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Community-Supported Management and Conservation Strategies for Seagrass Beds in Palk Bay

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Community-supported management and conservation strategies for seagrass beds in Palk Bay

Clown fish amongst the seagrass of Palk bay © SDMRI

Final Project Report
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IUCN, International Union for Conservation of Nature
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Project Details

Project Name	Community-supported management and conservation strategies for seagrass beds in Palk Bay
Grantee Name & Address	IUCN, International Union for Conservation of Nature India Country Office C4/25 Safdarjung Development Area, New Delhi, 110016, India
Project team	*Principle Investigator*: Ms. Nisha D'Souza, IUCN India Country Office *Project Associate*: Ms. Jagriti Kumari, IUCN India Country Office *Implementing partner:* Suganti Devadason Marine Research Institute (SDMRI) *Advisors*: Dr. NM Ishwar (Programme Coordinator, IUCN India Country Office); Dr. Saudamini Das (Associate Professor, Institute of Economic Growth); Dr. RC Bhatta (Professor of Fisheries Economics, College of Fisheries); Dr. Ruchi Badola (Scientist-G/Senior Professor, Wildlife Institute of India); Dr. E. Vivekananda (Scientist Emeritus, Central Marine Fisheries Research Institute); Dr. JD Sophia (Principal Scientist, M.S. Swaminathan Research Foundation); Dr. Y. Yadava (Director, Bay of Bengal Programme, Inter-Governmental Organization)
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1. Background to the Project

IUCN has been working in the Gulf of Mannar and Palk Bay seascape (in the southern Indian state of Tamil Nadu), since 2007, through its regional Mangroves for the Future (MFF) Initiative. Small Grant Funding (SGF) was provided to SDMRI in 2011 for a seagrass resources survey assessment in the seascape. The study revealed that an estimated 20% of seagrass was degraded in the region as a consequence of anthropogenic threats, and recommended a conservation strategy based on the scientific research gathered. The results were presented at CBD COP 11 in Hyderabad on 16 October 2012, following which an additional SGF project was sanctioned to SDMRI for the rehabilitation of degraded seagrass areas in the Gulf of Mannar. Through the project 1 km^2 of seagrass was restored, and a seagrass restoration protocol established for the region. Moreover, through the MFF SGF facility, IUCN worked with local fishing communities towards participatory community engagement and education for conservation of mangroves in Palk bay areas of Ramnathapuram district in Tamil Nadu, in partnership with the Society for People, Education and Economic Development (SPEED). In addition to restoration and plantation of mangroves, the project addressed livelihood security and poverty alleviation through the provision of alternate livelihoods.

IUCN India office was also engaged in a regional project in partnership with IUCN Sri Lanka to assess key species and habitats for enhancing awareness, and for conservation policy formulation in the Gulf of Mannar and Palk Bay. The project addressed threats to marine and coastal biodiversity in the region, which stemmed from lack of awareness, and inadequate policies, using a trans-boundary management approach.

IUCNs implementing partner, the Suganthi Devadason Marine Research Institute (SDMRI) has been working in the Gulf of Mannar and Palk Bay since 1998, on coral reefs, seagrass an associated biodiversity. In addition to monitoring the state of these ecosystems, SDMRI conducts research and assessments on reproductive biology of coral reefs, disease biology and reef fish. Tamil Nadu forest department and Gulf of Mannar Marine Biosphere Reserve Trust (GOMBRT) have awarded SDMRI more than 25 projects for work in the region. Dr. JK Patterson (Director, SDMRI) is a member of the Tamil Nadu State Steering Committee for mangroves, coral reefs and wetlands, as well as a member on the associated MoEF&CC committees. In addition to this, he is a member of the State Board of Wildlife (Chaired by the Chief Minister, Tamil Nadu). SDMRI has been identified as one of the key state-level institutions by the ICZM authority of Tamil Nadu to undertake baseline studies and rehabilitation of coastal and marine biodiversity.

