so the risk that registered fishers would be tempted to sell products of an unlawful size is considered to be low.

T. ananas is probably the species that is most vulnerable to non-compliance with regard to size limits because processors find it difficult to get a dried product that is at least 20 cm long using the processing methods that traders require. This is also the reason for the previously mentioned trader demand for a lower minimum dry length.

Each island's output also differed widely in terms of catch composition. Catches can be categorised more objectively – and the availability of certain resources gauged and the fishers' strategy assessed – when average annual output is considered.

When it comes to quantity, three islands stand out, each with an average annual output of over 1 t of dried products: Fakarava, Apataki and Kaukura. These are large atolls with at least 10 experienced and motivated fishers. Their waters had been heavily harvested for certain species prior to 2013.

Three other large atolls, where the fishers are fewer in number but motivated, produced between 500 kg and 1 tonne. Five average to large sized atolls, with a limited number of active fishers, produced between 200 kg and 500 kg. Lastly, except for the special case of Tahaa, which is a high island, the remaining islands registered less than 200 kg and are small atolls with very few active fishers.

The composition of the catches varied widely from one island to another, and reflects not only the actual availability of resources, but also the fishers' preferences for certain species.

In the large atolls producing a total of over 1 t of dried products, and despite the fact that *B. argus* is recognised as being the most abundant and accessible species for harvest, only Makemo and Raroia predominantly harvested that species. In the other atolls, fishers clearly targeted the two most prized species – *H. fuscogilva* and *H. whitmaei*, with Apataki being an extreme case with 82% of fishers exclusively targeting these species.

On average, and after combining the figures for *H. fuscogilva* and *H. whitmaei*, 54% of all fishers harvested a single species, 23% two species and 16% three species. Only 7% of fishers harvested all species.

Table 10. Product shipments (in numbers) from the various islands within French Polynesia to Tahiti from 2014 to 2017.

Year	No.	Island	Fishing effort		Species					Overall total
			Length of opened season (months)	Number of active fishers	*Bohadschia argus*	*Actinopyga mauritiana*	*Thelenota ananas*	*Holothuria fuscogilva*	*Holothuria whitmaei*	
2014	1	Apataki	6	31	943	264	38	1,921	310	3,476
	2	Aratika	5	1	597	462	8	7		1,074
	3	Faaite	7	1		83		9		92
	4	Fakarava	7	8	587	975	72	2,356		3,990
	5	Makemo	7	32	2,872	507	10	158		3,547
	6	Manihi	7	8	576	101		190		867
	7	North Marutea	7	3	1,343	492	29	168		2,032
	8	Motutunga	7	0						
	9	Nihiru	7	0						
	10	Taenga	5	0						
	11	Tahanea	7	4	972	226	30	22		1,250
	12	Toau	7	2			102	432		534
Total 2014		9/12 islands active	79	90	7,890	3,110	289	5,263	310	16,862
2015	1	Apataki	4	46				2 167	296	2,463
	2	Aratika	4	1	42	123		3		168
	3	Faaite	2	1	382	237		1	1	621
	4	Fakarava	4	6	55	149	30	3,000	56	3,290
	5	Hiti	4	0						
	6	Kauehi	4	3	196	12	18	104	30	360
	7	Katiu	4	0						
	8	Kaukura	4	48	2,021	2,983		1,329	262	6,595
	9	Makemo	4	23	1,815	521	1	10		2,347
	10	North Marutea	4	2		779				779
	11	Motutunga	2	0						
	12	Raroia	4	0						
	13	Tahanea	2	0						
	14	Tepoto sud	4	0						
	15	Toau	4	4			35	1,500	100	1,635
	16	Tuanaki	4	0						
Total 2015		9/16 islands active	58	134	4,511	4,804	84	8,114	745	18,258
2016	1	Apataki	5	52				2 797	500	3,297
	2	Aratika	2	1	5	46				51
	3	Faaite	1	1		125		120		245
	4	Fakarava	5	7	662	171	32	4,000	200	5,065
	5	Hiti	2	0						
	6	Kauehi	5	4	1,004	153	3	825	160	2,145
	7	Katiu	2	0						
	8	Kaukura	5	28	2,982	1,513	15	1,063	275	5,848
	9	Makemo	5	15	1,192	348	7	52		1,599
	10	North Marutea	5	0						
	11	Motutunga	1	0						
	12	Niau	4	2		400				400
	13	Raraka	4	7	577	47	115	1 032	237	2 008
	14	Raroia	4	4	3,465	95	14			3 574
	15	Tahaa	5	2	178	358	75	253	22	886
	16	Tahanea	1	0						
	17	Tepoto sud	2	0						
	18	Toau	4	8	1,303	93	217	2,045	153	3 811
	19	Vahitahi	1	1		14				14
	20	Tuanaki	2	0						
Total 2016		13/20 islands active	63	132	11,368	3,363	478	12,187	1,547	28,943

