Communications...

from: *C. Conand, H. Eriksson, A. Lovatelli, N.Muthiga and S.W. Purcell*

Workshop on sea cucumber fisheries: An ecosystem approach to management in the Indian Ocean, Zanzibar, Tanzania, 12–16 November 2012

The workshop was organised by the West Indian Ocean Marine Science Association (WIOMSA) and the Food and Agriculture Organization under the FAO/EU SmartFish project of the Indian Ocean Commission with additional financial contributions from the Australian Centre for International Agricultural Research (ACIAR) and the Sultanate of Oman. The final report will be published by FAO, in 2013. Please contact Alessandro Lovatelli for a hard copy (alessandro.lovatelli@fao.org).

Sea cucumber fisheries from the Indian Ocean are showing signs of significant decline from unsustainable exploitation rates (Conand 2008). This situation is worrying because sea cucumbers provide substantial income to people and countries in the region. This decline can, at least partly, be attributed to insufficient management (Eriksson et al. 2012a). To assist sea cucumber fisheries managers worldwide in decision-making, the Food and Agriculture Organization (FAO) has supported the development of improved management systems through several programmes (Lovatelli et al. 2004; Toral-Granda et al. 2008; FAO 2010; Purcell 2010). One of these programmes is a regional sea cucumber project to gain a comprehensive understanding on a range of aspects relating to this resource. It is supported by WIOMSA, through the Marine Science for Management (MASMA) programme (Conand and Muthiga 2007).

In addition, ACIAR (Friedman et al. 2008) and FAO (2010) recently developed pragmatic manuals for the management of this fishery. The ACIAR manual provides a "managers' toolbox" by outlining indicators that assist in identifying the status of a fishery and the FAO manual provides a "roadmap" to decision-making about management measures. These manuals have been widely distributed throughout the tropical world. Because this fishery is so little understood, a need was identified – to develop practical hands-on training approaches using these manuals so that managers could develop practical skills to guide their management decisions. This need was met through the development of a workshop series called *Sea cucumber fisheries: an ecosystem approach to management (SCEAM)* (Purcell and Lovatelli 2012a). The first workshop focussed on Pacific sea cucumber fisheries and was held in Fiji in 2011 (Purcell and Lovatelli 2012b).

Figure 1. The participants at the SCEAM Indian Ocean workshop (Image: Saad M.).

This article announces the completion of the SCEAM Indian Ocean workshop, held in Zanzibar in November 2012 (see also Eriksson et al. 2012b). Workshop participants were identified and selected on the principle that they had to be managers, or senior officers, with an intimate knowledge of the fishery in their country (Fig. 1). Other criteria were that they could actively contribute to the workshop and could influence management changes to improve their fisheries after the workshop. Fifteen participants from 14 countries participated in the workshop. Prior to the workshop, all participants submitted a data form that summarised

key aspects of their fishery. The information from these forms revealed, among other things, the diversity of fishery operations targeting sea cucumbers in the region and how there are different management needs and capacities in the countries of the Indian Ocean.

The workshop aimed to: (1) provide a forum for group sharing of experiences and lessons learned of sea cucumber fisheries management; (2) facilitate learning to support the development of new management plans (or revisions to existing plans) for sea cucumber fishery; and (3) collate and analyse current information from the Indian Ocean sea cucumber fisheries on management practices and constraints. The workshop was a week-long exercise and the programme was built around eight sessions that encompassed theoretical presentations by facilitators, plenary discussions, practical workgroup sessions and a field day.