In December 2013, the MFF National Coordination Body (NCB) India, Chaired by Additional Secretary, Ministry of Environment, Forest and Climate Change (MoEF&CC) requested IUCN/MFF India and SDMRI to develop a seagrass conservation and action plan for the Gulf of Mannar and Palk Bay. In order to address this IUCN/MFF developed this project, and with support from GIZ is working towards community-support management and conservation strategies for seagrass beds in Palk Bay.

The objectives of this project, with respect to the seagrass habitat of Palk Bay are to:

a) Value the economic benefits of ecosystem services rendered by seagrass beds, and the economic losses caused by anthropogenic activities affecting seagrass beds

b) Develop community-based strategies to optimised wise-use of the seagrass beds, whilst ensuring an equitable sharing of the identified benefits provided by this ecosystem

2. Summary of Project Activities

Activities	Details
Literature review on existing approaches to the management of seagrass beds	Literature review began in January 2015, and was strengthened throughout the duration of the project.
Expert consultation workshops to: (a) develop a comprehensive methodology for the economic valuation of services provided by seagrass beds (b) identify scope for field surveys in Palk Bay to diagnose information gaps	IUCN conducted an expert consultation meeting in New Delhi on 8th June 2015 to establish valuation methodologies, and identify information gaps in seagrass-based management. An Advisory Committee for the project was established, and IUCN was in regular touch with experts on a monthly basis. Refer to Annex 1 for the summary of proceedings.
Participation in stakeholder workshops	Between 8 and 12 July IUCN visited Palk Bay, Tamil Nadu, and with the support of implementing partner SDMRI met with several stakeholders including Mr. DH Dange (Trust Director, GOMBRT); Mr. Deepak S Bilgi (Wildlife Warden, Gulf of Mannar Marine National Park); and Mr. K. Nanthakumar (District Collector, Ramnathapuram). The purpose of these meetings was to establish support for the project, and identifying information gaps in management and conservation, to better advise the development of field surveys. In addition to this, Dr. Beela Rajesh (Commissioner of Fisheries Government of Tamil Nadu, Fisheries Department) and Dr. VK Melkani (Principle Chief Conservator of Forests and Chief Wildlife Warden, Tamil Nadu Forest Department) were also briefed about the project.
Participation in field surveys	IUCN and SDMRI conducted pilot socio-economic surveys between 8 and 12 July to establish a baseline for development of the management and conservation strategies. Fishermen were initially unwilling to participate openly due to a misapprehension that the project was aimed at establishing a marine Protected Area in Palk Bay. The length of the initial questionnaire survey was shortened considerably following the pilots. The revised surveys were reviewed by the Advisory Committee and modified accordingly; please refer to Annex 2 for the final survey. SDMRI began conducting surveys in September 2015 amongst artisanal fishermen operating exclusively within the seagrass beds; in total 300 surveys were conducted amongst 50 villages for

	the project.
Analysis of primary data in the context of the economic valuation study on the economic value of the services rendered by the seagrass ecosystem in Palk Bay	Secondary data for the valuation study was sourced from various Government departments and institutes including the Department of Fisheries, CMFRI, and the Department of Forests, State of Tamil Nadu. Data from SDMRI and IUCN projects, and MFF partner's studies (including University of Kolkata, and MSSRF) was also used. The methodologies for collection of primary data, and analyses of all data are detailed further in the main text of the report.
Conduct one expert consultation workshop to validate the scientific results presented in the context of the economic valuation study	Due to the unprecedented rains and floods in Tamil Nadu in December 2015, it was impossible to conduct the workshop in this month as originally intended. The workshop was therefore conducted on 7thJanuary 2016 at the Raintree Hotel in Chennai (please refer to Annex 5 for the record of proceedings)
Incorporate results and recommendations of the expert consultation workshop in the development of community-based management and conservation strategies to optimise the wise-use of the seagrass beds, whilst ensuring an equitable sharing of the identified benefits provided by this ecosystem	The draft report and recommendations were presented to experts and Government officials for review in early January 2016. They were further discussed at the stakeholder consultation meeting in Chennai on 7th January 2016. The comments and recommendations provided by stakeholders were incorporated into the final report and strategies for conservation and equitable use of the Palk Bay seagrass ecosystem.

