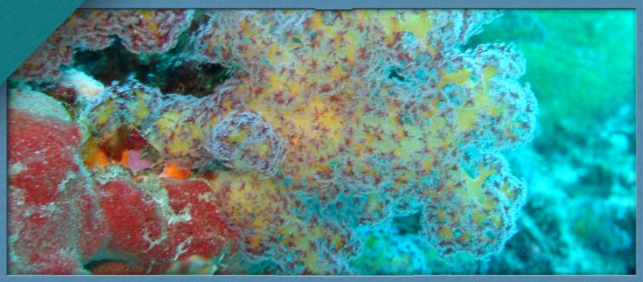
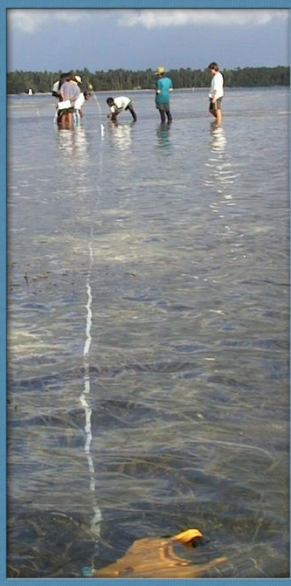
Bay of Bengal Large Marine Ecosystem Project





Participatory management for conservation of seahorses in the Gulf of Mannar, South-east coast of India

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FINAL REPORT

Participatory management for conservation of seahorses in the Gulf of Mannar, south-east coast of India






Project Funded by
The Food and Agriculture Organization of the United Nations (FAO) in support of the Sustainable Management of the Bay of Bengal Large Marine Ecosystem (BOBLME) Project

Implementing Partner:
Central Marine Fisheries Research Institute
(Indian Council of Agricultural Research)

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Food and Agriculture Organization of the United Nations

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Acronyms used

BOBLME	Bay of Bengal Large Marine Ecosystem
CITES	Convention on International Trade in Endangered Species of wild fauna and flora
CMFRI	Central Marine Fisheries Research Institute
DHAN	Development of Humane Action foundation
DNA	Deoxyribonucleic acid
FAO	Food and Agriculture Organisation
GOMBRT	Gulf of Mannar Biosphere Reserve Trust
ICAR	Indian Council of Agricultural Research
ICSF	International Collective in Support of Fishworkers
ICT	Information & Communications Technology
IFS	Indian Forest Service
IUCN	International Union for Conservation of Nature
MLS	Minimum Legal Size
MPA	Marine Protected Area
MPEDA	Marine Products Export Development Authority
MSSRF	M S Swaminathan Research Foundation
NETFISH	Network for Fish Quality Management & Sustainable Fishing
NGO	Non-Governmental Organisation
Hong Kong SAR	Hong Kong Special Administrative Region
SCUBA	Self-Contained Underwater Breathing Apparatus
TCM	Traditional Chinese Medicines
WCCB	Wildlife Crime Control Bureau

1. Introduction

The status of seahorse resources has become a major concern globally, due to the decline in population. There is an increasing demand for seahorses for use in Traditional Chinese Medicines (TCM), as ornamental fishes and for curiosities. They are heavily extracted, particularly for the dried trade to countries with large ethnic Chinese populations, and the demand greatly exceeds supply. The behaviour and ecology of seahorses suggests that they are vulnerable to over-exploitation. The degradation of their limited habitats like the seagrass meadows and coral reefs, mainly due to anthropogenic activities, also contributes to further depletion.

A total of nine species of seahorses have so far been reported from the Indian waters. The coasts of Tamil Nadu, particularly the Gulf of Mannar and Palk Bay, are known for rich diversity of seahorses, and this region was the main contributor for the export trade of seahorses from India. Until 1980s, the trade was based on the incidental catches of seahorses in trawl and other fishing gears. However, target fishing was initiated in 1992, which expanded rapidly during 1996-1997. The depletion of seahorse resources in the wild forced the Government to enforce a ban on the export permits of all species of Syngnathids from July 2001 and listed them under the Schedule I, Part-IIA of the Indian Wildlife (Protection) Act, 1972.

The enforcement of ban on collection and trade of seahorses from India might have helped in re-building the population of seahorses; however, the ban has seriously affected the livelihood of scores of poor coastal fishermen who were completely dependent on the collection of seahorses and had only few other options for their livelihood.

It was therefore felt imperative to analyse and understand the impact of listing on the conservation of seahorse resources in the wild and the implications of listing on the livelihood of the fishermen. In this backdrop, the project 'Participatory management for conservation of seahorses in the Gulf of Mannar, south-east coast of India' was funded by the Food and Agriculture Organization (FAO) of the United Nations, in support of the "Sustainable Management of the Bay of Bengal Large Marine Ecosystem (BOBLME)" Project, wherein the ICAR-Central Marine Fisheries Research Institute is the Implementing Partner. This is in line with the overarching objective of the BOBLME Project to contribute to improved biodiversity conservation and fisheries management, under an Ecosystem Approach to Fisheries Management, and with the project's focus on the transboundary critical habitat, the Gulf of Mannar.

The proposed study was therefore envisaged to provide a clear and objective review of listing and its on-going impacts and to come out with recommendations for measures and policy guidance to resolve some of the challenges identified through the study.

The seahorses belong to the family Syngnathidae. They are found distributed roughly from 50^{o} North to 50^{o} South latitude, with most species occurring in the Western Atlantic Ocean and the Indo-Pacific region. All seahorses are marine, except for some which are found in estuaries. They generally live among the seagrass beds and coral reefs in shallow temperate and tropical waters. Their demand coupled with decline in population in wild has become a cause of serious concern all over the world.

The peculiar body features, appearance, and behaviour make seahorses a highly sought-after fish for aquarium industry and are traded worldwide. The seahorses have head at right angles to their body and prehensile tail by which they wrap around seagrass stems, corals, sticks or any suitable substrata. These traits along with eyes that swivel independently of each other, tubular snout, lack of stomach and teeth, camouflaging behaviour and presence of a series of bony plates, make them unique. Unlike other fishes, the gills are small and compacted. They swim using the propulsive force of dorsal fin, and the pectoral fins are used for steering and stability. Adult seahorses attract fewer predators due to the presence of unappetizing bony plates and spines.

The seahorses are characterized by sparse distribution, low mobility, narrow home range, monogamous breeding behaviour, low fecundity, slow growth, site specificity and high degree of lengthy parental care which makes them more vulnerable to exploitation. In addition to their live trade in the aquarium industry, they are also highly sought-after for medicinal purposes. They form important components in Traditional Chinese Medicine (TCM) and for this reason they are targeted by poor subsistence fishers in large numbers and traded widely, causing their decline in population. They are also components in by-catch of many fishing gears, particularly the trawl.

Globally, syngnathid fisheries are generally not managed as there is not much understanding on their biology and population dynamics and partly because the fisheries often involve multiple fishing gears and multiple species in tropical countries. A total of 54 species of seahorses have been reported worldwide of which 40 species are included in the IUCN Red List of threatened species. Of the 40 species listed in the Red List, one species is Endangered (EN), 10 are Vulnerable (VU), 1 is Least Concern (Lc) and 27 are Data Deficient (DD) (IUCN, 2015).

Until late 1980s, seahorses were mainly caught as by-catch in trawl landings. Target fishing for export was initiated in 1992 in the Palk Bay, south-east coast of India (Marichamy *et al*., 1993) and expanded rapidly during 1996-1997 (Lipton *et al.*, 2002). Concerned by this, the Ministry of Environment, Forests and Climate Change (MoEF & CC), Government of India banned the export permits for all syngnathids from July 2001 and classified them under Schedule I, Part II-A of the Indian Wildlife (Protection) Act, 1972. Following implementation of ban, there is considerable decrease in fishing of syngnathids in the last 14 years, but clandestine fishing and trade takes place, as is evident from the occasional seizures of dried seahorses by the officials of the Forest Department.

1.1. Seahorse diversity and distribution in the Indian waters

Nine species of seahorses *viz*., *Hippocampus trimaculatus*, *H. kuda*, *H. fuscus*, *H. spinosissimus*, *H. kelloggi*, *H. borboniensis*, *H. histrix*, *H. mohinekei* and *H. camelopardalis* have been reported in the Indian waters (Marichamy *et al*., 1993; Lipton and Thangaraj, 2002; Murugan *et al*., 2008; Rajagopal *et al*., 2012; Subburaman *et al*., 2014). Of these nine species, eight (except *H. camelopardalis*) are found all along the Tamil Nadu coast (south-east coast of India), 2 species (*H. trimaculatus* and *H. borboniensis*) in Kerala waters (Sakthikulangara and Neendakara), 1 species (*H. kuda*) in Maharashtra (Mirya Creek), 1 species (*H. kuda*) in Goa (Zuari estuary), 3 species in Andaman and Nicobar Islands (*H. kuda*, *H. trimaculatus* and *H. histrix*) and 1 species (*H. camelopardalis*) in Gujarat (Mithapur reef). Based on the available literature, it is evident that the coast of Tamil Nadu is found to be one of the preferred locations for seahorses. The limitation of reef research is one of the main reasons for the poor understanding of seahorse diversity and distribution in India, particularly its occurrence from regions like the Andaman and Nicobar Islands and Lakshadweep Islands which are not yet well documented.

In the Gulf of Mannar, 7 species of seahorses viz., *Hippocampus trimaculatus*, *H. kuda*, *H. fuscus*, *H. spinosissimus*, *H. kelloggi*, *H. borboniensis* and *H. histrix* have been recorded, while in the adjacent Palk Bay, 6 species viz., *Hippocampus trimaculatus*, *H. kuda*, *H. fuscus*, *H. spinosissimus*, *H. borboniensis* and *H. mohinekei* are found to occur. Along the Coromandel Coast, 5 species of seahorses have been recorded (*Hippocampus trimaculatus*, *H. kuda*, *H. fuscus*, *H. spinosissimus* and *H. kelloggi*).

The seahorse survey undertaken by Murugan *et al.* (2008) during 2000 and 2001 reported that *H. kelloggi* was abundant in the Coromandel Coast, *H. kuda* in the Palk Bay, and *H. trimaculatus* in the Gulf of Mannar. *H. fuscus* was absent in the Coromandel Coast, and *H. kelloggi* was not recorded in the Palk Bay. The Colachel and Chinnamuttom region of Kanyakumari district and Coromandel Coast appears to be a major centre for large sized species of seahorse *H. kelloggi* which fetches around Rs. 200 to Rs. 350 (US$ 3.5 to 6.0) per individual.

1.2. History of seahorse collection in the Gulf of Mannar

The Gulf of Mannar was known for pearl oyster and sacred chank fishing for several centuries. For exploiting these resources, a well-managed fishing was organized through the Tamil Nadu State Fisheries Department. Due to huge demand for pearl oysters and sacred chanks, fishermen developed the skill for breath-hold fishing up to a depth of 60 m. The fishermen involved in these fisheries were distributed from Kanyakumari to Thondi region. Once the above resources were depleted, the fishermen targeted sea cucumber for their livelihood which was also found in large numbers in these ecosystems. Since in most of the areas, seahorses and sea cucumbers are found together and are easy to collect, the fishermen started collecting both the resources. When the demand from China increased for seahorses in the 1980s, incidental catches from various gears like trawl nets and target fishing provided the much needed numbers for the TCM trade. The seahorses were dried and exported by entrepreneurs through the Marine Products Export Development Authority (MPEDA). While seahorses were traded from 1977 onwards, the collection points and trade expanded from 1985. Enquiries made with fishermen who were involved in the collection of seahorse revealed that the density of seahorse was around 15 per m^2 during 1980s, which suggest that seahorses were abundant in the Gulf of Mannar and Palk Bay.

1.3. Seahorse fishing

Before implementation of ban, target fishing for seahorse, sea cucumber and sacred chank at Palk Bay was carried out by groups of six to eight divers in each boat, locally called *vallam*. Fishing season was determined by the prevailing weather conditions. Normally, the fishery was from May to October with a peak in August in Palk Bay. In Gulf of Mannar, fishing was from November to March, with peak in December. About 700 boats were in operation in the entire stretch of approximately 250 km along Palk Bay and Gulf of Mannar. Fishing was managed by small co-operatives established by the fishermen community, whereas the expense for the fishing boat was shared between the skin diving crew. The landing of seahorses was more along the Palk Bay region compared to the Gulf of Mannar.

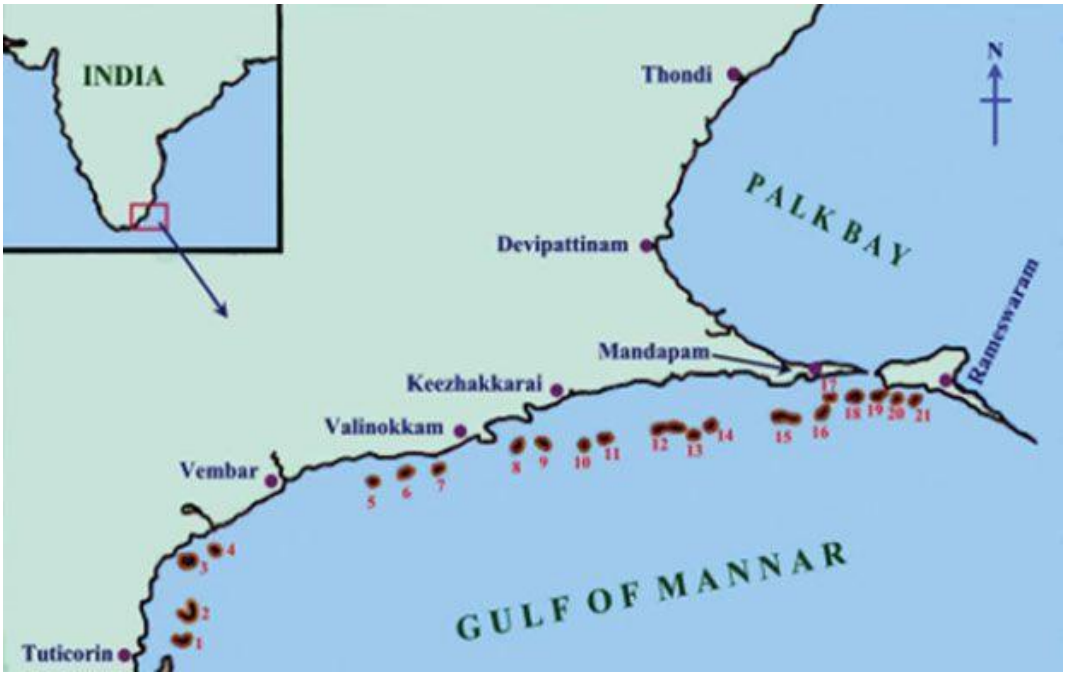


Figure 1 Gulf of Mannar and Palk Bay – main centres of seahorse collection and trade

The incidental catches of seahorse in small country trawls as well as shrimp trawls added substantially to the landings. The country trawls are wind-driven and are generally operated in shallow coastal waters at depths ranging from 2 to 6 m while the shrimp trawl nets are operated at depths from 3 to 12 m along the Gulf of Mannar and Palk Bay (Murugan *et al*., 2008). All species of seahorses found in the Gulf of Mannar and Palk Bay generally occur at depths less than 10 m.

1.4. Seahorse trade from India

India and the Philippines were the top source countries involved in collection and export of dried seahorses in the 1990s (Foster *et al*., 2014). Vincent (1996) reported that Palk Bay contributed 3.04 t (84.4%) to the annual seahorse trade of 3.6 t from India during 1995. After 1996, there was a steady increase in the quantity and value of seahorses exported which peaked at 4.34 t of dried seahorses from India worth about 2.7 million rupees (US$ 70,000) in 2001 (Anonymous, 2003).

According to Salin *et al*. (2005), the total estimated landing of seahorses from the Gulf of Mannar and Palk Bay was 18.246 t and the total quantity of dried seahorses that constituted the export trade from India was estimated to be 9.75 t during 2001. This clearly indicated that much of the exports from the country took place through unconventional routes which were not recorded. Along Palk Bay, Thondi was a major fishing centre for seahorse and an estimated 9.43t yr^{-1} was landed during 2001 (Salin *et al*., 2005) and the major fishery occurred from May to October.