During the workshop, the facilitators (C. Conand, H. Eriksson, A. Lovatelli, N. Muthiga and S.W. Purcell) held introductory seminars on up-to-date research and the ecosystem approach to management in sea cucumber fisheries, based on recent publications (Conand 2008; Conand and Muthiga 2007; Friedman et al. 2008; Purcell 2010; Eriksson et al. 2012a; Purcell et al. 2013; Toral-Granda et al. 2008). The workshop then built on interactive sessions to facilitate group discussions and exercises. After being guided through the ACIAR "toolbox", the participants worked in groups to review the six indicators in the manual to assign a status to their fishery. Based on this assigned status, the participants were led through the FAO "roadmap" and, in workgroups, decided what regulatory measures and management actions are appropriate for their fishery. In these exercises, emphasis was placed on the importance of interpreting the manuals in the context of the fishery operations and institutional system in the country. The manuals do not give definitive answers to the problems/challenges, but help guide the manager through decision-making. In an exercise to define management objectives, the highest ranked objective by the participants was to "maintain/restore abundances of sea cucumbers for future generations".

In the middle of the week, a day for field activities was organised to provide practical skills on sea cucumbers and trade products in Zanzibar. The first activity was a presentation by Conand C. on the commercial species of the Indian Ocean region, including an original laminated sheet of the 36 most commercially important species. The second activity was a walk in an intertidal zone, identifying species along the walk on the southwest corner of Zanzibar. The habitat was a mixture of seagrass beds and sand-muddy patches where the species recorded were sandfish *Holothuria scabra*, lollyfish *H. atra* and white threadsfish *H. leucospilota*. The third activity was a snorkel trip to Kwale Island. The group searched for holothurians among patches of live corals, sandy floor and seagrass areas. Surprisingly few sea cucumber individuals were found, indicating severe overfishing. The following species were found at this site in decreasing order of abundance: *Pearsonothuria graeffei*, *Thelenota ananas*, *Actinopyga echinites*, *H. atra*, *Bohadschia subrubra*, *Stichopus herrmanni* and *H. edulis*.

Finally, a visit to a processing facility north of Stone Town showed classical processing procedures. The participants observed live catch, salted and boiled products, smoking racks, drying in an oven and sun-drying on bare concrete. Species ready for the first boiling were: *Stichopus herrmanni*, *Holothuria spinifera* and *H. lessoni*. There was a large variety of species drying in the sun, sorted and graded by species; most were from medium to low value. The high-valued teatfish (black teatfish *H. nobilis*, white teatfish *H. fuscogilva* and *H.* sp. "pentard") and *Thelenota ananas* represented only a small percentage of the large quantities drying and many specimens were rather small, suggesting a decline in the high-value species (Fig. 2). A large batch of *Thelenota anax* of large size and many individuals of *Bohadschia* spp. (some *B. atra*, *B. vitiensis* and other species) were also drying on the concrete. A fair amount of the drying product were Stichopodids, especially *S. herrmanni* and another characteristic species with large papillae, which, when processed, present a spiny appearance and could be *S. naso* or a species not yet described. *Actinopyga*

Figure 2. Mixed species of medium-low quality drying in the sun (Image: Lovatelli A.).

spp. were also fairly abundant, especially *A. echinites* and *A. mauritiana*. Finally, several small-bodied species, including *H. atra*, were mixed together in batches. Participants also observed several bags containing the dry product, sorted by species, and ready for shipping in a large drying room.

Plenary sessions and discussions were an important component of the workshop agenda. Here, barriers or management challenges identified by participants were discussed. During the final plenary session, key priority research areas to aid management, and training needs to facilitate monitoring and enforcement of regulations, were identified. The regional/sub-regional movements of fishers and trade were frequently mentioned as a problem that undermines national management, and governance structures that can facilitate regional cooperative management were suggested as a means to tackle this challenge. The training needs that were identified included manuals for the identification of live animals (targeting management agencies and researchers; see Purcell et al. 2012, published a few weeks after the workshop) and dried products (mostly for customs monitoring and enforcement). A major benefit of the workshop was that managers from the region met and shared discussions on common challenges in managing fisheries in general and sea cucumber fisheries in particular. In the post-workshop satisfaction forms, all of the participants responded that the activity had been useful for them – emphasising that the workshop helped managers develop relevant practical skills using the manuals and existing publications and connecting science with policy.