3. Literature Review

3.1 Palk Bay seagrass ecosystem

Seagrasses are amongst the least understood marine ecosystems in India. Seagrass beds in the country are predominantly found in mudflats and sandy regions along open shores and in island lagoons, from the lower intertidal zone to a depth of approximately 10–15m (Jagtap, 1991, Ramamurthy et al., 1992). The major seagrass meadows are distributed amongst the Lakshadweep and Andaman and Nicobar Islands and along the southeast coast of India, in the Gulf of Mannar and Palk Bay; it is estimated that the maximum extent of seagrass are found in the latter region (Jagtap and Inamdar, 1991).

Palk Bay, in Tamil Nadu encompasses five coastal districts, Ramnathapuram (236.8 km coastline; 130 km in Palk Bay), Pudukottai (42.8 km coastline), Thanjavur (45.1 km coastline), Thiruvarur (47.2 km coastline) and Nagapattinam (187.9 km coastline), with a total coastline length of 453.1 km (Tamil Nadu ENVIS Centre data, 2008).

The Palk Bay marine ecosystem is highly productive as a result of the mosaic of habitats it hosts, including 135 km^2 of mangrove patches (MSSRF, 2002), and 11.34 km^2 of coral reefs (Patterson EJK et al., 2015). The most dominant of these habitats is the seagrass which covers an area of 209 km^2, and is composed of mono, and multi-species patches; 14 species of seagrass have been identified in Palk Bay (Forest Department, State of Tamil Nadu, and SDMRI, 2014). On average the seagrass occur between 50 to 1500 meters off shore at a depth ranging from 0.5 to 5.8 meters (Forest Department, State of Tamil Nadu, and SDMRI, 2014). During a recent study by SMDRI, and IUCN (2013) it was estimated that 20% of the existing seagrass habitat of Palk Bay is degraded, with this trend likely to continue if threats are left unaddressed.

Table 1: An indication of dominant seagrass species along the Palk Bay coastline (Forest Department, State of Tamil Nadu, and SDMRI, 2014)

	Zones	**Dominant seagrass species**
1.	Pamban	*Cymodocea serrulata* and *Thalassia hemprichii*
2.	Mandapam	*Cymodocea serrulata* and *Thalassia hemprichii*
3.	Vethalai	*Thalassia hemprichii* and *Syringodium isoetifolium*
4.	Uchipuli	*Cymodocea serrulata* and *Halodule pinifolia*
5.	Attankarai	*Cymodocea serrulata* and *Syringodium isoetifolium*
6.	Panaikulam	*Syringodium isoetifolium* and *Cymodocea serrulata*
7.	Devipattinam	*Syringodium isoetifolium* and *Cymodocea serrulata*
8.	Thirupalaikudi	*Cymodocea serrulata* and *Thalassia hemprichii*
9.	Morepanai	*Cymodocea serrulata* and *Syringodium isoetifolium*
10.	Mullumuani	*Thalassia hemprichii* and *Cymodocea serrulata*
11.	Thondi	*Syringodium isoetifolium* and *Cymodocea serrulata*
12.	Thamodirapattinam	*Syringodium isoetifolium* and *Cymodocea serrulata*

13.	Muthukuda	*Halodule pinifolia* and *Cymodocea serrulata*
14.	Kottaipattinam	*Syringodium isoetifolium* and *Cymodocea serrulata*
15.	Manalmelkudi	*Syringodium isoetifolium* and *Cymodocea serrulata*
16.	Kattumavadi	*Syringodium isoetifolium* and *Cymodocea serrulata*
17.	Senthalaivayal	*Halophila ovalis* and *Cymodocea serrulata*
18.	Sethubavasathiram	*Syringodium isoetifolium* and *Cymodocea serrulata*
19.	Mallipattinam	*Syringodium isoetifolium* and *Cymodocea serrulata*
20.	Adiramapattinam	*Syringodium isoetifolium* and *Cymodocea serrulata*