Table 10 (continued). Product shipments (in numbers) from the various islands within French Polynesia to Tahiti from 2014 to 2017.

Year	No.	Island	Fishing effort		Species					Overall total
			Length of opened season (months)	Number of active fishers	*Bohadschia argus*	*Actinopyga mauritiana*	*Thelenota ananas*	*Holothuria fuscogilva*	*Holothuria whitmaei*	
2017	1	Akiaki	6	0						
	2	Apataki	7	17	17			646	91	754
	3	Aratika	7	0						
	4	Faaite	7	1	189	456		5		650
	5	Fakarava	7	29	2,363	464	61	3,151	71	6,110
	6	Katiu	7	0						
	7	Kauehi	7	5	191		19	359	20	589
	8	Kaukura	7	17	2,448	749		529		3,726
	9	Makemo	7	2	57	230		10		297
	10	North Marutea	7	0						
	11	Motutunga	7	0						
	12	Niau	7	2		311	30			341
	13	Raraka	7	6	57	145	25	740	222	1,189
	14	Raroia	7	2	4,000		26	8		4,034
	15	Tahaa	7	1	19			32		51
	16	Tahanea	7	0						
	17	Toau	7	22	373			1 163	47	1 583
	18	Vahitahi	6	0						
Total 2017		11/18 islands active	118	104	9,714	2,355	161	6,643	451	19,324
Overall total			**318**	**287**	**33,483**	**13,632**	**1,012**	**32,207**	**3,053**	**83,387**
		Mean or %	**80**	**115**	**40.2%**	**16.3%**	**1.2%**	**38.6%**	**3.7%**	