We thank WIOMSA and FAO for the organisation, the support of ACIAR and the Sultanate of Oman, and the participants for their active engagement during the workshop.

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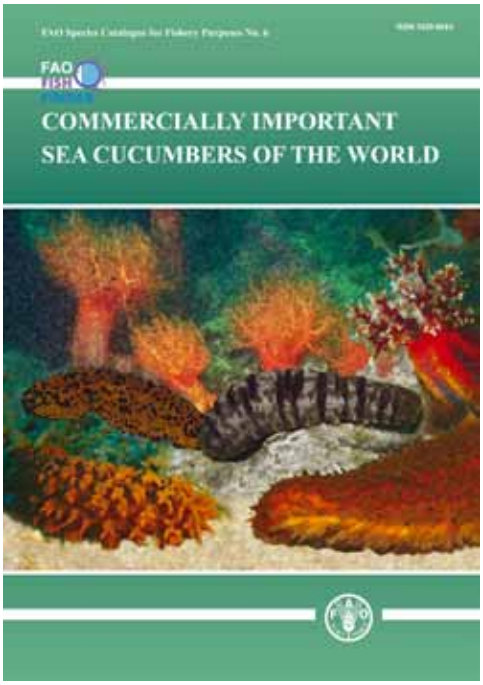
from: *C. Conand and A. Lovatelli*

Global sea cucumber identification book published by FAO

Sea cucumbers are presently harvested and traded in more than 70 countries worldwide. They are exploited in industrialised, semi-industrialised and artisanal fisheries in polar regions, temperate zones and throughout the tropics. In some fisheries, more than 20 species are exploited. The processed animals are exported mostly to Asian markets and need to be distinguished to species level by customs and trade officers. This presented a need for a global species identification book that also summarises the biology and exploitation of these species.

The citation for the book is: Purcell S.W., Samyn Y. and Conand C. 2012. Commercially important sea cucumbers of the world. FAO Species Catalogue for Fishery Purposes No. 6. Rome: FAO. 150 p. + 30 colour plates.

Available at: http://www.fao.org/docrep/017/i1918e/i1918e.pdf



For each of the 58 species, including 37 Holothuriidae, 18 Stichopodidae and 3 Cucumariidae, the following information is given.

- Species name and common names at different localities
- General appearance and descriptive characteristics
- Diagnostic features: description with drawing, ossicles, processed appearance, body weight and lengths
- Habitat and reproductive periods
- Exploitation: fisheries, regulations, and human consumption
- Market destinations, landing prices and Asian market prices
- Known geographical distribution, including a map

The book is intended as an identification tool for fishery managers, scientists, trade officers and industry workers to distinguish the more commonly exploited and traded species worldwide. It provides identification information on 58 species, including 37 Holothuriidae, 18 Stichopodidae and three Cucumariidae. There are presently many other species that are exploited, either in a small number of localities or in relatively small quantities, that are not presented in this edition.

The introduction summarises the general morphology and anatomy of sea cucumbers, their ossicles (and the method of their preparation), and post-harvest processing techniques. Two-page identification sheets provide information to allow readers to distinguish each species from other similar species, both in the live and processed (dried) forms. The following information for each species has been included: nomenclature together with known common names; general appearance and distinguishing features; scientific illustrations of the body and ossicles; descriptions of ossicles present in different body parts; colour photographs of live and dried specimens; basic information on size, habitat, biology, fisheries, human consumption, market value and trade; and a geographic distribution map. The bibliography, the index and a series of 30 colour plates of live and processed (when available) specimens are given at the end.

Users are encouraged to base their identifications on a combination of morphological features, samples of ossicles from different body parts and information on which habitat and locality the species was found.