The Traditional Chinese Medicine (TCM) traders believe that the trade ban in India was a consequence of CITES limiting its exports to countries like Hongkong, Taiwan and China (Lam *et al.,* 2015). The collection and trade of seahorses from Tamil Nadu continues in a clandestine manner even after the implementation of ban, which is evident from periodic reports in newspapers on seizures of dried seahorses by the Forest Department. Since the trade is not documented by any agency, the volume of export after 2002 is not known. It is understood that the target collection of seahorse through breath hold fishing has considerably reduced and illegal trade is mainly based on incidental catches in various fishing gears.

In India, the export value of dried seahorse ranged from Rs. 4,000/kg to Rs.8,000/kg or more before the ban. During ban period, the value substantially reduced and ranged from Rs.700/- to 800/- (500 to 600 numbers of dried seahorses/kg) and Rs. 1,000/- to Rs. 1,500/- (300 to 350 numbers of dried seahorses/kg), depending on the size.

Seahorses in India are rarely used as medicine, but with limited usage for curing whooping cough of children and asthma of adults especially among the fishing community. The seahorse is heated, powdered and mixed with honey and offered to patients. Many fishermen in Kerala believe that seahorses could prevent epilepsy or other similar disorders, if kept attached to the body as a talisman.

1.5. Policy for seahorse conservation

In 1975, the Convention for the International Trade of Endangered Species of Wild Flora and Fauna (CITES), came into force in order to reduce the threat to the species by international trade. Currently, there are 175 parties to the Convention. Despite its widespread uptake, the system is often open to fraudulent documents and permits. All seahorses (*Hippocampus* spp.) are listed in Appendix II of CITES in 2002, and implemented from 2004 (CoP-12, 2002). Since then, all nations that are signatory to CITES are required to submit export and re-export records for seahorses. As a result, there is an official database which can be used as a basis for understanding patterns in global seahorse trade. A review of trade surveys holds global estimates of annual dried seahorse trade between 39-67 t per year (Vincent *et al.,* 2011), compared to CITES records (2004-2008) of 16-49 t of dried seahorses per year. Before the CITES listing, India banned the trade and exploitation of seahorses and pipefish in 2001 by placing all species of syngnathids under Schedule I of the Indian Wildlife (Protection) Act, 1972 (Sreepada *et al*., 2002 and Murugan *et al.*, 2011). The Export-Import Policy (2002-07) of the Government of India also prohibits the import or export of syngnathid

species under the Export-Import (Development and Regulation) Act, 1991. This regulation is largely effective in India because of the absence of a domestic market, and the trade is entirely based on export.

1.6. Present study and its focus

The collection and trade of seahorse from Indian waters suffered a major setback due to many reasons. The increased demand for seahorse in the international market prompted over-exploitation of the wild stock and the unmanaged nature of fishery led to a decline in stock. The situation ultimately forced the Government to impose a ban on fishing and trade of seahorses from India in order to ensure conservation and protection of this vulnerable species. However, the blanket ban has affected the livelihood of hundreds of poor coastal fishers who were dependent on seahorse collection and trade.

A review of the available literature has clearly indicated that research on seahorses in India focused more on taxonomy, distribution, captive breeding and larval rearing. Information is also available on biology and genetics with regard to some species. Also, little information is available on conservation and management of seahorses in the Indian waters. However, no information is available on awareness of seahorse conservation and also on the involvement of communities in management and resource conservation. Also studies have not been conducted on the impact of seahorse trade ban on the recovery of seahorse population in the wild. Information on the implication of ban on the livelihood of coastal fishermen, who were once involved in the collection and trade of seahorses is also lacking. This clearly indicates that concerted efforts need to be made to understand the population structure of seahorses, their habitat status, perception of fishers and the impact of collection ban on livelihood. Such studies would help in the effective conservation and sustainable management of seahorse resources.

In the present study, an attempt was made to understand the diversity and abundance of seahorses in the Gulf of Mannar and Palk Bay and also their occurrences as incidental catches in different fishing gears. Studies were also conducted on the impact of ban on the livelihood of fishers through interviews, and attempts were also made to understand their perception about seahorse conservation and sustainable management. This case study undertaken in the Gulf of Mannar and Palk Bay has also come out with a management plan and policy guidelines for conservation and sustainable use of seahorse resources.

2. Project Inception Workshop

2.1. Scope and objectives of the Project Inception Workshop

The Inception Workshop of the research project “Participatory management for conservation of seahorses in the Gulf of Mannar, south-east coast of India” was organized on 27 December 2014 at the Mandapam Regional Centre of the Central Marine Fisheries Research Institute (ICAR), Mandapam Camp, Tamil Nadu.

The workshop was aimed to mark the beginning of the project activities in the Gulf of Mannar and also to bring to one place all the concerned stakeholders who are directly or indirectly associated with sustainable management of seahorse fishery and conservation, and to inform them about the project, its objectives and the expectations. The workshop was also aimed to discuss and get feedback on the methodology and approach for implementation of the project activities such as field surveys and interviews with the stakeholders. The workshop also focused to gather valuable inputs from various stakeholders, which are vital for the on-going project.

The workshop was conducted jointly with the inception workshop of another FAO-BOBLME funded project ‘An evaluation of the current conservation measures on sea cucumber stocks in Palk Bay and Gulf of Mannar of India’. As the stakeholders were almost the same for both the projects, the

morning session was conducted together. During the post-lunch session, the participants were requested to discuss the issues separately for seahorses and sea cucumbers.

2.2. Participants of the workshop

The participants included scientists, officials from the Department of Forests, Department of Fisheries, researchers from various Universities, Commandant of the Coast Guard Mandapam Station, representatives from the Non-Governmental Organisations (NGOs), members of various fishermen associations, fishers and traders who were involved in the collection and trade of seahorses prior to the fishing ban. A detailed list of all the participants is given in **Appendix I**.

2.3. Inaugural session

The programme started at 1000 hrs and Dr A.K. Abdul Nazar, Senior Scientist & Scientist-in-charge, Mandapam Regional Centre of CMFRI welcomed all the participants to the Project Inception Workshop. The Inception Workshop was formally inaugurated by Dr E.Vive kanandan, Senior Advisor of the project by lighting the auspicious lamp. In his inaugural address, Dr Vivekanandan gave a brief introduction of the project and its genesis. Dr G. Gopakumar, Former Head, Mariculture Division and Former Scientist-in-charge, Mandapam Regional Centre of CMFRI, Commandant H.H. More, Coast Guard Station, Mandapam, and Dr K.K. Joshi, Principal Scientist & Head, Marine Biodiversity Division, CMFRI, Kochi gave their felicitations. Dr R. Saravanan, Scientist, Mandapam Regional Centre of CMFRI proposed the vote of thanks. The inaugural session which gave a perfect start to the workshop, came to a close at 1035 hrs.

Figure 2 Inauguration of Inception Workshop

Figure 3 Inaugural address by Dr E. Vivekanandan, Senior Advisor of the project

2.4. Technical session

The technical session started at 1100 hrs and the session was chaired by Dr E. Vivekanandan, Senior Advisor of the project. Dr Vivekanandan initiated the session with a brief of the project, its genesis and the overall expectations from the project. He also gave an overview of the activities of the Bay of Bengal Large Marine Ecosystem (BOBLME) Project and its activities for sustainable development in the Bay of Bengal ecosystem. He said that the project will be able to provide the current status of seahorses in the Gulf of Mannar and would address the various issues involved in conserving and protecting this vulnerable group. Many success stories from across the globe were also cited to outline that sustainable fishing and conservation is possible by adopting participatory management approaches. Efforts to breed seahorses in captivity and to sea ranch the young ones in the wild was also stressed as an attempt to revive the natural population.

Figure 4 Technical session in progress

Dr G. Gopakumar and Dr H. Mohamad Kasim spoke on the various challenges we face in the conservation of protected species. It was also highlighted that livelihood of fishers should be given due importance in parallel with the conservation measures. Dr R. Senthil Kumar, Biodiversity Programme Officer, Gulf of Mannar Biosphere Reserve Trust (GOMBRT), Ramanathapuram gave a brief account of the role of the Trust in conservation activities in the Gulf of Mannar ecosystem. Dr K. Vinod, Principal Investigator of the seahorse project and Dr P. S. Asha, Principal Investigator of the sea cucumber project detailed the activities proposed in the projects and the expected outcome. The presentations had opened up discussions on sustainability of fishing practices, dwindling stocks, impact of fishing ban and other protection measures on livelihood etc.

Dr G. Gopakumar

Dr H. Mohammed Kasim

Commandant H.H. More, Coast Guard Station, Mandapam

Figure 5 Opening address during technical session

The discussions after the presentations highlighted the following important points:

The present status of different species of seahorse population in the Gulf of Mannar is largely unknown as concerted efforts have not gone in for a periodic review of the status. It was therefore felt that scientific studies are immensely essential to understand the stock status. Globally, syngnathid fisheries are not well managed as there is insufficient understanding on their biology and population dynamics. Moreover, the tropical fisheries are multi-gear and multi-species. Also protection of ecosystems like the seagrass meadows and coral reefs, which are the preferred habitats of seahorses would help in the revival of population of these vulnerable animals. The fishers and traders did have a concern for conservation, but they felt that the ban on seahorse fishing should be lifted to help the coastal communities who have very less alternate options for their livelihood. They have represented their concerns at various fora, but no favourable decisions have been made so far.

Dr K. Vinod, PI presenting the status of seahorse in the Gulf of Mannar

Dr G. Gopakumar, Dr K. K. Joshi and Dr A. K. Abdul Nazar during the interaction

Figure 6 Technical presentation & interactions

Dr E. Vivekanandan and Dr H. Mohammed Kasim interacting with stakeholders

Figure 7 Interactions with stakeholders

The Chairman informed that the current project is one step forward to address the concern of fishers who were involved in collection and trade of seahorses prior to the ban. He said that the opinion of the stakeholders would be given due importance and will be highlighted in the form of reports and documents under this project, which will be forwarded to the authorities who are involved in decision-making.

2.5. Group discussion

The technical session was followed by group discussion and presentation. Altogether four topics were thrown open for discussion and the participants opted for the group based on their own interests. In each group, one member was identified as a moderator and one member as presenter who presented the outcome of the group discussion.

2.5.1. Salient outcome of group discussion

Group I: What are the livelihood issues and benefits to fishers after implementation of ban on collection of seahorses?

- The fishermen and traders feel that listing of seahorse under Schedule I of the Indian Wildlife (Protection) Act, 1972 and imposition of ban on collection and trade of seahorses has seriously affected their livelihood.
- The ban has resulted in fishing in the Sri Lankan side of the Gulf of Mannar.
- While genuine few fishers and traders have stopped collection, illegal collection and trade of seahorses continues. Thus the purpose for which the ban is imposed has been defeated.

Group II: What is the role of society in resource conservation and livelihood enhancement?

- The community volunteered to come forward to govern the seahorse resources through community participation.
- The group opined that there should be Government assistance to provide alternative livelihood options to seahorse fishers and traders who are affected by the ban.
- Government and society should support progressive fishing communities which adopt sustainable and eco-friendly fishing methods.

Group III: What is the role of research in resource conservation and livelihood enhancement?

- Research works need to be undertaken to survey and monitor the health of ecosystems like seagrass meadows and coral reefs which are the preferred habitats of seahorses.
- The research institutions should generate database on resources and ecosystems and also on their socio-economic conditions.
- There is a need to build scientific and extension infrastructure.
- Developing cost-effective and viable technologies for captive breeding and rearing of seahorses and identifying newer methods of conservation.
- The research institutions should have outreach programmes through ICT for information communication and dissemination.

Group IV: What is the role of Central and State Governments in resource conservation?

- The Government should take initiatives in building awareness among fishers on the need to conserve the vulnerable resources.
- The fishermen community felt the need to have a separate governing body at the national level to manage the issues related to marine fisheries.
- The fishermen should be encouraged to take up deep-sea fishing by providing incentives and technical know-how.
- The Government should adopt a ‘bottom-up approach’ while planning various schemes for the benefit of fishermen community.
- Government can also think of a temporary relaxation of ban and allow fishing with proper quota and monitoring systems.

- The Government, after gathering sound scientific information on stock structure of seahorse, and if appropriate, can think of moving seahorses from Schedule I to less severe schedules.

Figure 8 A view of the group discussion and presentation by group representatives

The group discussions evoked very strong response from all the participants and there were discussions after each presentation by group representatives.

2.6. Concluding session

Dr E. Vivekanandan, Senior Advisor of the project moderated the concluding session which again witnessed very fruitful discussions. He informed the house that the major inputs that have emerged during the workshop will be considered while carrying out the project work and during preparation of the project report. The fishers and traders assured to extend all support to the project team during their field surveys and agreed to provide any information that is crucial for the project.

Figure 9 Plenary session in progress

Dr B. Johnson, Co-Principal Investigator proposing the vote of thanks

Figure 10 Pleanary session & vote of thanks

It was also felt that one of the major constraints in executing the project is the short time period of less than three months, within which the proposed activities need to be completed. Therefore it was suggested to explore the possibility of extending the project duration by three more months i.e. till May 2015. The Inception Workshop provided a lot of inputs to execute the project; the active participation and positive interactions by all stakeholders were indeed the success of the workshop. The stakeholders evinced keen interest to co-operate with the interviews and other project activities.

3. Diversity of seahorse in the Gulf of Mannar and Palk Bay

3.1. Introduction

All seahorses are marine, except a few which are found in estuaries. They are slow swimming, found in shallow waters and generally remain among the coral reefs, seagrass beds and seaweeds which are their preferred habitats. A total of 54 species of seahorses have been reported worldwide of which 40 species are included in the IUCN Red List of threatened species. Of the 40 species listed in the Red List, one species is Endangered (EN), 10 are Vulnerable (VU), 1 is Least Concern (Lc) and 27 are Data Deficient (DD) (IUCN, 2015). In India, 9 species of seahorses have been reported till date viz., *Hippocampus kuda*, *H. trimaculatus*, *H. borboniensis*, *H. spinosissimus*, *H. fuscus*, *H. kelloggi*, *H. mohnikei*, *H. histrix* and *H. camelopardalis*. Except for *H. camelopardalis*, all the other eight species have been reported from the coast of Tamil Nadu.

In the Gulf of Mannar and Palk Bay, seahorses are generally caught as by-catch in trawl operations and they also form incidental catches in the country trawl locally called '*thallumadi*' which are

operated in the seagrass beds. Apart from these gears, they are also caught in shore seines, but the occurrence is very less.

3.2. Methodology

During the study period, surveys were conducted in various fish landing centres along the Gulf of Mannar and Palk Bay (Table 1) where the catches of trawl, country trawl and shore seines are landed, to understand the species diversity of seahorses in this region. The shore seines are of two types namely, *Kara valai* and *Ola valai*. The former is operated with the help of vallam fitted with outboard engines and is mainly used for capturing small pelagic fishes while the latter is operated with the help of non-mechanised boat for capturing small shrimps and small pelagic fishes. The shore seines are operated in shallow region at a depth range of 1 to 5 m and the net is dragged towards the shore by 25 to 30 people who also include women.

The landing centres were surveyed once in a fortnight and observations on seahorse landings were made. The species identification was done referring standard seahorse species identification guide (Lourie *et al*., 2004).

In addition to observation in fish landing centres, underwater surveys were conducted in the Gulf of Mannar and Palk Bay to study the species diversity and enumerate the density of seahorses. The underwater surveys were conducted by SCUBA diving and the seahorses were photographed in their natural habitat for identification of species.