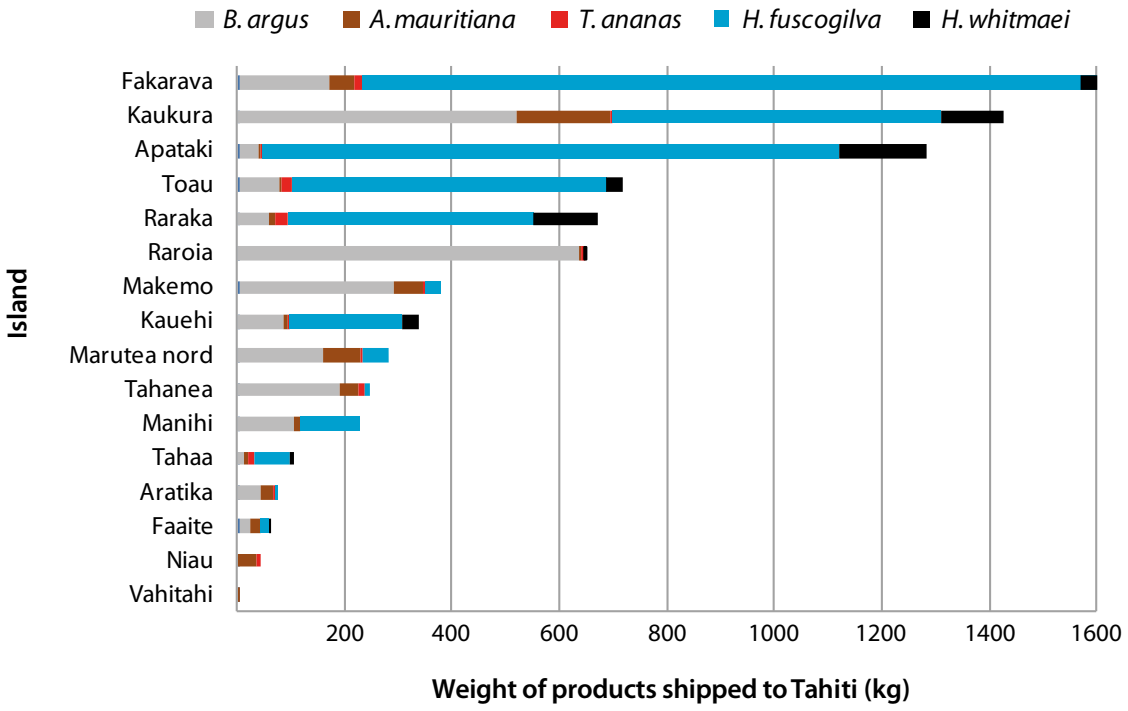

Figure 6. Island ranking by average annual production from 2014 to 2017.

Table 11. Fishers' preferences for certain sea cucumber species in the different islands.

Species	Islands		
	Highly targeted species >75%	Mainly targeted species >50%	Species absent, rare or not targeted < 5%
Holothuria fuscogilva and *H. whitmaei*	Apataki, Fakarava, Raraka, Toau	Kauehi, Tahaa, Kaukura	Vahitahi, Niau, Raroia, Aratika, Tahanea
Bohadschia argus	Raroia, Makemo	Tahanea, Aratika, Marutea nord	Vahitahi, Niau, Apataki
Actinopyga mauritiana	Vahitahi, Niau		Toau, Apataki, Raroia, Raraka, Kauehi, Fakarava, Manihi
Thelenota ananas	none	none	All the islands except Niau

Table 12. Details of 2014–2017 shipments and final destination (in numbers of specimens per year).

Year	Shipments to Tahiti	Seized	Local sales	Export	Not sold
2014	16,862	235	7	16,610	10
2015	18,258	24	0	18,234	0
2016	28,943	89	191	28,103	560
2017	19,324	32	785	18,507	0
Total	**83,387**	**380**	**983**	**81,454**	**570**
%		**0.5%**	**1.2%**	**97.7%**	**0.7%**

Table 13. Sea cucumber exports from French Polynesia from 2014 to 2017.

Year		Species					Overall total
		Bohadschia argus	*Actinopyga mauritiana*	*Thelenota ananas*	*Holothuria fuscogilva*	*Holothuria whitmaei*	
2014	number	7,773	3,106	167	5,254	310	16,610
	kg	1,220.1	307.6	43.4	2,227.6	157.5	3,956.1
2015	number	4,511	4,781	83	8,114	745	18,234
	kg	676.8	371.5	25.0	3,350.1	344.8	4,768.2
2016	number	10,679	3 318	459	12 100	1 547	28,103
	kg	1,871	306	121	4,842	648	7,787.3
2017	number	8,988	2,355	138	6,582	444	18,507
	kg	1,684.6	236.0	45.7	2,867.6	208.4	5,042.3
Overall total	**number**	**31,951**	**13,560**	**847**	**32,050**	**3,046**	**81,454**
	kg	**5,452.0**	**1,221.0**	**234.9**	**13,287.3**	**1,358.7**	**21,553.9**
	% kg	**25.3%**	**5.7%**	**1.1%**	**61.6%**	**6.3%**	

4.2 Marketing

Sea cucumbers shipped from the various islands of French Polynesia to Tahiti are then either sold on the local market, exported, seized or not sold. Details of shipments between 2014 and 2017 are given in Table 12.

Exports accounted for almost 98% of output by number and 96% by weight. Between the time sea cucumbers left the outer islands and were exported, the processed products lost some of their mass, either as a result of natural dehydration or because the exporter wanted to improve their processing. *H. fuscogilva*, *H. whitmaei* and *A. mauritiana* lost,

on average, 13–16% of their weight, whereas *B. argus* and *T. ananas* lost 9% and 2%, respectively.

The quantities sold on the local market and the amounts seized following trader inspections are also known, and are presented in Table 14. Sales on the local market concern only two species to date, *B. argus* and *H. fuscogilva*.

With regard to seizures, the existing web application can be used to configure a plausible range of values for the average weight of the various species that were shipped. If the weight is clearly less than the lowest value in the range, there is a strong likelihood that specimens of less than standard size were present, which may trigger an inspection of the trader by the Fisheries Department. The amounts seized between 2014 and 2017 are presented in Table 15.