To request a hard copy of the book, please contact Mr Alessandro Lovatelli (Alessandro.Lovatelli@fao.org). Please provide your full name, position (in your organisation), name of your institute, full mailing address and contact details (including your email address).

from: *A.-R. Dabbagh, M. Keshavarz, H. Atashzaban and M.R. Sedaghat*

Problems related to *Holothuria scabra* culture in Iran

The present paper concerns problems in the breeding and culture of the sea cucumber *Holothuria scabra* in Iran. Earlier breeding attempts in Hormozgan and Sistan-Baloochestan provinces did not bear fruit. The current breeding and culture efforts started in 2010 in the Persian Gulf Mollusc Research Station, which is located in Bandar-e Lengeh, Hormozgan Province in south Iran.

In that year, prior to the main activity, a survey was carried out by the author on the identification and diversity of Iranian holothurians. Stocks of commercial species were identified, in particular of the highly valued sandfish sea cucumber, known from Qeshm Island (Dabbagh et al. 2012a). At that time, due to an absence of knowledge on breeding and culture of sea cucumbers, it was decided to start with breeding an abundant and highly accessible species, *Holothuria leucospilota*, which is found in some coastal areas around Bandar-e Lengeh, for example at Bandar-e Bostaneh. After learning the necessary techniques the commercially important species *Holothuria scabra* would be collected and studied.

First, in the early summer of 2010, 20 *Holothuria leucospilota* broodstock were transferred to the Persian Gulf Mollusc Research Station. On the day after this transfer, the broodstock was exposed to a thermal shock. Although a number of them spawned, due to inexperience, the eggs were not successfully collected. But the next time, with more knowledge, the eggs were stocked in 300 litre tanks and reared according to methods described in the breeding manual by Agudo (2006). After observation of doliolaria larvae, a fibreglass sheet was put in the tanks as a settlement substrate. However, due perhaps to the use of excessive amounts of *Sargassum* (brown algae) extract, intended to induce larvae to settle, as well as failure to sterilise this extract, many unwanted organisms were found in the larval tanks. Juveniles of 1 mm length were observed but nothing more (Dabbagh et al. 2011a).

In the following year (2011) more studies were carried out, this time with sandfish. We tried to benefit from the experiences of several scientists, including Drs Mary Byrne, Beni Giraspy, Anne Mercier, Rayner Pitt and Steven Purcell. In early summer, 20 broodstock sandfish (*Holothuria scabra*) were transferred to the Persian Gulf Mollusc Research Station from Qeshm Island. A few days later, however, after attempting to stimulate spawning, no eggs were obtained. Various methods such as thermal shock, pressure shock and drying were used without success.

The next attempt to induce new broodstock to spawn also failed. The broodstock was maintained in a tank beside blacklip pearl oysters for a month and fed with extract of phytoplankton cultured on the station. The final attempt to induce the broodstock took place in late summer, and we succeeded in getting eggs from *H. scabra* for the first time in Iran.

The general methods for rearing larvae and early juveniles followed methods described in recent papers: Pitt and Duy (2004), James (2004), Ivy and Giraspy (2006). Early juveniles were fed only commercial supplements such as Algamac 3050, Algamac Protein plus and Spirulina powder (Dabbagh et al. 2011b). One problem here is that no mud-flat area could be found around Bandar-e Lengeh for culture of juveniles. Hence, just commercial supplements were used. Algamac 3050 led to less growth and higher juvenile mortalities. Also, because environmental conditions were not perfect we had to use artificial light. Where we were able to use natural light and food such as extract of *Sargassum*, this resulted in better juvenile growth.

It seems the most fundamental problems leading to the low growth of juveniles in Bandar-e Lengeh were the salinity of the Persian Gulf (40‰ and sometimes even more), and the intense sunshine. Temperatures are over 30°C for most of the year, with only three months a year in when temperatures are below 25°C.

Surviving juveniles were cultured under these conditions for a year, after which time they reached 20 g in weight (Dabbagh et al. 2012b) (Fig. 1). We looked at the environmental conditions in other parts of the world with similar latitudes. For example, in Madagascar temperatures are like those in the Persian Gulf but the salinity (35‰) is less. This is because the Persian Gulf is semi-enclosed and salinity may increase towards the end of the gulf. The growth rate in Madagascar was 300 g in 10–12 months (Eeckhaut et al. 2008). Since the project of breeding and culture of sandfish was not an approved project and not awarded sufficient funding we had difficulties in overcoming such problems, in lowering the salinity and transferring mud (from the natural habitat of sandfish) from Qeshm Island.