Table 1 List of landing centres surveyed during the study period

(A)	**Trawl**	
	Palk Bay	**Gulf of Mannar**
1	Rameswaram	Pamban
2	Mandapam North + Koilvadi	Mandapam South
3	Soliyakudi	Keelakarai
4	Jegathapattinam	Ervadi
5	Kottaipattinam	
6	Sethubavachatiram	
7	Mallipattinam	
(B)	**Country trawl**	
	Palk Bay	**Gulf of Mannar**
1	Devipattinam	Chinnapalam
2	Karangadu	Akkalmadam
3	Mullimunai	Vethalai
4	Thondi	Periyapattinam
5	Mimmisal	Thalamuthunagar
6	Kattumavadi	
7	Karanguda	
8	Adhiramapattinam	
	Shore seine	
	Palk Bay	**Gulf of Mannar**
	Mukundarayar Chathiram North	Mukundarayar Chathiram South

	Cherankottai	Paaradi
	Ariyaman	Kundukal
	Irumeni	Vethalai
	Othathalai	Pudhumadam
		Erantharavai
		Ervadi
		Sadaimuniyan valasai
		Mariyur
		Mundhal
		Valinokkam

3.3. Results and discussion

During the study period, five species of seahorses viz., *H. trimaculatus, H. kuda*, *H. borboniensis*, *H. spinosissimus* and *H. fuscus* were recorded from both Gulf of Mannar and Palk Bay (Table 2). In addition to the five species, *H. kelloggi* was recorded, but rarely only from the Gulf of Mannar and was not observed in Palk Bay. *H. kelloggi* was recorded for the first time from the Gulf of Mannar by Murugan *et al*. (2008). *H. histrix* (Lipton and Thangaraj, 2013) and *H. mohnikei* (Lipton and Thangaraj, 2013) reported by earlier workers from the Gulf of Mannar and Palk Bay respectively, were not observed in the present survey. In the Gulf of Mannar region, the dominant species was *H. trimaculatus* followed by *H. kuda* while in the Palk Bay, the dominant species was *H. kuda* followed by *H. trimaculatus* (Table 3).

Table 2 Seahorse species recorded from the Gulf of Mannar and Palk Bay

S.No.	Gulf of Mannar	Palk Bay
1	*Hippocampus trimaculatus*	*Hippocampus trimaculatus*
2	*Hippocampus kuda*	*Hippocampus kuda*
3	*Hippocampus borboniensis*	*Hippocampus barboniensis*
4	*Hippocampus spinosissimus*	*Hippocampus spinosissimus*
5	*Hippocampus fuscus*	*Hippocampus fuscus*
6	*Hippocampus kelloggi*	
	*Hippocampus histrix**	*Hippocampus mohnikei**

*Species not recorded during the present study, but reported by earlier workers.

Table 3 Dominant species of seahorse in the Gulf of Mannar and Palk Bay

S.No.	Gulf of Mannar	Palk Bay
1	*Hippocampus trimaculatus*	*Hippocampus kuda*
2	*Hippocampus kuda*	*Hippocampus trimaculatus*

3.4. Brief description of the species recorded during the study

1) *Hippocampus trimaculatus* Leach, 1814 (Fig. 11)

H. trimaculatus is commonly called the longnose seahorse. Globally, this species is found in Australia, Cambodia, China (Hong Kong SAR and Province of Taiwan), France (Tahiti), India, Indonesia, Japan, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam (Lourie *et al*., 2004).

In the present study, this species was recorded from both the Gulf of Mannar and Palk Bay and was the most dominant species in the Gulf of Mannar. This species inhabits gravel or sandy bottoms around shallow reefs, estuaries and near mangroves and can tolerate lower salinities. The maximum recorded adult height is 17 cm. Their colouration is golden orange, sand coloured or totally black and may have large dark spots on the dorso-lateral surface of the first, fourth and seventh trunk rings. The dark spots are more common in males than females and they are less visible in dark specimens. Some specimens have a zebra pattern striped in brown and white. They are also characterized by a narrow head, low coronet, hook-like cheek, eye spines which appear flat, and absence of nose spine.

Figure 11 ***Hippocampus trimaculatus***

H. trimaculatus is generally dried for use in traditional Chinese medicines and curios. They are listed as Vulnerable (VU) in the IUCN Red List of Threatened Species and are also listed in the Appendix II of CITES, effective from May 2004 and a minimum legal size of capture of 10 cm applies. In India, this species is listed in the Schedule I of the Indian Wildlife (Protection) Act, 1972 since the year 2001, which bans collection or trade.

2) *Hippocampus kuda* Bleeker, 1852 (Fig. 12)

H. kuda is commonly called the yellow seahorse or the spotted seahorse. This species is found in Australia, Cambodia, China (Hong Kong SAR and Province of Taiwan), Fiji, France (New Caledonia and Tahiti), India, Indonesia, Japan, Malaysia, Pakistan, Papua New Guinea, Philippines, Federal States of Micronesia, Singapore, Solomon Islands, Thailand, Tonga, United States of America (Hawaii) and Vietnam (Lourie *et al*., 2004).

During the present study, this species was found to be dominant in the Palk Bay and the second dominant species in the Gulf of Mannar. This species inhabits coastal bays and lagoons rich in seagrass and floating weeds. They can tolerate even lower salinities and are found in muddy bottom of mangrove regions. The maximum recorded adult height is 17 cm. The colouration is often totally black with a grainy texture, alternatively pale yellow or cream with fairly large dark spots. Sometimes they are sand coloured blending with the surroundings. They are also characterized by a deep head, deep body and a thick snout. The coronet is of low to medium height, rounded and overhanging at the back, often with a cup-like depression on the top. The spines appear as low rounded bumps and are not spiny.

Figure 12 ***Hippocampus kuda***

H. kuda is dried for use in traditional Chinese medicines and curios. They are also traded live to meet the demand of aquarists and hobbyists. They are listed as Vulnerable (VU) in the IUCN Red List of Threatened Species and also listed in the Appendix II of CITES, effective from May 2004 and a minimum size of 10 cm applies. In India, this species is listed in the Schedule I of the Indian Wildlife (Protection) Act, 1972 since the year 2001.

3) *Hippocampus borboniensis* Dumeril, 1870 (Fig.13)

H. borboniensis is commonly called the Reunion seahorse. Globally, this species is distributed in France (Reunion), Madagascar, Mauritius, Mozambique, South Africa and the United Republic of Tanzania (Lourie *et al*., 2004).

During the present study, this species was observed both in the Palk Bay as well as in the Gulf of Mannar. This species inhabits soft bottom rich in seagrass. The maximum recorded adult height is 14 cm. They have a dusty green-brown colouration with dusty yellow dots and marbling and broken lines on head. They are also characterized by a low coronet with five rounded knobs. The spines appear as well developed rounded knobs and the eye spine is prominent and rounded.

Figure 13 ***Hippocampus borboniensis***

H. borboniensis is dried for traditional medicines and curios. They are also traded live for aquarium and hobbyists use. They are listed as Data Deficient (DD) in the IUCN Red List of Threatened Species and also listed in the Appendix II of CITES, effective from May 2004, and a minimum size of 10 cm applies. In India, this species is listed in the Schedule I of the Indian Wildlife (Protection) Act, 1972 since the year 2001.

4) *Hippocampus spinosissimus* Weber, 1913 (Fig.14)

H. spinosissimus is commonly known as the hedgehog seahorse. Globally, this species is found distributed in Australia, Cambodia, China (Province of Taiwan), Indonesia, Malaysia, Myanmar, Philippines, Singapore, Sri Lanka, Thailand, Vietnam (Lourie *et al*., 2004).

During the present study, this species was observed both in the Palk Bay as well as in the Gulf of Mannar. This species inhabits the sandy bottom near coral reefs. The maximum recorded adult height is 17.2 cm. They are pale with darker saddles across dorso-lateral surface and with darker cross bands on tail. Their coronet is of low to medium height with four or five sharp spines. The spines are generally well developed, either blunt or sharp; usually longer on first, fourth, seventh and eleventh trunk rings and with a regular series of longer spines on tail. The nose spine is small or absent and the cheek spine is either single or double. The spine in front of coronet is undeveloped.

Figure 14 *Hippocampus spinosissimus*

H. spinosissimus is dried for traditional medicines and curios. They are also traded live for aquarium and hobbyists use. They are listed as Vulnerable (VU) in the IUCN Red List of Threatened Species and also listed in the Appendix II of CITES, effective from May 2004, and a minimum size of 10 cm applies. In India, this species is listed in the Schedule I of the Indian Wildlife (Protection) Act, 1972 since the year 2001.

5) *Hippocampus fuscus* Ruppell, 1838 (Fig.15)

H. fuscus is commonly called the sea pony. Globally, this species is found distributed in Djibouti, India, Saudi Arabia and Sri Lanka (Lourie *et al*., 2004).

During the present study, this species was observed both in the Palk Bay as well as in the Gulf of Mannar. This species inhabits shallow, protected waters on the edges of algal reefs or seagrass beds. The maximum recorded adult height is 14.4 cm. They are usually dark but sometimes appear as bright yellow. Their head is large compared to body. The coronet is low. The arch of neck is a smooth curve or is slightly raised and rough.

Figure 15 *Hippocampus fuscus*

H. fuscus is dried for traditional medicines and curios. They are also traded live for aquarium and hobbyists use. They are listed as Data Deficient (DD) in the IUCN Red List of Threatened Species. They are also listed in the Appendix II of CITES, effective from May 2004, and a minimum size of 10 cm applies. In India, this species is listed in the Schedule I of the Indian Wildlife (Protection) Act, 1972 since the year 2001 which bans the collection and trade.

6) *Hippocampus kelloggi* Jordan & Snyder, 1901 (Fig.16)

H. kelloggi is commonly called the Great seahorse. Globally, this species is found distributed in China, India, Indonesia, Japan, Malaysia, Pakistan, Philippines, Thailand, United Republic of Tanzania and Vietnam (Lourie *et al*., 2004).

During the present study, this species was observed only in the Gulf of Mannar. This species is found in the soft bottom and are generally found associated with gorgonids and sea whips. This species grow to very large size and the maximum recorded adult height is 28 cm. They are pale often with tiny white spots running in vertical lines. They are characterized by a deep head and a narrow body with a thick snout. Their coronet is high, with five short spines and there is a high plate in front of coronet. They have thick body rings and a prominent rounded eye spine. The spines are low and rounded. They have long, slightly backward pointing, rounded cheek spine.

Figure 16 Hippocampus kelloggi

H. kelloggi is dried for traditional medicines and curios. They are also traded live for aquarium and hobbyists use. They are listed as Vulnerable (VU) in the IUCN Red List of Threatened Species. They are also listed in the Appendix II of CITES, effective from May 2004, and a minimum size of 10 cm applies. In India, this species is listed in the Schedule I of the Indian Wildlife (Protection) Act, 1972 since the year 2001 which bans the collection and trade.

3.5. Underwater surveys

The underwater surveys were conducted in seagrass beds of the Gulf of Mannar and Palk Bay following the Underwater Visual Census with 50 m belt transects; covering a total area of 100 m^2 during each dive, and the number of seahorses observed within that area was recorded. In each diving site, a total of 4 dives (each dive covering 100 m^2 area) were conducted with the help of two SCUBA divers and three local breath hold fishermen, and each dive period was approximately of 2 to 3 hours duration. The diving sites along the Gulf of Mannar were off Vethalai, Mukundarayachathiram and Kundukal; while in Palk Bay the diving sites were off Rameswaram, Olaikuda, Morepannai, Mullimunai, Karangadu and Devipattinam. Thus, a total of 12 dives were conducted in the Gulf of Mannar and 24 dives in the Palk Bay. During the underwater surveys, an average of 2 nos. of seahorses were observed from a 100 m^2 area in the Palk Bay, while in the Gulf of Mannar, the seahorses were rarely encountered. As underwater surveys conducted were restricted to one-time survey at different study locations, the sighting of seahorses was very low. Therefore, long-term underwater surveys with higher frequency will indicate the actual density and abundance of seahorses in the study area.

3.6. Conclusion

The present study could record a total of six species from the Gulf of Mannar and five species from the Palk Bay. The species *H. histrix* and *H. mohnikei* which were reported earlier from the Gulf of Mannar and Palk Bay respectively were not observed during the present study. The results of the incidental catches of seahorse that occur in different gears are presented in Chapter 4.

4. Incidental catch of seahorse in different fishing gears

4.1. Introduction

The seahorses are in great demand for export as traditional medicines, curios and for aquarium. There was an organized fishery and trade for seahorses in India, prior to the ban imposed by the Government in 2001, listing all species of seahorses under the Schedule I of the Indian Wildlife (Protection) Act, 1972. Prior to the ban, fishery of seahorse was mainly concentrated from the Gulf of Mannar and Palk Bay which are well known coral reef and seagrass meadows. Vincent (1996) reported that about 3.6 t of seahorses were dried for export from India during 1995. According to the official estimates, about 2.53 t of seahorses worth 1.5 million rupees (US$ 72 million) was exported from India during 2000-2001 and 4.34 t worth 2.63 million rupees (US$ 126.24 million) during 2001-2002 (Anonymous, 2003). The export from India was mainly to countries like Singapore, Hong Kong and the United Arab Emirates.

At present, there is no targeted fishery for seahorse and seahorses are not collected by skin diving. However, the seahorses that are landed as incidental catches in trawl, country trawl and to a small extent in shore seines are not discarded, but enter the trade. In order to understand the quantity of seahorses caught as incidental catches in various gears, field surveys were conducted in various landing centres which land the catches of trawl, country trawl and shore seines.

4.2. Methodology

During the study period from January to May 2015, surveys were conducted in fish landing centres where regular landings of seahorses occurred along the Gulf of Mannar and Palk Bay (Table 1). For observations on trawl landings, a total of seven landing centres were identified along the Palk Bay (Rameswaram, Mandapam North, Soliyakudi, Jegathapattinam, Kottaipattinam, Sethubavachatiram, Mallipattinam) and four centres along the Gulf of Mannar (Pamban, Mandapam South, Keelakarai, Ervadi). The observations of incidental catches of country trawl were made at Devipattinam, Karangadu, Mullimunai, Thondi, Mimmisal, Kattumavadi, Karanguda and Adhiramapattinam along the Palk Bay and at Chinnapalam, Akkalmadam, Vethalai, Periyapattinam and Thalamuthunagar along the Gulf of Mannar. The landings of shore seines were observed at five landing centres along the Palk Bay (Mukundarayar Chathiram North, Cherankottai, Ariyaman, Irumeni, Othathalai) and at eleven landing centres along the Gulf of Mannar (Mukundarayar Chathiram South, Paaradi, Kundukal, Vethalai, Pudhumadam, Erantharavai, Ervadi, Sadaimuniyan valasai, Mariyur, Mundhal, Valinokkam). Observations were made at fortnightly intervals in all the centres.

The seahorses that are caught in the gears were segregated species-wise and counted. Species identification was done referring standard seahorse species identification guide (Lourie *et al*., 2004). The standard length (head length + curved trunk length + tail length) of representative specimens of each species was measured. The standard length (SL) was taken using a thread and measured on a metre scale. The number of boats operated per day and the average number of seahorses landed per day were recorded. The total number of boats operated in five months period from each landing centre was also recorded through discussion with fishers, and the total number of seahorses landed at each landing centre was estimated for the period.

Discussions were also held with the fishermen to assess the actual number of seahorses that were caught. In the case of trawl, the people who are engaged to dry the by-catch in the drying yards usually remove the seahorses. These people were also contacted and discussions were held to assess the number of seahorses that is usually caught in the trawl, and also the channel by which it enters the trade. In the case of country trawl, in most cases, the seahorses are segregated and removed by the crew in the boat itself, before they reach the landing centre.

The male and female specimens of each species were segregated and counted to understand the sex ratio in wild. The number of brooding and non-brooding males was also counted and juveniles were also separated and counted.

4.3. Results and discussion

The present study has shown that in the Gulf of Mannar region, the dominant species was *H. trimaculatus* followed by *H. kuda*, while in the Palk Bay, the dominant species was *H. kuda* followed by *H. trimaculatus*.

4.3.1. Size range

The Standard Length (SL) of male, female and juvenile specimens of *H. kuda* and *H. trimaculatus* observed in the incidental catches from Gulf of Mannar and Palk Bay landing centres are given in Tables 4 and 5. The males and females of *H. kuda* caught in the Gulf of Mannar were bigger and had a higher SL when compared to the males and females of the same species caught in Palk Bay. In the case of *H. trimaculatus* too, the male and female specimens of Gulf of Mannar were larger in size than those caught in different gears along the Palk Bay.

Table 4 Size range of *Hippocampus kuda* and *Hippocampus trimaculatus* caught from the Gulf of Mannar

Hippocampus kuda	**Standard length (mm)**
Male	98 to162
Female	96 to 166
Juveniles	65 to 82
Hippocampus trimaculatus	
Male	100 to 160
Female	104 to 161
Juveniles	55 to 76

Table 5 Size range of *Hippocampus kuda* and *Hippocampus trimaculatus* caught from the Palk Bay

Hippocampus kuda	**Standard length (mm)**
Male	92 to 160
Female	90 to 161
Juveniles	50 to 85
Hippocampus trimaculatus	
Male	95 to 154
Female	92 to 153
Juveniles	64 to 81

4.3.2. Distribution of male and female seahorses in the incidental catches

The distribution of male and female specimens of *H. kuda* in the incidental catches at major landing centres is shown in Table 6. The female specimens showed a higher percentage of occurrence irrespective of the landing centres. At Mandapam North, Mandapam South and Keelakarai, the males were around 42% while the females were around 57%. At Ervadi, the females were considerably high (66.66%) when compared to male specimens of *H. kuda* (33.33%).