Accounting differences between the quantities shipped and the quantities previously indicated are the result of products that were apparently not sold and, thus logically, were eaten in Tahiti. This concerned 570 specimens in 2016, representing a weight of about 90 kg, 92% of which were *B. argus*.

4.3 Exports

The Fisheries Department also collects data on the value of exported products via Customs. The data are compiled monthly for all species. Except for the data on the number of specimens in 2014, when there was a shortfall of 3,673 individuals, very slight differences exist between the data compiled by the Fisheries Department on the products intended for export and Customs data (Table 16).

The entire exported output consisted of dried products (beche-de-mer), all of which were air shipped to Hong Kong. In four years, 21 t of goods, representing a declared customs value of XPF 180 million, were exported by seven sea cucumber traders.

Table 14. Local market sales from 2014 to 2017.

Year		Species		Overall total
		Bohadschia argus	*Holothuria fuscogilva*	
2014	number	7		7
	kg	3.0		3.0
2016	number	166	25	191
	kg	38.0	12.0	50.0
2017	number	726	59	785
	kg	150.0	28.5	178.5
Overall total	**number**	**899**	**84**	**983**
	kg	**191.0**	**40.5**	**231.5**
	% kg	**82.5%**	**17.5%**	

Table 15. Seizures from 2014 to 2017.

Year	Trader	*Bohadschia argus*	*Actinopyga mauritiana*	*Thelenota ananas*	*Holothuria fuscogilva*	*Holothuria whitmaei*	Overall total
2014	1			112			112
	2			3			3
	3	110	4		6		120
Total 2014		110	4	115	6	0	235
2015	1		23	1			24
Total 2015		0	23	1	0	0	24
2016	1		25	19	45		89
Total 2016		0	25	19	45	0	89
2017	1			23	2	7	32
Total 2017		0	0	23	2	7	32
Overall total	**4**	**110**	**52**	**158**	**53**	**7**	**380**
	%	**28.9%**	**13.7%**	**41.6%**	**13.9%**	**1.8%**	

Table 16. Annual exports from 2014 to 2017

Parameter	2014	2015	2016	2017	Total
Number of active traders	5	3	3	3	7
Number of specimens	12,937	18,234	27,913	18,481	77,565
Weight in kg	3,930	4,735	7,639	5,002	21,306
Value in XPF	25,867,755	45,721,623	67,730,159	40,768,193	180,087,730
Average XPF price per kilo	6,582	9,656	8,866	8,150	8,452
Percentage of *Hf* and *Hw*	60.3%	77.5%	70.5%	61.0%	68.0%