The extent of seagrass globally has been reducing at a rate of 110 km^2y^{-1} since 1980 (Waycott *et al*., 2009). The most severe of the threats to seagrass in Palk Bay are shore seine nets (almost exclusively in Ramnathapuram), inshore bottom trawling, and boat anchoring. Although the damage of bottom trawling on Palk Bay seagrass has not been quantified, the resultant damage to seagrass in the neighbouring Gulf of Mannar has been documented, including damage to the plants, and biodiversity in the form of bycatch (Stallings et al, 2014). Similarly several studies have revealed the damage of seagrass beds and negative effects on the associated fauna due to boating activities, including boat anchoring (Francour *et al.,* 1999) and propeller scar (Bell *et al.,* 2002; Burfeind, 2004). The seagrass can make self-recovery and regrow in propeller scars, however it takes time and is largely species dependent (Dawes *et al.,* 1997).

Artisanal fishing community of Palk Bay, and livelihood profile

Ramnathapuram has 83 fishing villages, Pudukottai has 33, Thanjavur has 31, and Thiruvarur has 13 (Central Marine Fisheries Research Centre (CMFRI) Census, 2010). It is difficult to ascertain the number of villages in Nagapattinam, as some are located towards the interior of the district, at a significant distance from the sea; the number is not thought to exceed more that 5.

The exact number of artisanal fishermen in Palk Bay that fish exclusively within the seagrass is unknown; however local district authorities indicate that the number of traditional fishermen is decreasing as a result of more economically favorable livelihoods outside the region, and the introduction of better fishing technologies. The majority of the artisanal fishers are non-motorized boat users; the two most popular traditional crafts that operate almost exclusively in the seagrass (operating between 4 – 7m) are the *Thallumadi* (country trawl boat), and the *Chalavalai* (sardine gill-nets). The nets used in these crafts target shrimps and other food fishes, but removes large quantities of other biota including sea urchins, gastropods, non-edible crabs, sponges, starfishes and seahorses. Both men and women are involved in fishing allied occupations; for a summary of the fishermen community's livelihood profile, please refer to Annex 6. Within Palk Bay local fishermen also dive within the seagrass beds to collect shells, seaweeds, sea cucumber and seahorses, although collection of the latter two has decreased considerably following their protection under Schedule 1 of the Wildlife Protection Act (1972), India.

3.2 Linkages Between Seagrass and Fisheries

Seagrasses have been typically managed through their association with fisheries, however the fundamental link between fisheries and seagrass is complex. There are several studies of associations between specific fisheries species and seagrass ecosystems, which support the theory that seagrass are important in supporting healthy fisheries. For instance, a number of reports have correlated diminishing seagrass cover to declining fish catches. Examples include the King George whiting

(*Sillaginodes punctata*) in Westernport Bay Victoria, Australia (Kikuchi 1974, Bell & Pollard 1989), and the soft-shell blue crab (*Callinectes sapidus*) in Chesapeake Bay, USA (Shabmann & Capps 1985).

In studying the association between seagrass and fisheries, a fishery species is generally considered as one that is either directly destined for sale, or captured for culturing purposes As such, when considering these associations caution must be exercised. In several cases, juveniles of species may utilise seagrass beds in sites where they are not exploited (for temporary foraging or short term refuge), to migrate to other locations where they may be fished. Other species may have indirect importance by being, for instance, the dominant prey or a directly exploited species (Jackson, E. et al., 2001). Defining the scale of connectivity, or exchange, among marine populations and determining the factors driving this exchange are pivotal to our understanding of the population dynamics, genetic structure, and biogeography of many coastal species. The prevailing thought is that patterns of fish-use of the mosaic of habitats is similar all over the world (Able, KW., 2005). Species that exhibit the strongest relationships with seagrass are those that spend their entire life cycle, and are therefore permanent residents, in the habitat. Identifying which species are permanent residents requires long-term seasonal sampling, analysis of length-frequency distributions and age classes, or novel methods such as tagging techniques. Typically, these are burrowing, or smaller organisms which have a lesser to no commercial importance (Jackson, E. et al., 2001). However there are exceptions, including the blue crab in the *Zostera marina* beds of Central and South America and brown tiger prawns *Penaeus esculentus* in northern Australian seagrass beds (Bell & Pollard 1989; Loneragan et al. 1998).