Table 6 Male and female distribution of *H. kuda* in incidental catch

Centres	Male	Female
Mandapam North	42.65%	57.34%
Mandapam South	42.75%	57.24%
Keelakarai	42.10%	57.89%
Ervadi	33.33%	66.66%
Overall percent of distribution	**40.21%**	**59.78%**

The percentage distribution of male and female specimens of *H. trimaculatus* was similar to that of *H. kuda* (Table 7). The observation along the major landing centres revealed that male specimens of *H. trimaculatus* were less in number when compared to their female counterparts. The study has clearly indicated that number of males in the wild population is always less when compared to *H. trimaculatus*. Therefore, harvesting of males, particularly the pregnant ones will have a serious impact on the recruitment of these syngnathids.

Table 7 Male and female distribution of *H. trimaculatus* in incidental catch

Centres	Male	Female
Mandapam North	46.43%	53.57%
Mandapam South	43.98%	56.01%
Keelakarai	45.71%	54.29%
Ervadi	42.68%	57.32%
Overall percent of distribution	**44.70%**	**55.30%**

4.3.3. Incidental catch of seahorse in trawl

The trawl nets operated in the Gulf of Mannar and Palk Bay are 100 m long and 25 m wide and are operated using a winch. The mesh size at the mouth region is 80 mm which gradually decreases to 60, 50, 40, 35, 30, 25 and 20 mm towards the cod end of the net. The trawl nets (shrimp trawl nets) are operated up to 44 km offshore at depths ranging from 3 m to 40 m and spend around 8.2 ± 0.48 h trawling actively per night in Mandapam (South) and Pamban (South) with 4 to 6 tows per fishing trip (Murugan *et al*., 2011). In Rameswaram, the trawlers operate up to 35 km offshore, at depths ranging from 5 to 35 m and spend around 16.8 ± 1.25 h actively trawling day and night with 16 to 20 sweeps per fishing trip (Murugan *et al*., 2011). In the Gulf of Mannar, the trawlers go for fishing thrice a week with fishing days commencing on Mondays, Wednesdays and Saturdays.

The period of survey for incidental catches was limited to five months i.e. from January to May 2015. Table 8 shows landings of seahorse from incidental catches in trawl operations along the Gulf of Mannar and Palk Bay. The observation at different landing centres ranged from 8 to 12 days and the number of fishing boats observed at different centres ranged from 64 to 252. The region has rich seagrass beds and is a coral reef area. The number of seahorses caught in trawl was more from the Palk Bay region when compared to the Gulf of Mannar region. This could be because the extent of seagrass beds is more in the Palk Bay when compared to the Gulf of Mannar. The number of seahorses per boat ranged from 3.42 (Ervadi) to 4.97 (Mandapam South) in the Gulf of Mannar region. In the Gulf of Mannar region, highest number of boats is operated from Mandapam South landing centre and therefore an estimated 8,964 number of seahorses were caught from this centre, followed by Pamban with an estimated 1,709 numbers caught, during the study period.

In the Palk Bay region, Rameswaram landing centre operated the highest number of trawl (6180 numbers) during the period of study, followed by Mandapam North & Koilvadi (3066 numbers) and Jegathapattinam (1032 numbers). The number of seahorses per boat was highest at

Jegathapattinam (8.90 numbers), followed by Kottaipattinam (7.33 numbers), Mandapam North & Koilvadi (6.22 numbers) and Rameswaram (5.0 numbers). The estimated catch of seahorse during the survey period was highest in Rameswaram (30,900 numbers) followed by Mandapam North & Koilvadi (19,070 numbers).

Table 8 Incidental catch of seahorse in trawl

Landing centres	Observed fishing days	No. of boats observed	No. of seahorses recorded	Average no. of seahorses per boat	Total boats operated in five months	Estimated catch during the survey period
Gulf of Mannar						
Pamban	8	180	894	4.97	344	1,709
Mandapam South	8	204	1003	4.92	1822	8,964
Keelakarai	8	64	243	3.81	160	609
Ervadi	9	102	348	3.42	279	954
Palk Bay						
Rameswaram	12	276	1380	5.00	6180	30,900
Mandapam North + Koilvadi	12	158	982	6.22	3066	19,070
Soliyakudi	8	96	264	2.76	344	949
Jegathapattinam	12	204	1,815	8.90	1032	9,184
Kottaipattinam	12	252	1,840	7.33	912	6,685
Sethubavachatiram	8	240	504	2.10	480	1,008
Mallipattinam	8	200	568	2.84	584	1,658

Figure 17 Picking of seahorse from trawl by-catch at Mandapam South

Figure 18 *H. trimaculatus* caught in trawl at Mandapam

Figure 19 *H. trimaculatus* caught in trawl at Mallipattinam

Figure 20 Incidental catch of seahorse in trawl at Keelakarai (left) and Ervadi (right)


Figure 21 A view of a trawler and the trawl net operated from Rameswaram fish landing centre

4.3.4. Incidental catch of seahorse in country trawl

The country trawl locally called *thallumadi* is operated in shallow regions at depth ranging from 4 to 7 m, exclusively in the seagrass beds. They generally trawl for about 6 hours with the help of wind and perform 5 to 7 tows per fishing trip, with each tow period of 1 hour. The country trawl net has a length of 10 m and width of 5 m. The mesh size at the mouth region of net is 30 mm which gradually decreases to 25 and 20 mm towards the code end of the net. This net targets shrimps and other food fishes, but removes a large number of non-edible biota including sea urchins, gastropods, non-edible crabs, sponges, starfishes etc. The seahorses which are one of the residents of seagrass beds are also caught in the country trawl.

The number of seahorses caught in country trawl from the Palk Bay is higher when compared to the number caught in the Gulf of Mannar region (Table 9).

In the Gulf of Mannar, the number of seahorses caught per boat ranged from 2 (Periyapattinam) to 4.4 (Akkalmadam). The number of country trawl operated during the study period were more at Thalamuthunagar (264 nos.) with an average of 3.0 numbers of seahorses caught per boat and an estimated total of 792 during the study period. The estimated number of seahorses caught was 432 and 422 from Chinnapalam and Akkalmadam respectively.

In the Palk Bay, the number of seahorses caught as incidental catches in country trawl was more and ranged from 4.23 (Adhiramapattinam) to 12.31 (Devipattinam) per boat. The number of country trawls operated from Thondi was 3,120 with an estimated total catch of 25,864 numbers of seahorses during the study period. The total estimated catch of seahorse was 25,555 numbers from 2,076 boats in Devipattinam landing centre.

Figure 22 A view of country trawl (*Thallumadi*)

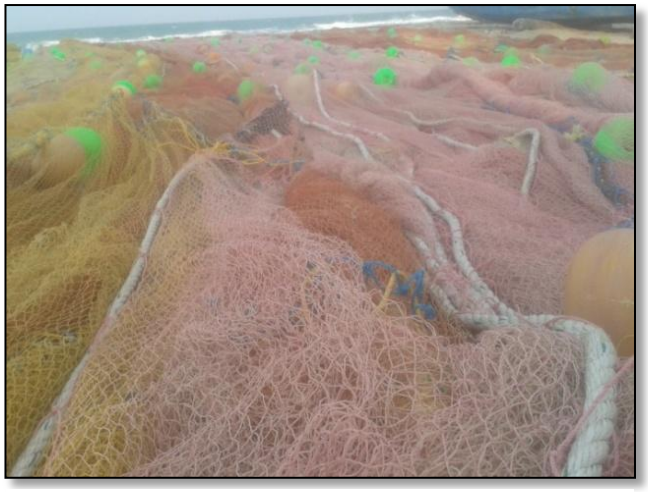


Figure 23 A view of shore seine

Figure 24 Olavalai (a type of shore seine)

Figure 25 Seahorses caught by country trawl at Chinnapalam

Table 9 Incidental catch of seahorse in country trawl

Landing centres	Observed fishing days	No. of boats observed	No. of seahorses recorded	Average no. of seahorses per boat	Total boats operated in five months	Estimated catch during the survey period
Gulf of Mannar						
Chinnapalam	12	36	108	3.0	144	432
Akkalmadam	12	24	105	4.4	96	422
Vethalai	12	24	72	3.0	48	144
Periyapattinam	8	16	32	2.0	32	64
Thalamuthunagar	8	120	360	3.0	264	792
Palk Bay						
Devipattinam	12	420	5,170	12.31	2,076	25,555
Karangadu	12	336	2,143	6.38	504	3,215
Mullimunai	12	432	4,713	10.91	456	4,974
Thondi	12	312	2,586	8.29	3,120	25,864
Mimmisal	12	120	745	6.21	312	1,937
Kattumavadi	12	180	1,679	9.33	504	4,702
Karanguda	12	216	1,242	5.75	420	2,415
Adhiramapattinam	12	192	812	4.23	396	1,675

Figure 26 Seahorses caught as incidental catches at Mimmisal

4.3.5. Distribution of brooding and non-brooding males in the incidental catches

The harvest of brooding males of seahorses will affect the recruitment. The present study has shown that the brooding males constituted a sizeable percentage and in the case of *H. kuda* it ranged from 16.95 to 37.5% while in the case of *H. trimaculatus* it ranged from 11.54% to 34.29% (Tables 10 & 11). The number of developing embryos in a pregnant male ranged from 45 to 700 in the case of *H. trimaculatus* and 91 to 982 in the case of *H. kuda*. The seahorses show a monogamous breeding behavior and successful pair bonding would continue for several seasons and sometimes for the

entire life. If the pregnant males are caught, the female partner would find it difficult for successive mating and transfer of egg clutch.

The occurrence of seahorse in shore seines was negligible and rarely 1 number per net per day was caught.

Table 10 Distribution of brooding and non-brooding males of *H. kuda* in incidental catch

Centres	Brooding	Non brooding
Mandapam North	24.59%	75.41%
Mandapam South	16.95%	83.05%
Keelakarai	37.5%	62.5%
Ervadi	25.0%	75.0%

Table 11 Distribution of brooding and non-brooding males of *H. trimaculatus* in incidental catch

Centres	Full pouch	Empty
Mandapam North	11.54%	88.46%
Mandapam South	33.02%	66.98%
Keelakarai	25.0%	75.0%
Ervadi	34.29%	65.71%

Figure 27 The seahorses collected by traders

4.4. Conclusion

The present study has shown that large quantities of seahorses are landed by both trawl and country trawl along the Gulf of Mannar and Palk Bay which is known for its rich coral reef and seagrass meadows. These ecosystems happen to be the preferred habitats of the seahorses. Some of the trawls which operate very close to the shore sweep over the seagrass beds resulting in the removal of seahorses. The country trawl operates exclusively in the seagrass beds resulting in the degradation and removal of seagrass while catching the targeted shrimps and other resources.

The seahorses move slowly and generally cling on to dead corals, shoots of seagrass and seaweeds using their prehensile tail. This behaviour makes them more vulnerable and they are easily caught in any net that is dragged in their habitats. The seahorses which are caught in various gears, if alive, are not released back into the sea as they fetch revenue to the fishers. In the case of trawl, the people who engage themselves in drying of by-catch remove the seahorses and in the case of country trawl, the fishers themselves remove the seahorses. These seahorses are then collected by middlemen who in turn sell the seahorse to small traders. Although the seahorse forms an incidental catch,

collectively it becomes a trade. While there is a ban on collection and trade of seahorses in India since 2001, the illegal collection and trade thrives as there is always a demand for dried seahorses in the overseas markets for use in traditional medicines.

Prior to the restriction on collection and trade of seahorses imposed by the Government of India in the year 2001, the fishery of seahorse was somewhat organized and the exports were mainly contributed by the by-catch from trawl and country trawl and also from targeted fishing by divers. The Palk Bay region contributed about 76% to the total landings along the southern Tamil Nadu coast. Among the centres of Palk Bay, Thondi landed about 68% of seahorses (Salin *et al*., 2005). Thondi continues to be a prominent site for the landing of seahorses and during the present study, a total of 25,864 numbers of seahorses were estimated to be the total catch in five months period from this centre in country trawl. Along the Palk Bay, Devipattinam has also been found to contribute immensely to the seahorse landings with an average of 12.31 numbers of seahorses landed per boat in a day.

5. Socio-economic survey

5.1. Introduction

The enforcement of ban on the capture and trade of seahorses might have helped in reviving their population; at the same time, the ban would possibly have a social and economic impact on those who were dependent on the seahorse fishery. It is therefore imperative to analyse and understand the implications of listing on the livelihood of the fishers. By conducting interview survey, the study was also intended to come out with management options for conservation and sustainable use of seahorse resources, if the ban is lifted or relaxed.

5.2. Methodology

The interview survey with an ex post-facto research design was undertaken in Gulf of Mannar and Palk Bay. In Gulf of Mannar, Ramanathapuram and Tuticorin districts; and in Palk Bay Ramanathapuram, Pudukottai and Thanjavur districts were selected for the survey. Based on available documents on sea horse occurrence and discussions with fishermen and officials of fisheries and forest departments, 21 villages in Gulf of Mannar and 20 villages in Palk Bay (Figs. 28 & 29) were selected for the survey. A total of 450 fishermen who were engaged in seahorse fishery (like skin diving, trawl fishery and other modes of small-scale fishing), 40 middlemen and 10 traders were selected using proportionate random sampling technique from the selected villages (Tables 12 & 13).

The details related to seahorse fishing and its economics were collected from the fishermen, whereas the details pertaining to general information on seahorses, marketing, trade and management measures were collected from all the respondents. Data collection was done through interview method, key-informant interview and focused group discussion.

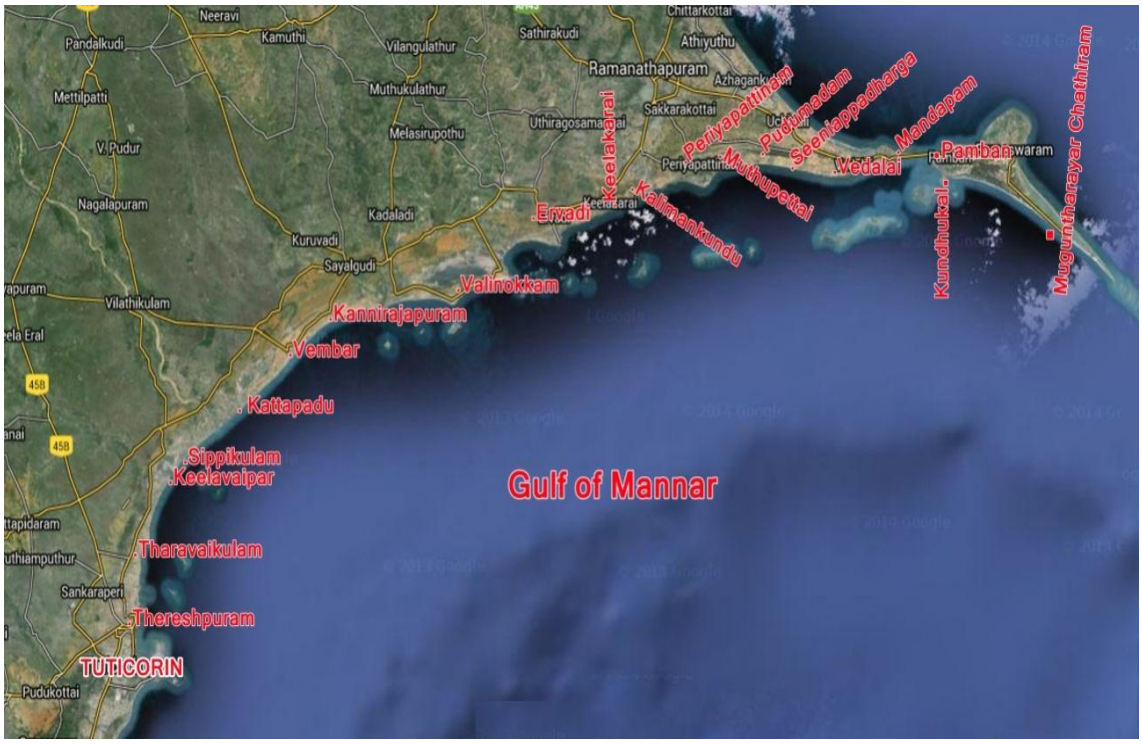


Figure 28 Map showing the surveyed villages in Gulf of Mannar

Figure 29 Map showing the surveyed villages in Palk Bay

Table 12 Number of respondents selected proportionally for the study from the selected villages in Gulf of Mannar region