Figure 1. A nursery in the Persian Gulf Mollusc Research Station.

Figure 2. A 10 m^3 concrete pond in Bandar-e Moallem Center.

Figure 3. Male spawning spontaneously after the water change.

In 2012 a new attempt to breed and culture sandfish was launched in Bandar-e Moallem Center, a hatchery next to Bandar-e Lengeh. This centre was originally set up to breed shrimp and high-value marine fish such as silver bream and groupers. We decided to breed sandfish there, and part of the centre was allocated to us for that purpose. The remaining sandfish broodstock were stocked in 10 m^3 concrete ponds under shade, with a layer of fine sand, and extract of *Sargassum* was used for feeding. In early summer the first batch of broodstock sandfish was transferred there from Qeshm Island (Fig. 2). At that time temperature and salinity were 28ºC and 40‰, respectively. Water was changed daily.

Two weeks after stocking (at two individuals per square metre) the first male spawned spontaneously after the water change (Fig. 3). After that, males spawned again several times and were removed so they would not stimulate females to spawn. However, when this did in fact happen, the facilities and unicellular algae were not ready. When these essentials had been prepared, unfortunately no more sandfish, not even a new broodstock batch, could be induced to spawn. A further batch was transferred in early fall but never spawned.

A problem that we have encountered in Bandar-e Moalem was that most broodstock eviscerated. This occurred throughout the period of our trials, which we consider may be due to environmental factors, with temperatures rising to more than 30ºC as well as salinity of 40‰. The water was not treated by UV sterilisation. We were told by an expert that evisceration is common under these conditions.

Being unable to reduce the salinity we decided to the maintain broodstock in seawater near the hatchery into which fresh water flows from a cave, and which has a salinity of 30‰. Again the result was not a success as the animals were not fed and their movement decreased. After the failure of this project, it was decided to leave the broodstock in the sedimentation tank of the hatchery centre for a long time. After six months we observed a reduction in their weight.

In conclusion, sandfish culture and breeding need to be carried out under controlled conditions of water temperature and salinity. Hence we would suggest the use of Qeshm Island as a hatchery centre because of ease of access to broodstock. Also we propose that mariculture of juveniles may be done in pens, which could be set up, for example, in the mangrove forest of Bandar-e Khamir, where the salinity is lower than in other places.

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Sea cucumbers: The new resource for a hungry fishery (CUMFISH). Project PTDC/MAR/119363/2010

Sea cucumber stocks have been overfished in many countries around the Indian and Pacific oceans as a result of ever-increasing market demand, uncontrolled exploitation and/or inadequate fisheries management. The life-history traits of holothurians make them especially vulnerable to overfishing because they have low or infrequent recruitment, high longevity and density-dependent reproductive success.

This situation has resulted in catches of new target species from the Mediterranean Sea and northeastern Atlantic Ocean, whose fisheries are in the process of development. Among the new economically important species to stress are *Holothuria mammata* (Grube, 1840), *H. tubulosa* (Gmelin, 1970) and *H. polii* (Delle-Chaije, 1823) (Fig. 1). The main problem of these fisheries is the existence of several sea cucumber species living in the same region with similar external morphology, very difficult identification and scarce information about life strategies, population dynamics and evolution history. Another target species from the Mediterranean Sea, Atlantic Ocean, Antilles and Gulf of Mexico is *Parastichopus regalis* (Cuvier, 1817), which is commercialised mainly for human consumption in the NW Mediterranean (Catalonia) (Fig. 1). *H. arguinensis* (Koehler and Vaney, 1906), could become a very important target species. The last considered species is *Isostichopus badionotus* (Selenka, 1867) which is found throughout the Caribbean and is very common in Bermuda (Fig. 1).