To a large extent, managing seagrass is an essential part of managing the fisheries, especially in nursery stage. It is important that the impact scales of seagrass-related human multi-sector activities be identified and included in Integrated Coastal Management practices. In knowing this, alternative strategies for seagrass integrated-management may be designed in advance to support sustainable fisheries productivity (Nadiarti et al, 2012).

Underwater studies conducted (over a period of 2 seasons) by IUCN and SDMRI between 2011 and 2013 documented diversity and density of faunal species groups within the seagrass of Palk Bay. The five most prominent species groups identified through the study included Rainbow sardines (*Dussumieria acuta*), Splendid ponyfish (*Leiognathus splendens*), Common ponyfish (*Leiognathus equulus*), Great barracuda (*Sphyraena barracuda*) and Small-scaled terapons (*Terapon puta*). In addition crustaceans including crabs and shrimp, and cephalopods like cuttlefish were commonly caught.

3.3 Economic Valuation of Seagrass

Ecosystems provide a range of services, which are important to human well-being and survival (Costanza et al., 1997; Millennium Ecosystem Assessment (MA), 2005; TEEB Foundations, 2010). The importance of ecosystem services can be established from the fact that they provide food security, job opportunities, health, survival, income and livelihoods as well as traditional cultural identity to humankind. In recent times there has been a growing understanding of the links between ecological systems and social processes. As such, maintaining the long-term opulence and sustainability of these resources is not only of political and social significance, but also of economic and ecological importance (Unsworth et al., 2013). However, despite dedicated interventions global biodiversity continues to decline at an unprecedented rate. Loss of biodiversity and ecosystem degradation can impede the functioning and resilience of ecosystems, which jeopardizes the flow of ecosystem services.

Coastal ecosystems intersect land and sea, and provide both terrestrial and marine ecosystem services (UNEP 2010). In accounting for coastal, marine and coral reef ecosystem values in management decisions, we can sustain their flow of goods and services in the interest of current and future generations (ICRI 2008). Coral reefs, mangroves, seagrasses, and other near-shore ecosystems are intimately connected in their physical and biological dependence on each other (Nagelkerken *et al.*, 2000; Nagelkerken *et al.*, 2002). Coastal and marine ecosystems are facing an array of threats that can disrupt the flow of ecosystem services; these losses in services will eventually affect the economy and well-being of humans. Threats to coastal and marine ecosystems include nutrient overloading,

sedimentation, habitat destruction, overexploitation of marine resources, climate-related impacts, as well as a variety of other anthropogenic pressures such as pollution. These anthropogenic pressures have led to a reduction in the coverage of coastal and marine resources globally. At least, 30% of total seagrass cover has been lost; the decline in seagrass worldwide is quite dramatic, with an annual average loss of about 3,370 km^2 at a rate of 27 $km^2 yr^{-1}$ (USA, Europe and Australia) (Waycott et al., 2009).

It is apparent that a sustainable approach is required to regulate the prompt decline of resources due to human activities. A monetary understanding of natural resources is useful to promote sustainable local use over the long-term requirements?. Economic valuations of these natural resources are based on the various services provided by them and these are classified into four categories i.e. provisioning services, regulating services, cultural services and habitat services. The estimated annual benefit from coral reefs derived primarily from tourism lies between USD 79,099 ha^{-1} and USD 129,200/ha^1 (this value varies from region to region). Mangroves are estimated to be worth on average USD 4,290/ha, while estuaries, lagoons and seagrasses are estimated to provide benefits of an average value of USD 73,900/ha (TEEB, 2009).