(n = 295)

S. No	Village	Fishermen	Middlemen	Traders
1	Muguntharayarchathiram	24	0	0
2	Kundhukal	30	0	0
3	Pamban	3	0	0
4	Mandapam	9	3	0
5	Vedalai	22	3	2
6	Seeniappadarka	12	2	0
7	Pudumadam	7	0	0
8	Periyapattinam	10	0	0
9	Muthupettai	7	0	0
10	Kalimankundu	15	0	0
11	Keelakarai	10	3	1
12	Ervadi	10	3	1
13	Valinokkam	14	1	0
14	Kannirajapuram	22	0	0
15	Vembar	11	0	0
16	Kattapadu	13	0	0
17	Sippikulam	12	0	0
18	Keelavaipar	11	0	0
19	Tharavaikulam	4	0	0
20	Thereshpuram	12	2	1
21	Tuticorin	13	2	0
	Total	**271**	**19**	**5**

Table 13 Number of respondents selected proportionally for the study from the selected villages in Palk Bay region

(n = 205)

S. No	Village	Fishermen	Middlemen	Traders
1	CheranKottai	5	0	0
2	Rameswaram	5	4	2
3	Sangumal	16	0	0
4	Olaikuda	26	2	1
5	Pamban	2	0	0
6	Mandapam	12	0	0
7	Thillaimadam	4	0	0
8	PirappanValasai	4	0	0

9	Irumeni	23	2	0
10	Panaikulam	13	0	0
11	Devipattinam	19	4	0
12	Thiruppalaikuti	5	3	1
13	Karankadu	7	1	0
14	Mullimunai	7	0	0
15	Thondi	2	2	0
16	Jegathapattinam	5	0	0
17	Kottaipattinam	5	0	0
18	Kattumavadi	7	0	0
19	Sethuvarsathiram	2	0	1
20	Mallipattinam	10	3	0
	Total	**179**	**21**	**5**

5.2.1. Tools of analysis

Percentage analysis and Garrett ranking were done to process the data and to arrive at meaningful conclusions. The data obtained from the respondents were systematically tabulated for the purpose of analysis.

Garrett's ranking technique was used to identify and rank the attributes based on what ways the seahorse ban has affected their livelihood. Garrett's ranking technique provides the change of orders into numerical scores. The prime advantage of this technique over simple frequency distribution is that the attributes are arranged based on their importance from the point of view of respondents.

Garrett's formula for converting ranks into percent is given below:

Percent position = $100^* (R_{ij}-0.5) / N_j$

where,

R_{ij} = Rank given for i^{th} factor by j^{th} individual

N_j = Number of factors ranked by j^{th} individual

The percent position of each rank was converted into scores referring to the table given by Garret and Woodworth (1969). For each factor, the scores of individual respondents were added together and divided by the total number of respondents for whom scores were added. The mean scores for all the attributes were arranged in descending order, ranks were given and the most important attributes were identified. The scoring values are given in **Appendix II**.

5.2.2. Limitation of the study

The present study relied on primary data collected through the survey methodology. The information was collected from the respondents based on their memory and experience and bias cannot be eliminated completely. However, care was taken to avoid personal bias while capturing information. Limitations like getting only seasonal information, having data for a specified period of time, dependence on data that is word of mouth (with its inherent contradictions) as primary data could not be ruled out.

5.3. Results and discussion

5.3.1. Perception on seahorse biology, ecology and population

Out of five statements in Table 14, the first three statements were related to seahorse biology and the last two to its ecology. For each statement, the respondents gave their response in a five point continuum starting from "strongly agree to strongly disagree". Fishermen perception and knowledge about seahorse biology is less in comparison to their knowledge about its ecology, since 11 to 36% of respondents did not know have much information on seahorse biology (Table 14). About three-fourth of the respondents expressed the similar view of Murugan *et al*. (2008) who reported that the seagrasses, dead corals, and seaweeds are important habitats of seahorses; however, in general, seagrasses are the preferred habitat of seahorses as they provide excellent holdfast and better protection from predators. Tipton and Musick (1988) also stated that the seagrass environment provides rich epi-faunal assemblage, on which the seahorses prey.

Table 14 Respondents' perception (%) on seahorse biology and ecology in Palk Bay and Gulf of Mannar

(N=500)

Particular	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
Seahorse spawn throughout the year	42	45	11	1	1
Seahorses are used for medicinal purpose	66	29	3	1	1
Seahorses are highly vulnerable to intense fishing	11	25	36	16	12
Sea grass, sea weed, coral reef are suitable habit for sea horses	70	27	3	0	0
Seahorses are widely used in marine aquaria	74	19	6	1	0

The respondents had a better perception and knowledge about seahorse population which is evident from their response regarding the availability and the status of seahorse population.

The fishermen involved in seahorse fishing opined that the availability of seahorses is more during August to October in Gulf of Mannar and February to April in Palk Bay. The depth of collection of seahorses ranged from 3 to 15 m in the Gulf of Mannar and 3 to 8 m in the Pak Bay. Among the sea horse species *Hippocampus trimaculatus* and *Hippocampus kuda* are mostly preferred by the fishermen for fishing. About 64% of the fishermen did not acknowledge that seahorses are vulnerable to intense fishing.

About two-third of the respondents stated that the seahorse population has decreased during ban. The major reduction is due to clandestine removal of seahorses and incidental catch in trawl and mini-trawl. This opinion is similar to the one reported by Lourie *et al.* (2004) that seahorse populations throughout the world have continuously been declining due to the traditional medicine trade, overfishing, destructive fishing methods such as trawling and dynamite fishing and marine aquarium, as well as habitat destruction and pollution. The degradation of their limited habitats like the seagrass beds, mainly due to anthropogenic causes is also a serious concern.

5.3.2. Mode of seahorse fishing

It is clear from Figure 30 that before ban the seahorses were mostly exploited by skin divers (34%) along with sea cucumbers and gastropods. The skin divers involved in seahorse collection used country craft with inboard/outboard engine to reach the area where seahorse availability is better (8-10 m depth). The other modes of collection of seahorses were by-catch in *thallumadi* (mini-trawl) (33%), shore seine (26%) and trawling (7%).

(N=450)

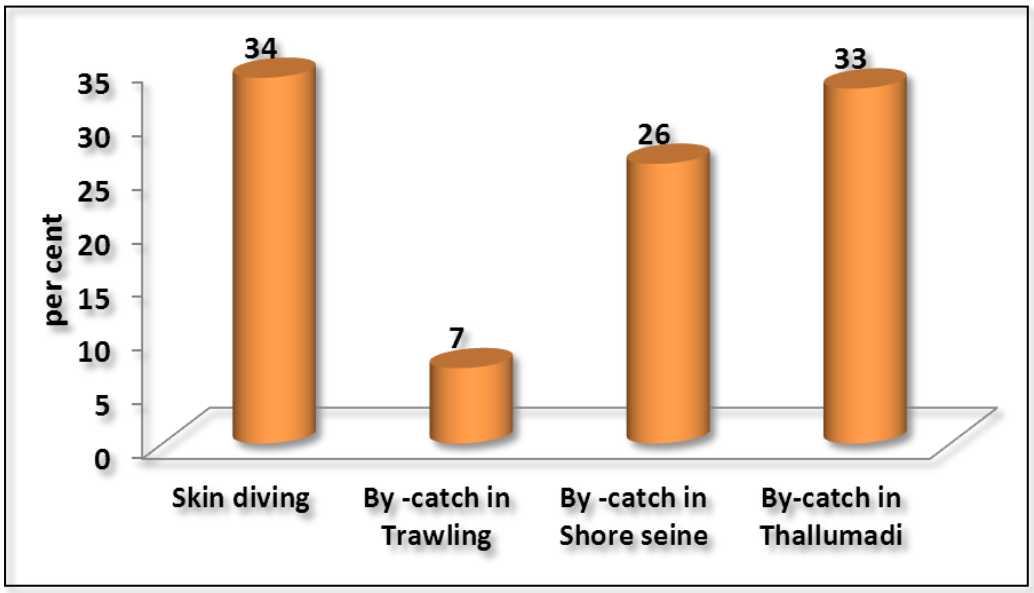


Figure 30 Distribution of respondents based on mode of fishing of seahorse before ban

Among two types of shore seine (*Karavalai, Olaivalai*) operated in Gulf of Mannar, remarkable quantities of seahorses were not caught, but the possibility of entangling of sea horses more in *Olaivalai* (shore seine tied with palmyra leaves) as it touches the bottom of the sea shore more than *Karavalai* (shore seine). Fishers also expressed that during the ban, seahorses were mostly exploited by trawling and *thallumadi* as by-catch which is also evident from the field surveys carried out under this project.

All the respondents were involved in fishing/trade of seahorse, but 10% of the respondents left the activity after declaration of ban. The remaining 90% of the respondents is continuing the seahorse fishing/trade. Fishers expressed that during ban, seahorses were mostly taken as by-catch in *thallumadi* (29%), followed by skin diving (24%), as by-catch in trawling (20%) and shore seine (8%) (Fig.31). During the field surveys, the project team did not encounter target fishing by skin divers in any of the centres; however, skin diving for collection of seahorse might be taking place in a clandestine manner. The fishers who were doing skin diving informed us that they were collecting only chanks.

(N=500)

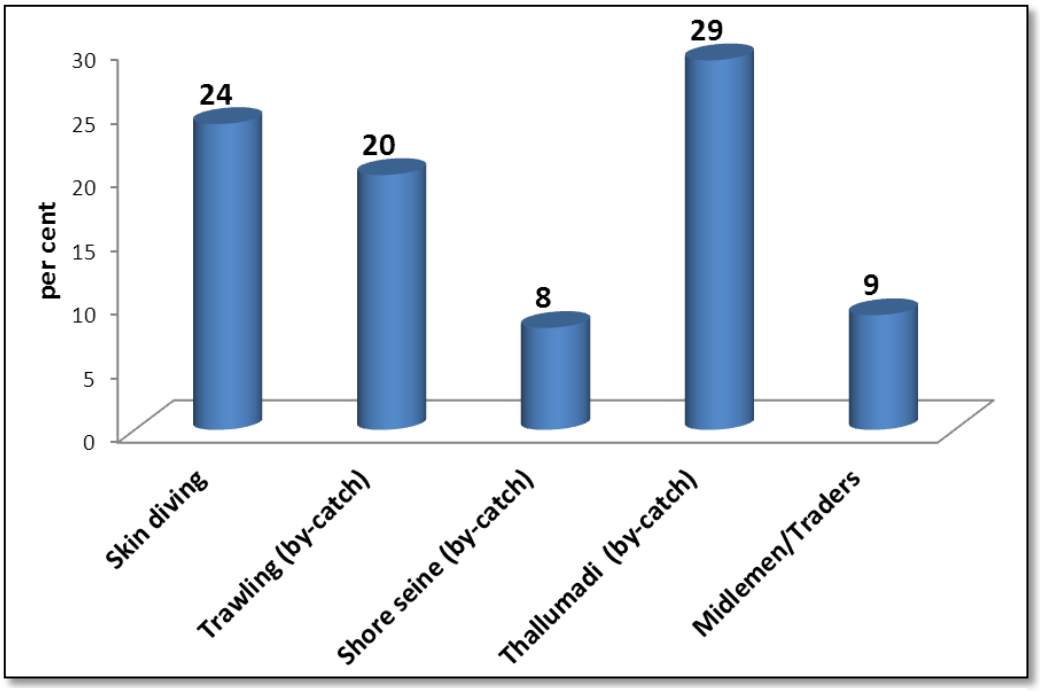


Figure 31 Distribution of respondents based on seahorse fishing/trade during the ban

5.3.3. Economics of fishing (including seahorse and other fishes)

Table 15 Economics of fishing (including seahorse and other fishes) before ban

Mode of fishing sea horses	Expenditure incurred per trip (operating cost) (Rs.)	Gross revenue per trip (Rs.)	Operating ratio (operating cost/ gross revenue)
Skin diving	1,300	3,000	0.43
By-catch in trawling	33,000	59,000	0.56
By-catch in *thallumadi*	2,200	5,000	0.44
By-catch in shore seine	4,600	10,000	0.46

Before ban, the average operating cost of sea horse fishing by skin diving was Rs. 1,300/- per trip with gross revenue of Rs. 3,000 per trip (Table 15). The operating cost of skin diving includes rent for the boat, fuel and food expenses. When targeting for shrimps in *thallumadi*, fishermen were getting seahorses, shrimps, silver biddies, mullets, barracuda, silver sillago, catfishes and goat fishes as by-catch (total operating cost per trip was Rs. 2,200/- and gross revenue was Rs. 5,000/-). In shore seine, mullets, goatfishes, silver biddies, needle fishes and catfishes are caught along with seahorses as by-catch (total operating cost per trip was Rs. 4,600/- and gross revenue was Rs. 10,000/-). When targeting for shrimps in trawling, fishermen were getting shrimps, catfishes, goat fishes, squids, needle fishes, cuttlefishes, silver biddies, mullets, seahorses and rays as by-catch (total operating cost per trip was Rs. 33,000/- and gross revenue was Rs. 59,000/-). The operating ratio (operating cost/gross revenue) for getting seahorse and other fishes was less for skin diving (0.43) and *thallumadi* (0.44). It is evident from Table 4 that seahorse fishers were able to get good revenue before the ban. Fishing through skin diving was more economically efficient than other modes of fishing as the cost of operation and investment were very low.

Table 16 Economics of fishing (including seahorse and other fishes) during the ban

Mode of fishing seahorse	Expenditure incurred per trip (operating cost) (Rs.)	Gross revenue per trip (Rs.)	Operating ratio (operating cost/ gross revenue)
Skin diving	1,500	2,300	0.65
By-catch in trawling	35,000	43,000	0.81
By-catch in *thallumadi*	2,300	4,500	0.51
By-catch in shore seine	4,000	7,000	0.57

During ban, the average operating cost of getting seahorse and other fishes by skin diving was Rs. 1,500/- per trip with gross revenue of Rs. 2,300 per trip (Table 16). When targeting for shrimps in *thallumadi*, fishermen were getting silver biddies, mullets, barracuda, silver sillago, catfishes, goat fishes and seahorses as by-catch (total operating cost per trip was Rs. 2,300/- and gross revenue was Rs. 4,500/-). In shore seine, mullets, goatfishes, silver biddies, needle fishes and catfishes are caught along with seahorses as by-catch (total operating cost per trip was Rs. 4,000/- and gross revenue was Rs. 7,000/-). When targeting for shrimps in trawling, fishermen were getting catfishes, goat fishes, squids, needle fishes, cuttlefishes, silver biddies, mullets, seahorses and rays as by-catch (total operating cost per trip was Rs. 35,000/- and gross revenue was Rs. 43,000/-). The operating ratio (operating cost/gross revenue) for getting shrimps and other fishes including seahorses was less for *thallumadi* (0.51). Fishing through *thallumadi* was economically more efficient than other modes of fishing during ban as the cost of operation and investment were very low.

As in the pre-ban period, fishing through *thallumadi* was economically more efficient during the ban than the other modes of fishing as the cost of operation and investment were very low. For fishing through skin diving, the revenue in terms of operating cost was 2.3 times in the pre-ban period, which has reduced to 1.5 times in the ban period because fishers were getting less catch during ban and moreover it is a clandestine activity.

5.3.4. Effect of ban on livelihood

Those who complied with the ban and left seahorse fishing expressed the opinion that the ban has affected their livelihood (Table 17). There was loss in their regular income as they were not able to invest and do other fishing activities. As a consequence, their debts increased.

Table 17 In what ways seahorse ban affected your livelihood

S. No	Particulars	Score	Garrett rank
1	Affected their standard of living	73.0	I
2	Loss in regular income	56.0	II
3	Increase in debts	43.0	III
4	Loss in savings	27.0	IV

5.3.5. Seahorse supply/value chain

Before ban, seahorse was mostly sold in dry form, whereas during the ban period, it is mostly sold fresh. Mostly fishermen sell the seahorses to local agents. Majority of seahorse fishers have stated that they do not consume sea horses, whereas some are using as medicine. Marichamy *et.al*. (1993) also reported that the dried seahorses are used as a medicine to arrest whooping cough in children.