Therefore, the main goals of this proposal are to study the incipient sea cucumber fisheries of several sites from Mediterranean Sea and Atlantic Ocean (Fig. 2) and to assess the genetic structure of these species, including the selection effects of fisheries. More precisely, the aims are: (1) to clarify the taxonomic status of holothurian target species; (2) to quantify the captures from these incipient fisheries; (3) to increase the knowledge of biological features of these species; (4) to assess the genetic diversity and gene flow between populations of these new target species; (5) to identify the possible stocks; (6) to assess the effects of human selection (fishery) on sea cucumber genetic structure; and (7) to suggest management measures for the sustainability of their fisheries.

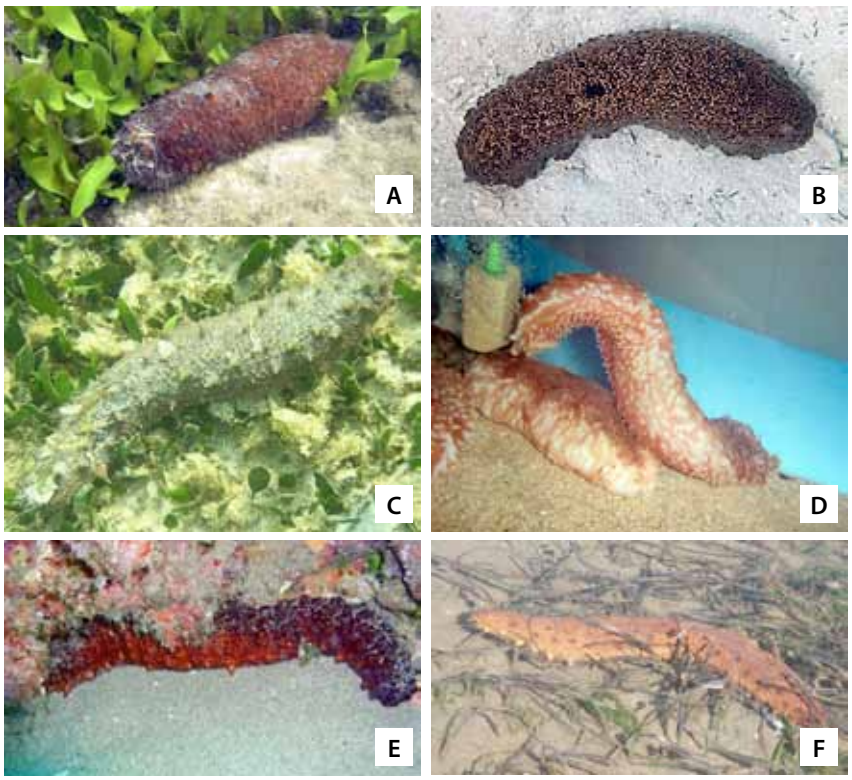

Figure 1. Sea cucumber target species.
A: *Holothuria polii*; B: *Isostichopus badionotus*; C: *Holothuria tubulosa*;
D: *Parastichopus regalis* (Image: Nuno Vasco); E: *Holothuria mammata*; F: *Holothuria arguinensis*.

To implement this project and to accomplish the aims we rely on other highly qualified researchers working on different subjects such as sea cucumber systematic, population genetics, phylogeography and fisheries: Dr Gonçalves from Coastal Fisheries Research team, Centro do Ciências do Mar, CCMAR (Portugal); Dr Aydin from Ordu University (Turkey); Nuno Vasco from Escola Superior de Turismo e Tecnologia do Mar de Peniche; Dr Lleonart from Consejo Superior de Investigaciones Científicas, CSIC (Spain); and Dr Ramón from the Instituto Español de Oceanografía, IEO (Spain).