Source: Customs data

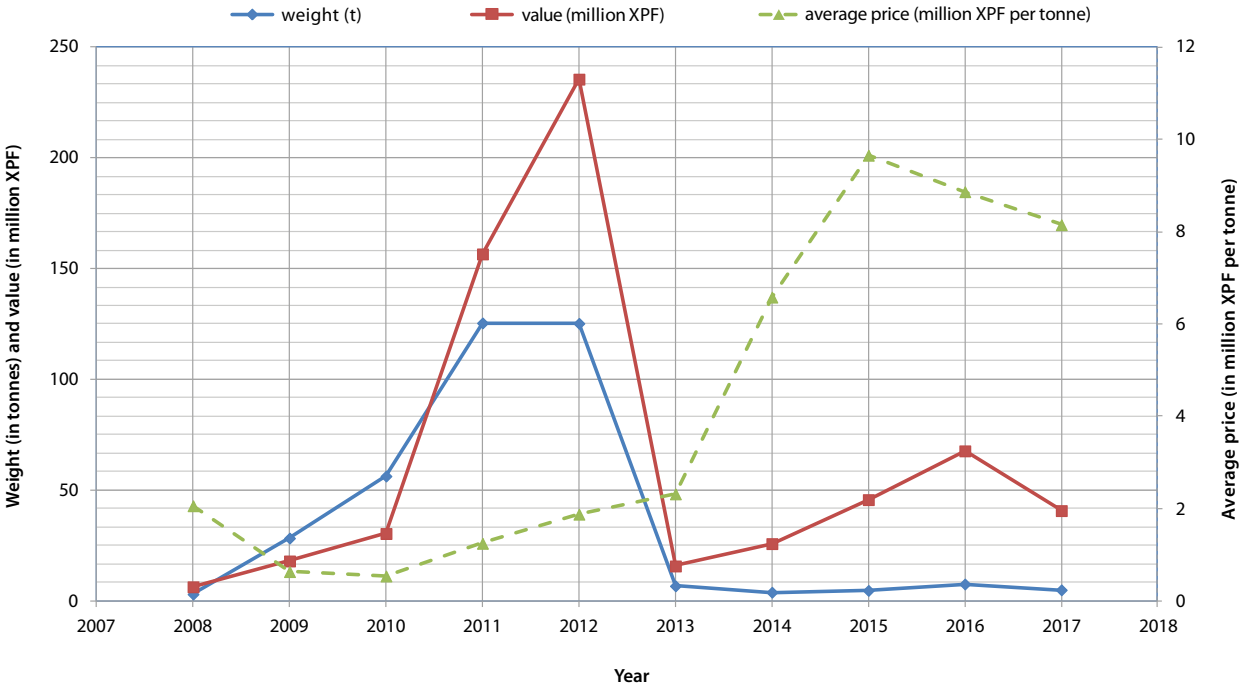

Figure 7. Annual exports from 2008 to 2017. Source: Customs data

Prices vary from year to year, essentially because of the proportions of *H. fuscogilva* and *H. whitmaei*, which account, on average, for 68% of total exports. As those two species are the most highly prized, the average price obtained each year varies in direct proportion to their share of exports.

Prices improved overall between 2014 and 2017 because even though the proportions for the two most prized species remained the same, the average price rose by 24%.

A comparison of the harvests in recent years with those that took place between 2008 and 2013 shows that in addition to the more accurate information obtained on the species and the places they were harvested, there were two major changes (Fig. 7): 1) a steep drop in the number of tonnes harvested, from 132 t (including 88 t of dried product) in 2012 to between 4 t and 8 t of dried product annually between 2014 and 2017; and 2) a substantial rise in declared export prices, which rose from XPF 2,320 kg^{-1} for dried products in 2013 to between XPF 6,500 and 9,600 kg^{-1} for the period 2014–2017.

5. Conclusions

The introduction of harvest regulations, which led to the re-opening of certain lagoons to sea cucumber fishing, generally speaking resolved most of the obvious problems observed in 2012, in that it:

- sharply decreased the harvest rate for certain species from islands where harvesting was allowed;
- increased the value of products because of the promotion of dried products;
- enabled all fishers to process the products themselves and, in that way, to benefit from the added value associated with this activity;
- sharply reduced product wastage;
- made it more difficult for both fishers and traders to cheat due to an effective system of product traceability;
- forced processors to adopt more hygienic practices;
- involved the communities in implementing the government's authorised harvest project; and
- restricted the role of public authorities to granting authorisations and their control, directly from Tahiti.

The regulations also served to build up a database on harvested or marketed products by weight and number, species and geographical origin. The main negative effect is, no doubt, the drastic drop in activity for many islands in which harvest authorisations were not renewed, given that the value of exports plummeted from roughly XPF 200 million between 2011 and 2012 to XPF 45 million between 2014 and 2017. Was the 2011–2012 level of exploitation sustainable? Probably not.

While guaranteeing the sustainable development of this fishery, certain islands already involved in harvesting could improve their turnover by more specifically targeting *B. argus*, which predominates in most lagoons, and the harvest season could be extended to other average-sized or large atolls.

References

Andréfouët S., Chauvin C., Spraggins S., Torres-Pulliza D. and Kranenburg C. 2005. Atlas des récifs coralliens de Polynésie française. Centre IRD de Nouméa. 38 pages + 86 planches.

Biodax Consulting. 1998. Rapport final relatif à la réalisation d'une étude préalable sur l'exploitation des bêches-de-mer (*rori*). Biodax Consulting R.C 23 760 – A N° TAHITI 336 255. 102 p.

Lucett E. 1851. Rovings in the Pacific from 1837 to 1849, with a glance at California. London, United Kingdom: Longman, Brown, Green and Longmans. 390 p.

SNC Pae Tai – Pae Uta Études Environnement. 1997. L'exploitation des holothuries en Polynésie française. Polynésie française, Papeete : Service de la mer et de l'aquaculture. 69 pages + 9 Annexes.