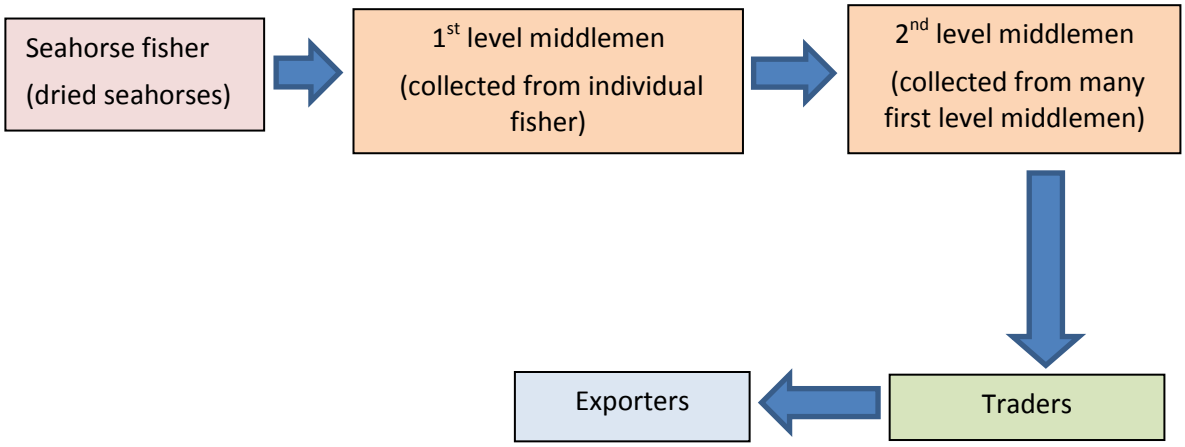


Figure 32 Marketing channel in seahorse trade before ban

Before ban, majority of the fishers sold the seahorses in dry form (sun dried) to first level middlemen. In every location there were many first level middlemen, who collected the dried seahorses in small quantities from individual fishers, and sold to second level middlemen. The second level middlemen sold the dried seahorses to the traders, who covered a larger area. The traders, after suitable packing sold it to exporters. Further, exporters export the packed seahorses to the international markets (Fig 32).

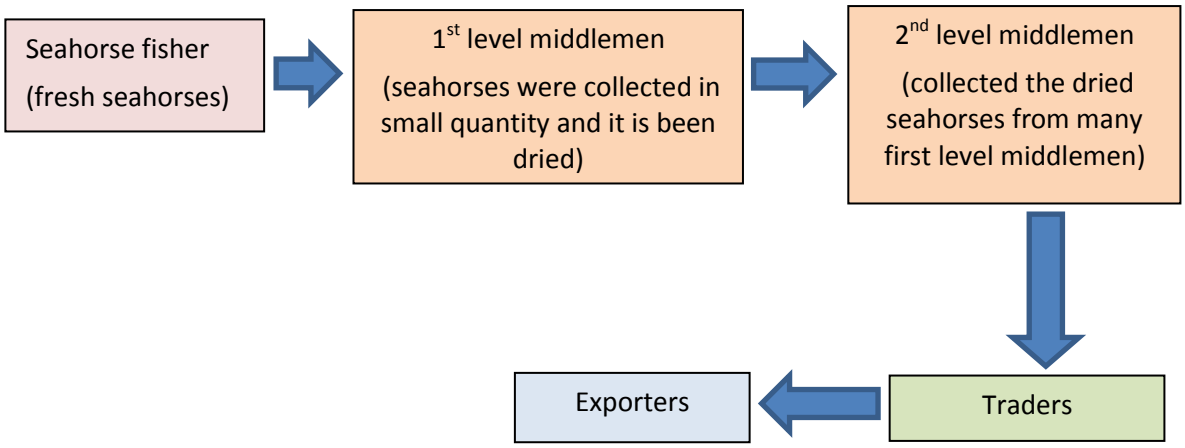


Figure 33 Marketing channel existing in seahorse trade during the ban

During ban, majority of the fishers sell the seahorses in fresh form to first level middlemen. In every location, there are many first level middlemen, who collect the fresh seahorses in a small quantity and after drying sell to second level middlemen. The second level middlemen sold the dried seahorses to the traders, who covered a larger area. It takes some time for the traders to slowly accumulate the dried seahorses from middlemen. Once sufficient quantity is gathered, traders sell the products to exporters after suitable packing. Exporters send the packed seahorses to the international markets (Fig. 33).

Table 18 Average price for dried seahorses across supply chain (1US$ = Rs 65 approximately)

Actors in supply chain	Before ban (before 2001) (Rs. per kg)		During ban (2015) (Rs. per kg)	
	400-600 counts	900 counts	400-600 counts	900 counts
Fishermen	3,500	2,000	12,000	6,000
1st level middlemen	3,900	2,100	13,500	6,500
2nd level middlemen	4,200	2,250	15,000	7,000
Traders	5,000	3,000	25,000	9,500
Exporters	10,500	6,000	40,000	12,000

5.3.6. Average market price for dried seahorses

All those in the supply chain received a better price for dried seahorses in comparison to fresh ones, since the fresh seahorses cannot be stored for long duration. Moreover the dried seahorses can be readily used for medicine preparation. Both fresh and dried seahorses are sold either as 400-600 or 900 counts. During ban fishers mostly sell the fresh seahorses of 900 counts (approximately 2.5 kg) to the first level middlemen for Rs. 2,000/- per kg. However, some fishermen were also selling fresh seahorses of 400-600 counts (approximately 2 kg) to the first level middlemen for Rs. 5,000/- per kg. Dried seahorses of 400-600 counts fetches good price than 900 counts and it is mostly preferred in the trade, since it yields more quality and quantity in further processing. However, availability of large-sized seahorses has reduced now and hence; the sale consists of mostly of 400-600 counts.

In the last 14 years after implementation of ban, the price of 400-600 counts of dried seahorses has increased three to five times at every level in the market chain and that of 900 counts has doubled or tripled (Table 18). The increase in price is due to the high demand in international markets for its medicinal property, which resulted in increase of price over the years.

Fishermen got approximately 30% of the value of seahorses before the ban. But during the ban they are getting approximately 30 to 50% of the value of seahorses. The maximum profit during the ban was for the exporters, who sold the products for Rs. 40,000 (for 400-600 counts) by investing only Rs. 25,000, i.e, a profit of about 60% over investment. However, before ban, the profit margin (% over investment) for exporters (400-600 counts and 900 counts) was almost 100 per cent. This may be because exporters were not revealing the actual export price to the fishers/middlemen/traders, which is not possible now.

5.3.7. Management measures suggested by the fishers

We asked the respondents to suggest some effective management measures if a suggestion has to be made to lift the ban (Table 19).

Table 19 Potential management measures as suggested by the respondents for sustaining the seahorse stocks if the ban is lifted/relaxed

(N=500)

Management measures	(%)
Improved techniques of aquaculture	20
Awareness programme on conservation	75
Gear limitation	80
Strict enforcement of banned gears and fishing methods	75
No-take zone	80

Stock enhancement through sea ranching	90
Restriction on collection of seahorse brooders and juveniles	60
Licensing	5
Reporting the catches	5

1. **Stock enhancement through sea ranching**

It was suggested by 90% of fishers to enhance the wild population of seahorses through land based hatchery production of juveniles and sea ranching the same at selected areas. Sadovy (2001) and Denney *et al*. (2002) suggested that 'as seahorse species are vulnerable to over-exploitation, replenishing the stocks is warranted at least in selected marine habitats. The replenishing of seahorse stock can be achieved through sea ranching'.

2. **Gear limitation**

Majority of fishers suggested that measures should be taken to reduce the numbers of trawlers.

3. **No-take zone**

Majority of respondents suggested that the areas where the seahorse population is more may be demarcated and all forms of fishing banned in that area for a specified period. By this the population can be increased. Several studies have convincingly demonstrated that creation of no-fishing reserves allows rapid build-up of fish spawning stock biomass (Roberts and Polunin, 1991; Dugan and Davis, 1993; Allison *et al*., 1998).

4. **Strict enforcement of banned gears and fishing methods**

Three-fourth of the respondents suggested that use of banned gears (pair trawling, *roller madi, thallumadi*) and dynamite fishing should be stopped completely.

5. **Conducting periodical awareness programme** on conservation of seahorses at village level was suggested by three-fourth of the respondents**.**
6. **Restriction in the collection of seahorse brooders and juveniles** was suggested by nearly two-third of the respondents.
7. **Improved techniques of aquaculture**

It was suggested to improve and standardize the technologies for aquaculture of selected species of seahorses.

8. Only five per cent of respondents suggested that fishermen cooperatives can be given license for seahorse trade.

Vaitheeswaran *et al*. (2012) suggested that 'strict management measures need to be undertaken to conserve seahorse species from further exploitation and to restore their population in Gulf of Mannar'. Majority of the respondents suggested that the participatory co-management of seahorse conservation may be done through community monitoring at village level, for which they suggested establishment of Councils at the village level. Local institutions such as fishermen associations and fisherwomen cooperatives can involve in effective management of sea horse fishery. Apart from these community organizations, non-government organizations, and self-help groups may be considered as stakeholders for effective management of the resources. "Implementation of a co-management regime in the Galapagos has increased the effectiveness of license and quota control and reduced conflict between management and fishers" (Shepherd *et al.*, 2004). Similar successful cases from many countries show that co-management will be effective.

5.4. Conclusion

As the project duration was for a shorter period, the resource surveys have not given a clear picture of the status of the sea horse stocks. However, the results of interview surveys based on the perception of fishermen reveals that the status of sea horse population has significantly decreased after the implementation of ban in the Gulf of Mannar and Palk Bay region. As the fishermen do not want to engage in alternate livelihood options, they have resorted to clandestine fishery, making the Wildlife (Protection) Act ineffective. The fishermen want the ban on seahorse fishing to be lifted. They are agreeable to follow regulatory measures for conservation of the resource with participatory co-management.

Figure 34 Focused Group Discussion

Figure 35 Interview with key informant

Figure 36 Data collection

6. Project report finalization workshop

During the course of the project, field surveys were conducted in various fish landing centres to assess the incidental catches of seahorses in trawl, country trawl and shore seines. Underwater surveys were also conducted in the Gulf of Mannar and Palk Bay. Interviews were conducted with the fishers and traders to understand their socio-economic status and their perception on the present status of seahorse and the conservation needs.

In order to prepare the management strategies for sustainable management of seahorse fishery and conservation of the wild stock, it was felt essential to hold a project report finalization workshop towards the final phase of the project. The workshop was held at Tuticorin, Tamil Nadu on 30 June, 2015 and all the concerned stakeholders including fishers, traders, scientists, students, officials from the Government and Non-Government Organisations participated. The workshop was conducted jointly with the project report finalization workshop of another FAO-BOBLME funded project 'An evaluation of the current conservation measures on sea cucumber stocks in Palk Bay and Gulf of Mannar of India', as the stakeholders were almost the same for both the projects.

6.1. Objectives of the workshop

- To discuss the results obtained from various activities of the project.
- To finalize the recommendations for conservation and sustainable use of seahorses along Gulf of Mannar and Palk Bay.

6.2. Participants of the workshop

The participants of the workshop included Dr P.S.B.R. James, former Director, ICAR-CMFRI; Dr D.B. James, former Principal Scientist, ICAR-CMFRI; Dr E. Vivekanandan, former Principal Scientist, ICAR-CMFRI and Senior Advisor of the Project; Dr A.P. Lipton, former Principal Scientist, ICAR-CMFRI; Shri C.M. Muralidharan, Project Manager, Bay of Bengal Large Marine Ecosystem (BOBLME) Project; Dr P.P. Manoj Kumar, Scientist-in-charge, Tuticorin Research Centre of ICAR-CMFRI; Dr A.K. Abdul Nazar, Scientist-in-charge, Mandapam Regional Centre of ICAR-CMFRI; Dr S.G. Dange, Director of GOMBRT; Dr C.S. Shine Kumar, Deputy Director, MPEDA; Shri T.P. Pradeep, Inspector, Wildlife Crime Control Bureau (WCCB); Dr Venugopal, International Collective in Support of Fish workers (ICSF); Shri Issac Jayakumar, Assistant Director of Fisheries, Tuticorin; Shri J. Vincent Jain, Association of Deep Sea Going Artisanal Fishermen; Shri Arul Ananadam, Alliance for Relief of Innocent Fishermen; representatives from MPEDA, NETFISH, NGOs like DHAN foundation; scientists and researchers from ICAR-CMFRI, Annamalai University, Bharatidasan University, Madurai Kamaraj University, Bharathiyar University, Fisheries College and Research Institute, Tuticorin; fishermen and fishermen leaders belonging to various associations.

6.3. Inaugural session

Dr P.P. Manoj Kumar, Principal Scientist and Scientist-in-charge, Tuticorin Research Centre of ICAR-CMFRI welcomed the dignitaries and all the participants (Fig.37). The workshop was inaugurated by Dr P.S.B.R. James, former Director of ICAR-CMFRI by lighting the traditional lamp and delivered the presidential address. In his address, Dr James spoke about the past and present scenario of seahorses in the Gulf of Mannar and Palk Bay and stressed the need for conducting long-term studies on this syngnathid group.

Figure 37 Welcome address by Dr P.P. Manoj Kumar, Scientist-in-charge, Tuticorin Research Centre of ICAR-CMFRI

Figure 38 Inauguration of workshop by lighting the traditional lamp

Figure 39 Final workshop inaugural function

The felicitation address was given by Shri C.M. Muralidharan, Project Manager, BOBLME, Dr T.S. Dange, IFS, Director, GOMBRT and Dr K.K. Joshi, Head, Marine Biodiversity Division, ICAR-CMFRI, Kochi. Shri Muralidharan gave an overview about the activities of the Bay of Bengal Large Marine Ecosystem Project, the countries involved and the projects successfully implemented by the member countries in the BOBLME region. Dr Dange in his felicitation address informed the role of the Gulf of Mannar Marine Biosphere Reserve Trust in the conservation activities of this important Marine Protected Area and assured full support for any programmes aimed at conservation of threatened marine fauna. Dr K.K. Joshi impressed upon the need for undertaking such programmes which directly address the issues concerning conservation of marine resources and the livelihood of coastal communities.

Shri C.M. Muralidharan, Prject Manager, BOBLME

Dr T.S. Dange, Director, GOMBRT

Dr K.K. Joshi, ICAR-CMFRI

Figure 40 Final workshop felicitation addresses

6.4. Technical session

Dr Vivekanandan gave an overview of the project and explained in brief about the genesis of the project, its planning and execution.

Dr E. Vivekanandan chairing the session

Dr P.S.B.R. James, Dr D.B. James & Dr P.S. Asha

Figure 41 Technical session in progress

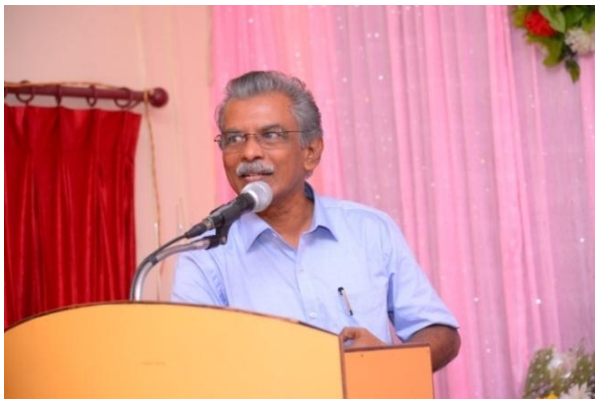
A brief summary of BOBLME Project findings on seahorse was presented by Dr K. Vinod, Principal Scientist, ICAR-CMFRI. He presented the results on underwater surveys, and incidental catches of seahorse in various fishing gears. He informed the house that although there is a ban imposed by the Government on the collection and trade of seahorses, the trade is continuing as an illegal practise. The fishers who were involved in collection and trade prior to the moratorium have lost their livelihood and some middlemen and illegal traders who are involved in this clandestine trade are reaping the benefit. The major findings of stakeholder survey were presented by Dr B. Johnson, Scientist, ICAR-CMFRI. He explained in detail about the impact of ban on livelihood of fishers and their perception on sustainable fisheries management of seahorse resources and their conservation.