This project started last year (1 February 2012) with three years to run and it has been funded by FCT (Fundação para a Ciência e a Tecnologia, Ministério da Ciência, Tecnologia e Ensino Superior, Portugal). Two grants are associated with this project and several MSc students are collaborating with us. More information about this project is available on our website (http://www.ccmar.ualg.pt/cumfish/) and the CUMFISH Facebook group (http://www.facebook.cm/groups/408508309208037/). So if you are interested, you can contact us. People wishing to collaborate with us will be welcome.

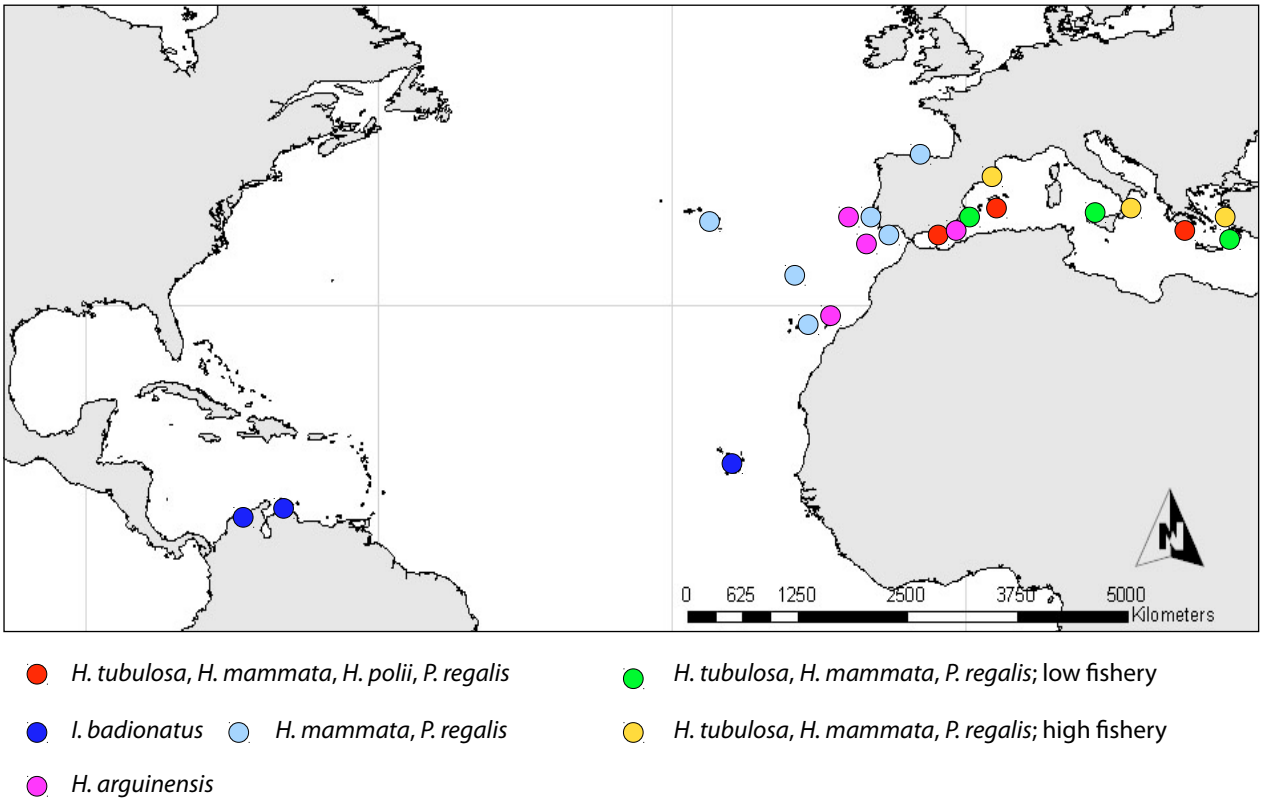

Figure 2. Sampling sites
(Tasks 1, 2, 3, 4 and 5: red, magenta and blue circles; Task 6: green circles, areas with low fishery pressure, and orange circles, areas with high fishery pressure).