Dr K. Vinod, Principal Investigator

Dr B. Johnson, Co-Principal Investigator

Figure 42 Presentation of salient findings

Dr D.B. James, former Principal Scientist, ICAR-CMFRI delivered a lecture on conservation of sea cucumbers in India followed by Dr A.P. Lipton, former Principal Scientist, ICAR-CMFRI spoke on the conservation of seahorses in India. Dr Lipton also informed about the diversity of seahorses in the country and the prospects of captive breeding of certain species of seahorses like the *Hippocampus kuda* and *H. trimaculatus*. Shri Issac Jayakumar, Assistant Director of Fisheries, Tuticorin explained the challenges and opportunities on conservation of endangered species. Shri T.P. Pradeep, Inspector, Wildlife Crime Control Bureau (WCCB) made a presentation on the role of WCCB in the Gulf of Mannar. He explained about the anti-poaching measures taken by the Bureau and the incidences of seizures of seahorses from various places.



Dr A.P. Lipton

Shri T.P. Pradeep

A member of fishermen association expressing his views

Figure 43 Presentations/feedbacks by deligates

The importance of conservation and sustainable use of seahorse was discussed in detail during the technical session. The leaders and members of various fishermen organisations expressed their views on the possibilities of sustainable seahorse fishery and trade, if the Government is ready to lift the ban. The fishermen and traders voiced their concern that the ban on seahorse fishery has affected their livelihood and wanted the ban to be lifted. They also expressed that the ban has increased their debts and they were not able to give quality education to their children. Some fishermen opined that the blanket ban can be lifted by the Government for about two years on an experimental basis, with regulations like issue of licenses to the prospective fishers, minimum size of capture, catch quota etc.

6.5. Plenary session

The plenary session was held as a panel discussion and was chaired by Dr P.S.B.R. James, former Director of ICAR-CMFRI. The panellists were Dr E. Vivekanandan, former Principal Scientist, ICAR-CMFRI & Senior Advisor of the Project; Shri C.M. Muralidharan, Project Manager, BOBLME; Shri Issac Jayakumar, Assistant Director of Fisheries, Tuticorin; Shri Arul Ananadam, Alliance for Relief of Innocent Fishermen and Shri N. Venugopalan, International Collective in Support of Fish workers. The Chairman initiated the plenary session by making his observations on the technical session and

informed that the technical session has provided valuable points for drawing recommendations. Each panellist then expressed his views and the participants interacted and contributed to finalise the recommendations.

Figure 44 Panelists of the plenary session

6.6. Recommendations of the workshop

The major recommendations that emerged during the panel discussion were:

- There is a need for a detailed scientific survey on distribution of species in Gulf of Mannar and Palk Bay and the results should be examined by the stakeholders.
- To evaluate the quantity available in natural stock, assessment of breeding population and size at first maturity should be made. Based on the results, steps need to be initiated for delisting of seahorses from the Schedule of Indian Wildlife (Protection) Act.
- Removal from a total ban to a regulated seahorse fishery. This would only be possible with the cooperation between the Ministry of Environment, Forests & Climate Change (MoEF & CC), the Ministry of Agriculture & Farmers' Welfare and the Department of Fisheries, Govt. of Tamil Nadu.
- In India, the moratorium may be relaxed for one or two years, and the fishery be allowed in a regulated manner. By observing the behaviour of fishermen and traders and response of the resources, decision could be taken on continuation of fishing with changes in restrictions.
- All the stakeholders including the local fishers should be considered while preparing any management plan aimed at conservation and sustainable use of seahorse resources.
- Participatory co-management approach will be more effective in managing the resources.
- Seasonal fishing ban and minimum legal size of capture can be adopted.
- Standardized hatchery technology should be adopted and hatcheries have to be developed for seed production, with funding from the state government. This would help in sea ranching and replenishment of stock.
- Already, the Gulf of Mannar Marine Biosphere Reserve is a Marine Protected Area (MPA) which by default will be contributing to conservation and revival of natural stock. However, specific 'no-take zones' may be identified in Gulf of Mannar and Palk Bay for conservation as well as for ranching.
- The seahorse collection and trade is completely banned in India. However, the trade continues illegally and the seahorse is traded to Sri Lanka from where it is exported to other

countries. Therefore, there is a need for a regional co-operation and dialogue with neighbouring countries for the conservation of our resources.

The workshop witnessed active participation and cooperation of all the stakeholders. The frank opinion and suggestions given by them was the success of the workshop. The deliberations and discussions helped finalizing recommendations which would be useful for the fishery managers and policy makers to re-visit the existing moratorium. A sustainable seahorse fishery with conservation embedded into the process would provide livelihood for many poor coastal people who have very few alternate options of income generation.

Figure 45 Participants of the workshop

7. Recommendations for sustainable seahorse fisheries management and conservation

The project has attempted to gather information on the incidental catches of seahorses in various fishing gears like the trawl, the country trawl and shore seines; and the opinion of fishers and traders on the status of seahorse resource as well as the ideal management measures that can be adopted for a sustainable fishery and conservation. As the project duration was short, and was operational effectively for a period of only about six months, it is hard to arrive at conclusions and recommendations solely from the results of this project. However, from the past experience of the project personnel, interview surveys and discussions with the stakeholders and experts on seahorses, it is possible to bring out strong recommendations. The recommendations suggested in this section are the outcome from the following sources:

i) The results of surveys of incidental catches of the current project
ii) The existing management measures and their functioning
iii) Interview surveys with stakeholders
iv) Published scientific papers and reports
v) Formal and informal expert consultations

These sources have provided multiple indicators to understand the status of the resources and to arrive at potential management options for conservation and sustainable use of the seahorse

resource. While the conclusions from this project refer to seahorse resources in Gulf of Mannar and Palk Bay, the recommendations, to a large extent, are applicable to seahorse resource management along the Indian coast.

The Government of India banned the export permits for all syngnathids from July 2001 and classified them under Schedule I, Part II-A of the Indian Wildlife (Protection) Act, 1972. Following implementation of ban, there is considerable decrease in fishing of syngnathids in the last 14 years. However, the demand in the overseas market for dried seahorses has only resulted in clandestine fishing and trade which may continue and may increase in future, if unchecked. Almost every fishermen and trader who were earlier engaged in seahorse fishery opposes the ban. The livelihood of fishers who were engaged in the collection and trade of seahorses were severely affected and they have few alternate options of livelihood. The dependency on livelihood has also led to illegal collection and trade of seahorses even after the ban. The moratorium imposed by the Government may be effective in saving the stocks from extirpation, if illegal removals are effectively stopped and monitored. Nevertheless, enforcement of ban might have helped reviving the population of sea cucumbers in Palk Bay and Gulf of Mannar; at the same time, the ban has social and economic impacts on scores of people, particularly the fishers, who were dependent on the fishery. The studies have shown that a controlled or a regulated capture of seahorses from the wild with proper monitoring appears to be the preferred policy solution.

7.1. Principles of seahorse management

Any natural resource can be exploited continuously, if it is done in a sustainable manner. In the case of seahorses, the demand in the international market might have led to over-exploitation of wild resources, leading to a decline in stock. The objective of seahorse fishery management is that the resources should be conserved and sustainably utilized. Any long-term management plan must ensure that people and wildlife can co-exist. The communities should have access to the resources and at the same time take the responsibility to conserve and sustainably use it. Conservation and sustainable use will provide a practical and integrated approach. There are several opportunities to achieve this and there are also global evidences that this twin objective could be achieved by active and genuine participation of communities and government institutions.

For developing management strategies, it is always essential to have a very good understanding and knowledge of seahorse resources in the wild, their behaviour and biology, habitat status, and the various threats they face. At present, the information available on various biological parameters such as growth, mortality and recovery rates, spawning season, etc. are not sufficient to arrive at robust management decisions in Gulf of Mannar and Palk Bay. While attempting to gather more information on various aspects which are vital to management, the managers can go ahead and implement the best management practices, in order to initiate conservation measures.

7.2. Potential measures for management

The fishermen who were targeting sea cucumber were collecting seahorses too as both the resources are found in the same habitat and that the seahorses were fetching additional income to the sea cucumber collectors. As the demand for dried seahorses for traditional Chinese medicines increase, the seahorses were also targeted. As seahorses are slow moving and mostly found clinging to the seagrasses and dead corals, it is easily caught. They easily enter the trawl and country trawl when swept on the seagrass meadows. They could also be easily caught by skin divers who targeted seahorses.

The potential management measures for seahorse fishery may be grouped under three major categories: (i) Regulatory, (ii) Restocking, and (iii) Implementation. While the first is a bundle of measures imposed on fishers and traders, the second is a stock recovery measure and the third is a road map for establishing the mechanism for institutionalising and implementing the first two set of measures.

The potential management measures suggested in this chapter are a toolkit that could be used in specific situations and locations. All the tools in the kit may not be required, and selection depends on the management objectives, fishery types, species to be managed, acceptance by stakeholders and technical capacity of the managers.

7.2.1. Regulatory measures

i) Seasonal closure:

The restriction for fishing or collection for a certain period of year would help in replenishment of stock. If the seasonal closure coincides with the breeding season of seahorse species, it would help substantially in recruitment. Seasonal closures could protect reproductive stocks of seahorses and successive recruitment can be ensured. However, this measure would be difficult to implement because a total of seven species have been reported from the Gulf of Mannar and six species from the Palk Bay and the breeding seasons may vary with species. Therefore this measure of seasonal closures may not be effective in the Gulf of Mannar and Palk Bay where seahorse fishery is multi-species. It is suggested that seasonal closure may be considered for the peak spawning periods and frequency of spawning months of seahorse population.

In India, seasonal fishery closure is followed for mechanised boats for 45 to 60 days every year. This applies to Gulf of Mannar and Palk Bay as well, where a closure of 45 days is followed for the last 15 years during summer months from April 15 to May 30 based on the peak spawning season of commercially important finfish and shellfish species. As the mechanised trawlers are included in the closure, there will be a considerable reduction of seahorse by-catch, even though the seahorses are not the focus of this closure. To increase the effectiveness of seasonal closures with reference to seahorses, it is important to temporarily close the fishing of country trawl locally called *thallumadi* during this 45-day closure period as the country trawl also removes seahorses in large numbers from the seagrass meadows.

However, for seahorses, the presently existing 45-days closure may not be enough and if it has to be effective, it should be for a longer period. Also, the trawlers should be restricted from operating in the inshore areas, as these areas in the Gulf of Mannar and Palk Bay are known for the rich seagrass meadows which are the preferred habitat of seahorses. If the Government lifts the moratorium on collection and trade of seahorses, there should be a seasonal closure of six months which can be reviewed in the subsequent years.

ii) Minimum Legal Size (MLS):

For any sustainable fishery, the 'Minimum Legal Size' (MLS) is one of the important measures which would ensure restriction on removal of juveniles. The MLS is fixed based on the length at first maturity and this would vary from one species to the other. Unlike in other animals, in the case of seahorses, there will not be much difference in length between the fresh and dried specimen. The MLS therefore need to be fixed for each of the traded species so that each individual animal gets an opportunity to spawn at least once during their life time, before they are caught. This would ensure a steady recruitment in the wild. All the seahorse species found in the Gulf of Mannar and Palk Bay are listed in the Appendix II of CITES, wherein a minimum legal size of capture of 10 cm applies.

iii) Rotation of harvest areas:

During every subsequent fishing season for seahorses, rotation of harvest areas may help in revival of population. Therefore, during every fishing season, certain areas can be restricted from fishing and fishing can be done in the subsequent year in these areas. This regular rotation of harvest areas might also help in maximising the catch.

iv) No-take zones:

It is imperative to identify certain areas as 'protected habitats or 'no take zones' as a measure of conservation. Since most of the seahorse collection and trade is from the Gulf of Mannar and Palk Bay, it is imperative to identify certain pockets as 'no-take zones' where collection/fishing of

seahorses is completely restricted. The Gulf of Mannar Biosphere Reserve being a Marine Protected Area (MPA), might have already helped in the revival of depleted stocks of seahorses, as human interventions are very much restricted. Also, being MPA, it is easy to identify certain locations as 'no-take zones', through community participation.

The Palk Bay on the other hand is characterized by vast stretches of sea grass meadows which is an ideal habitat for many marine invertebrates and seahorses. Therefore creation of 'no-take zones' in Palk Bay would not only help in the conservation of seahorses, but also helps in the preservation of the sea grass habitats which are the preferred habitats of all syngnathids. As increasing abundance of juveniles and adults within the identified no-take zones and marine reserves can have spill-over effect through dispersal of animals to surrounding areas and these supplemented stocks can be fished out.

The 'no-take zones' need to be identified involving the local communities who were involved in seahorse fishing and have a rich knowledge on seahorse habitats and areas of abundance. A community level self-imposed regulation would be far-reaching and successful in restricting targeted fishing for seahorses in the designated no-take areas.

v) Gear limitation:

In addition to targeted collection of seahorses, they are also caught in trawl as incidental catches. The operation of trawl in the inshore areas, very close to the shore need to be restricted in order to minimize the by-catch of seahorses. Under Marine Fishing Regulation Act (1981), trawlers are not permitted to operate in inshore areas but this restriction is often violated by the fishermen. Also, the country trawl or the mini trawl which are operated exclusively in the seagrass beds target shrimps and fishes and also catch seahorses; in the process of operation, it damages the sea grass beds. Such destructive gears need to be limited or restricted.

vi) Catch quota:

The fishermen who were involved in the collection of seahorses should be registered and license need to be issued to each one of them. Also, quotas should be fixed for individual fishers or a fishing group, so that resources are not over-exploited and this also ensures equity in sharing of resource. The registered fishers should maintain log books on catch and sales, which should be made available to the concerned authorities for verification. Deciding upon 'Quota of Harvest' for each fishing unit should be based on the outcome of periodic stock assessment studies conducted by research institutions. Also, there should be strict inspection and monitoring of the harvested catch by the concerned authorities and the renewal of license should be denied for non-compliance of catch quota.

vii) Habitat protection:

The seagrasses and coral reefs are the much preferred habitats of seahorses. They normally hold on to the shoots of seagrasses and branches of dead corals, using their prehensile tail and feed on small planktonic organisms that come on its way. In India, the corals are protected under the Indian Wildlife (Protection) Act, 1972, but not the seagrass beds. The seagrass beds are used as trawling ground by the country trawl, which remove a large number of seahorses and other fauna that live amongst the seagrasses. The country trawls also remove large quantities of seagrasses during its operation. Therefore it is important to protect and restore the critical habitats such as seagrass beds and coral reefs for conservation of seahorses.

viii) Trade management:

The seahorses do not have any market within the country and therefore the collection and trade is totally export-oriented. Although regular fishing and trade happened for several years prior to the ban imposed by the Government in 2001, there is no much information or data available on the quantity of seahorse resources that were collected and traded. Even after the moratorium, illegal fishing and trade continues, which by all means defeats the efforts of conservation.

At present in the Gulf of Mannar and Palk Bay, illegal trade thrives and the fishers, middlemen, traders and exporters are all involved in a long market chain in a clandestine manner. If the Government lifts the moratorium and permits regulated fishing, the concerned Government agencies should ensure that the poor fishers who toil hard get a fair share of the export value. The concerned agencies should monitor the market chain within the country and also the export prices, so that the trade is well regulated. Monitoring the whole market chain from fisher to exporter allows government agencies to verify or set appropriate taxes and duties. It is necessary to have a process by which price data from the international market can be obtained regularly. Managers should also seek to involve the Marine Products Export Development Authority (MPEDA), Ministry of Commerce and the Customs Department in the country to support or conduct monitoring of export prices of seahorses.

7.2.2. Restocking programme

One of the favourable options for recovery of seahorse stocks is through hatchery seed production and sea ranching. In India, already standardized technologies are available for seed production of some of the seahorse species like the three-spotted seahorse *Hippocampus trimaculatus* and the yellow seahorse *Hippocampus kuda*. Therefore it would be possible to establish small hatchery units at different locations around the Gulf of Mannar and Palk Bay, involving the local communities for seed production. The seeds thus produced can be used for re-stocking and replenishment of stock. Community based hatchery programmes should be taken up and capacity building programmes should be initiated for the interested groups.

7.2.3. Implementation

Ideally, sustaining seahorse fisheries is possible by reducing the number of fishers per unit of fishing ground, improving the livelihood of local fisher communities and strengthening the enforcement capacity. An overarching goal in the management of seahorse fisheries should be to safeguard the pregnant males so that the replenishment of stock can be ensured. While we recognise that all these are difficult to achieve, it is possible to move towards meeting these goals by a careful planning process.

The regulatory measures should be carefully used and all the regulatory measures may not be used at a time. The most appropriate regulatory measures should be chosen and implemented depending on the level of exploitation, number of active fishers, etc.

Ecosystem approach:

In this background, it is suggested that effective management of seahorse fishery could be achieved by following the ecosystem approach, in which multiple regulatory measures and management actions could be applied in full consideration of the seahorse stocks, the ecosystems in which they live and the socio-economic systems that drive exploitation. In ecosystem approach, it is crucial to get the commitment of governments, fishery managers and scientists to develop, apply and strictly enforce the management measures, which have been developed in a highly participatory and inclusive manner, together with resource users and other stakeholders. Ecosystem approach attempts to achieve ecological well-being and human well-being through good governance.

Co-management:

Participation of all stakeholders holds the key for success in any fishery management plans. For sustainable management of seahorse fishery and conservation, a large number of stakeholders like the fishers, traders, exporters, officials of the Department of Fisheries, Department of Forests, Indian Coast Guard, Coastal Marine Police, Wildlife Crime Control Bureau, Gulf of Mannar Marine Biosphere Reserve Trust (GOMBRT), Non-Government Organisations, scientists and students have defined roles to play and they should be involved at each stage of dialogue and implementation of plans.

Any long-term management strategy should ensure involvement of local communities who are the custodians of resources in their locality. They are well aware of the resources and the importance of

each of the resources and thereby the need for sustainable utilization. While aiming at conservation, the communities should have access to the resources; the local communities should be assured that they have a stake on the resources, provided they do not violate the regulatory measures imposed by the Government.

In co-management of seahorse resources, both the communities or the local resource users and the government (Government of India and Government of Tamil Nadu) share the responsibility and authority for managing and determining the goals of the fishery, with various degrees of power sharing. Stakeholders will be the central part of the management process.

Institutional requirements:

For effective implementation of management measures, a governing council consisting of important players from fishing to export may be constituted. Establishment of institutions for resource management by fisher groups is a part of co-management and community-based management and encouraged within an ecosystem approach to fisheries. The management decisions and outcomes have to be vested with fishers or fishing communities who value the long-term benefits of a sustainable resource. Self-regulation by fishing groups and co-management can help to reduce the burden of conflict management that generally resides with management agencies. The government and non-government agencies in the governing council will play important roles in conflict resolution and ensure that the governing process is proceeding in the right direction.

To establish institutional mechanism, 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. Other management activities like monitoring, surveillance and enforcement should be devolved with the governing council. Government agencies may monitor the fisheries, and regularly arrange meetings and operationalize management decisions.

Capacity development:

Capacity development at all levels, from fishermen to government officials is necessary to promote development and implementation of sustainable management approaches. It is necessary to improve the capacity for management at all levels like fishing, inspection of trade, data collection and monitoring. Capacity building programmes within the fishery creates an enabling environment for better management decisions, through consensus building. Informed stakeholders are in a better position to manage their resources in co-management and community-based management systems.

Regional cooperation:

The Gulf of Mannar and Palk Bay is the predominant region for the harvest and trade of seahorses in India. The resources of this region are shared between India and Sri Lanka. While there is a complete ban on collection and trade of seahorses in India, there is no such regulation on the Sri Lankan side. Therefore, the seahorses that are illegally caught in India are supposedly sent to Sri Lanka from where it finds an overseas export market. Therefore, bilateral co-operation between the two nations is essential for strengthening the conservation efforts. It has been realised that bilateral consultations and agreements are needed, given the geographical distribution of the species. It is important that binding or non-binding arrangements are established between governments that promote cooperation towards common interests and objectives of conservation and sustainable use of seahorse resources.

The Bay of Bengal Large Marine Ecosystem (BOBLME) Project has been playing a crucial role in the Gulf of Mannar right from its inception. Already, the BOBLME member countries viz., Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand are working together through the BOBLME Project towards a coordinated programme of action aimed to better the lives of coastal populations through improved regional management of the Bay of Bengal environment and its fisheries. One of the project components of BOBLME is "Coastal/Marine Natural Resources Management and Sustainable Use" which is aimed to promote development and implementation of

demonstrative regional and sub-regional collaborative approaches for common and shared issues which affect the health and status of the BOBLME. The BOBLME Project promotes multi-national approaches to manage and address issues affecting transboundary coastal/marine ecosystems. The present project on seahorses funded by the FAO-BOBLME Project and undertaken by ICAR-Central Marine Fisheries Research Institute is therefore an outcome of this important mandate of the BOBLME Project as the Gulf of Mannar ecosystem is a critical marine habitat and the resources are shared between two member nations viz., India and Sri Lanka.

7.3. Ecosystem approach to management of Palk Bay and Gulf of Mannar

The Gulf of Mannar and Palk Bay are biodiversity hotspots and this area is well known for its critical habitats like the coral reefs, seagrass beds, seaweeds and mangroves. This area is also home for several endangered and vulnerable species such as dugong, dolphins, turtles, whale shark, sea cucumbers, seahorses, sponges, sea fans, etc. Considering the importance of these habitats and species, it is worthwhile considering managing the entire area through ecosystem approach by the two countries. It is recommended that a holistic approach for the management of Palk Bay and Gulf of Mannar may be followed by (i) setting up of a cooperative mechanism within the existing bi-lateral framework of the Governments of India and Sri Lanka, (ii) enhancing knowledge on ecological characters and conducting impact assessments, (iii) ensuring conservation of resources and restoring fisheries habitats, (iv) ensuring effective stakeholder participation, (v) promoting livelihood options, and (vi) strengthening institutions and capacities.

The above recommendations are generic but if appropriately implemented they should assist in conservation and sustainable use of the habitats and biodiversity in Palk Bay and Gulf of Mannar. The solutions need to be tailored to the specific context within which the challenges occur.

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Appendix I List of participants of the Inception Workshop

S. No	Participants
1	Dr E. Vivekanandan, Senior Advisor of the Project & Consultant NICRA, Madras Research Centre of CMFRI, Chennai
2	Dr G. Gopakumar, Principal Scientist (Retd.), CMFRI
3	Dr K.K. Joshi, Head, Marine Biodiversity Division, CMFRI Cochin
4	Dr H. Mohamad Kasim, Principal Scientist (Rtd.), CMFRI
5	Commdt. H.H. More, Commandant, Coast Guard Station, Mandapam
6	Dr B. Ravindran, Assistant Director, Department of Fisheries, Mandapam
7	Dr A.K. Abdul Nazar, Scientist-in-charge, Mandapam Regional Centre of CMFRI
8	Dr K. Vinod, Principal Scientist, Calicut Research Centre of CMFRI
9	Dr P.S. Asha, Principal Scientist, TRC of CMFRI, Tuticorin
10	Dr B. Johnson, Scientist, Mandapam Regional Centre of CMFRI
11	Shri R. Saravanan, Scientist, Mandapam Regional Centre of CMFRI
12	Shri L. Ranjith, Scientist, TRC of CMFRI, Tuticorin
13	Dr P. Laxmilatha, Principal Scientist, CMFRI, Cochin
14	Dr R. Jeyabaskaran, Senior Scientist, CMFRI, Kochi
15	Dr A. Murugan, State Coordinator, NETFISH, Tuticorin
16	Dr R. Senthil Kumar, Biodiversity Programme Officer, GOMBR Trust, Ramanathapuram
17	Shri H. Hameedkalanjiyam, Forest Branch Officer, GOMBRT, Ramnad
18	Dr T. Thangaradjou, Assistant Professor, CAS in Marine Biology, Annamalai University
19	Dr A. Saravanakumar, Assistant Professor, CAS in Marine Biology, Annamalai University, Parangipettai
20	Shri P. Rajakumaran, SRF, CMFRI, Mandapam
21	Shri C.S. Subin, SRF, CMFRI, Mandapam
22	Shri M. Sheik Mohamed, SRF, Mandapam
23	Shri B. Ramkumar, Research Scholar, Madurai Kamaraj University, Madurai
24	Dr A. Sivakumar, MSSRF, Chennai
25	Dr A. Mubarak Ali, MSSRF, VRC, Nagercoil
26	Shri J.A. Kevikumar, MSSRF, Thangachimadam
27	Dr Sumana Narayanan, ICSF, Chennai
28	Shri G. Senthil Kumar, Senior Project Executive, DHAN Foundation, Madurai
29	Shri V. Arulanantham, ARIF Trust, Pamban
30	Shri K.A. Jabar, District Sangubaaku Servicing Group, Vedalai
31	Shri G. Joseph, Secretary, Ramnad Fish worker Trade Union, Ramanathapuram
32	Shri K. Kamalanathan, TRRM, Ramanathapuram
33	Shri S. Ghorie Mohamud, Omega Marine Fresh, Mandapam
34	Shri J. Arulanadhan, Karankadu
35	Shri A. Amalraj, Karankadu
36	Shri A. Palsamy, RFTW, Karankadu
37	Shri S. Antonysamy, Karankadu
38	Shri A. Antonysamy, Karankadu
39	Shri A. Arulanbu, Karankadu

40	Shri R. Chellappan, Karankadu
41	Shri Jhon Beritto, Karankadu
42	Shri A. Lawrence, Karankadu
43	Shri M. Panjanathan, Rameswaram
44	Shri P. Muniaswamy, Ganthamatha Paruvatham, Rameswaram
45	Shri B.G. Sekar, Old Market Street, Rameswaram
46	Shri R. Maaripitchai, Gandhi Nagar, Rameswaram
47	Shri J. Charoonkumar, Olaikuda, Rameswaram
48	Shri T. Vetrivel, Tiruvelluvar Nagar, Rameswaram
49	Shri N.J. Bose, Rameswaram
50	Shri T.N. Sekaran, Rameswaram
51	Shri K. Jayabalan, Rameswaram
52	Shri B. Joseph Jeromias, Olaikuda, Rameswaram
53	Shri J. Alphonse, Olaikuda, Rameswaram
54	Shri M. Nagoor Ali, West Street, Mandapam
55	Shri S.M. Halieeh Marikar, Kilakarai
56	Shri S.S. Muhamed Ibrahim, Kilakarai
57	Shri S. Akbar Ali, Barathan Street, Kilakarai
58	Shri P. Seeniappan, Pudupattinam
59	Shri B. Murugasen, Pudupattinam
60	Shri A. Arockaiyadass, Pudupattinam
61	Shri K. David, North Thondi, TCN
62	Shri G. Malaiselvan, Thondi
63	Shri Ubaiyaulla,Vedalai
64	Shri N. Raji, NLC Swimming Club, Neyveli
65	Shri M. Ravichandran, Thiruppalaikudi
66	Shri K. Kamalanathan, TRRM, Ramanathapuram
67	Shri P. Venkatesan, Anaikkarai, Kumbakonam
68	Shri V. Irudayaraj, Mullimunai
69	Shri A. Chellaraja, Mullimunai
70	Shri E. Munis, Mullimunai
71	Shri S. Munusamy, Treasurer, Vellankudieruppu
72	Shri K. Madasamy, Kuavankudi

Appendix II Garrett's score table

Percent	Score	Percent	Score	Percent	Score	Percent	Score
0.09	99	11.03	74	52.02	49	90.88	24
0.20	98	12.04	73	54.03	48	91.67	23
0.32	97	13.14	72	55.03	47	92.45	22
0.45	96	14.25	71	58.03	46	93.19	21
0.61	95	15.44	70	59.99	45	93.86	20
0.76	94	16.65	69	61.94	44	94.03	19
0.97	93	19.01	68	63.85	43	95.08	18
1.20	92	19.20	67	65.75	42	95.62	17
1.42	91	20.33	66	67.43	41	96.11	16
1.63	90	22.32	65	69.39	40	96.57	15
1.90	89	23.63	64	71.14	39	96.99	14
2.03	88	26.43	63	72.85	38	97.37	13
2.63	87	27.16	62	74.52	37	97.72	12
3.01	86	28.66	61	76.12	36	98.04	11
3.43	85	30.61	60	77.68	35	98.32	10
3.89	84	32.42	59	79.17	34	98.68	9
4.38	83	34.25	58	80.61	33	98.82	8
4.92	82	35.15	57	81.99	32	99.03	7
5.51	81	38.06	56	83.31	31	99.22	6
6.14	80	40.01	55	84.56	30	99.39	5
6.81	79	41.97	54	85.75	29	99.55	4
7.55	78	42.97	53	86.89	28	99.68	3
8.33	77	45.97	52	87.95	27	99.80	2
9.17	76	47.98	51	88.97	26	99.91	1
10.06	75	50.00	50	89.94	25	100.00	0

Appendix III Interview schedule

Participatory management for conservation of seahorses in the Gulf of Mannar, south-east coast of India

Interview schedule

1. Name :
2. Age :
3. Address:
4. Level of education :
5. Experience in fishing (In Years) :
6. Perception on sea horse biology and ecology

Statement	**Strongly agree**	**Agree**	**Undecided**	**Disagree**	**Strongly disagree**
Seahorse spawns throughout the year					
Seahorses are used for medicinal purposes					
Seahorse are highly vulnerable to intense fishing					
Seagrass, seaweed, coral reef are suitable habitat for seahorse					
Seahorse are widely used in marine aquaria					
Others (specify if any)					

Before seahorse ban

7. Experience in seahorse fishing (In Years):
8. Were you exclusively fishing/dependent on seahorse fishery for income? **Yes/No**
9. Mode of fishing of seahorse**: Skin diving/By-catch in trawling/By-catch in shore seine/By-catch in *Thallumadi/*Other (specify if any)**
10. Economics of seahorse fishing

Mode of fishing seahorse	**Expenditure incurred**	**Income**
Skin diving		
Other (specify if any)		

11. Depth of collection of seahorses:
12. How many species of seahorse do you used to get?
13. Which species of seahorse was preferred for fishing?
14. In which habitat and location do you used to get seahorse:
15. Season of maximum abundance:

16. Whether it is abundant at fishing grounds and reserves: **Yes/No**
17. To whom do you used to sell the seahorse?
18. In what form do you used to sell the seahorse: **Fresh/Dry**
19. What price do you get per piece?

S. No	Seahorse species	Fresh (`)	Dry (`)
1			
2			
3			
4			
5			

20. What price do middlemen get per piece

S. No	Seahorse species	Fresh (`)	Dry (`)
1			
2			
3			
4			
5			

21. Whether there was any community initiative for sustainable seahorse fishing
22. Opinion about blanket ban on seahorse:

After seahorse ban

Status of seahorse population (Increase/Decrease/Do not know)

	Before ban	After ban
Change in seahorse population		

23. If the seahorse population is reduced, what are the major reasons for reduction
24. After seahorse ban, what type of activity you are involved:
25. What is your monthly income in that activity?
26. Whether seahorse fishing is continued after ban? (Yes/No/Do not know)
27. If yes,

Type of gear	Quantity	Rs./No.

28. During regular fishing whether do you get seahorse incidentally: **Yes/No**
    i) If yes how much quantity:
    ii) What you do with that catch:

Give to the forest officials/Put in the sea back/destroying it/sell it

29. Whether seahorse ban affected your livelihood: **Yes/No**

    i) If Yes, what way it affected your livelihood:

30. If a decision to lift the blanket ban is made in future, what effective management measures do you suggest for sustaining the stocks?

Management measures	**Whether it can be implemented (Yes/No)**	**If yes, give your suggestion**
Improved techniques of aquaculture		
Awareness programme on conservation		
Gear limitation		
No-take zone		
Stock enhancement through sea ranching		
Licensing		
Reporting the catches		
Others (specify if any)		

31. Scope for participatory management and how it can be done:

Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand are working together through the Bay of Bengal Large Marine Ecosystem (BOBLME) Project to lay the foundations for a coordinated programme of action designed to better the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

The Food and Agriculture Organization (FAO) is the implementing agency for the BOBLME Project.

The Project is funded principally by the Global Environment Facility (GEF), Norway, the Swedish International Development Cooperation Agency, the FAO, and the National Oceanic and Atmospheric Administration of the USA.

For more information, please visit www.boblme.org

Food and Agriculture Organization of the United Nations

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