One of approaches on economic values of coastal and marine resources has been by accounting for the annual revenue generated by fisheries. Capture fisheries in coastal waters alone account for USD 34 billion in yields annually (MA, 2005). A 2007 study found that the total value of services provided by marine and coastal ecosystems globally adds up to USD 25,783 billion per year (Martinez et al., 2007), while total net benefit derived from the world's coral reefs alone adds up to USD 29.8 billion per year (Cesar, Burke and Pet-Soede, 2003). The total net benefit of these coral reefs accounts for various services like fishing, biodiversity, tourism, recreation and coastal protection. Recently, the total economic value of coral reefs has increased 40 fold, from USD 8,400 $ha^{-1} yr^{-1}$ (1997) to USD 3, 52,250 $ha^{-1} yr^{-1}$ (2011) (Costanza et al.2014).

Worldwide, seagrass are experiencing all five of the most serious threats to marine biodiversity; overexploitation, physical modification, nutrient and sediment pollution, introduction of non-native species and global climate change (EA Norse, 1993). The current estimate of the total area of seagrasses is ≈ 177,000 km^2 (Taylor et al. 2003). Extrapolating the conservative net loss (29%) to this global scale suggests that more than 51,000 km^2 of seagrass meadows have been lost in the last 127 years (Waycott et al. 2009). The annual revenue generated from seagrass meadows adds up to USD 105,990/year? (Samonte-Tan et al., 2007). Seagrass meadows globally are closely linked with high fisheries production, principally due to their value as critical nursery habitats in all regions of the world (Coles et al., 1993; Jackson et al., 2001; Unsworth et al., 2008). Seagrass meadows provide various supporting services, and various attempts has been made to evaluate this benefit in different regions. Supporting services provided by seagrass meadows are valued between USD 1.1 million yr^{-1} to USD 100 million ha^{-1}. One of the imputed values associated with seagrass meadows is of exploited fisheries. The value of overexploitation ranges from USD 47 $ha^{-1} yr^{-1}$to USD 3500 $ha^{-1} yr^{-1}$. Regulating services provided by seagrass through nutrient recycling have been estimated to be around USD 19,002 $ha^{-1}yr^{-1}$(Costanza et al.1997). Values of seagrass associated with rehabilitation in Plato's forest (US) were calculated using the replacement cost method. Costs associated with habitat rehabilitation ranged from USD 1,200 ha^{-1} to USD 140,000 ha^{-1}(Seagrass Watch; issue. 41). Since the cost of rehabilitation is so high, it is even more critical to reduce the exploitation of resources in order that these costs are not incurred.

Table 2: Summary of economic valuations of seagrass from around the world

Services	**Authors**	**Location**	**Value**
Fisheries exploitation	Watson et al., 1993	Queensland, Australia	USD 3,500 $ha^{-1} yr^{-1}$
Fisheries production	McArthur et al., 2006	South Australia	USD 120 $ha^{-1} yr^{-1}$

Fisheries standing stock	Unsworth et al., 2010	Wakatobi, Australia	USD 78 ha^{-1} yr^{-1}
Nutrient recycling	Costanza et al., 1997	Global	USD 19,004 ha^{-1} yr^{-1}
Restoration	Thorhaug., 1990	US	USD 1,236 ha^{-1}
Restoration	Engeman et al., 2008	Florida US	USD 141,094 ha-1 yr^{-1}
Use value	UNEP., 1990	SE Asia	USD 215,000 ha^{-1}
Use value	Kuriandewa et al., 2008	South China sea	USD 80,226 ha^{-1} yr^{-1}
Carbon sink	Cebrian& Duarte., 1996	Mediterranean	Up to USD 27 ha^{-1} yr^{-1}
Carbon storage	Lavery et al., 2013	Australia 2013	USD 394 ha^{-1} yr^{-1}
Carbon standing stock	Duarte &Chiscano., 1999	Global	(mean) USD 28 ha^{-1} yr^{-1}
Total economic value	Dirhamsyah., *2007*	East Bintan, Indonesia	USD 2,287 ha^{-1} yr^{-1}
Total economic value	Samonte-Tan et al., 2007	Philippines (2004)	USD 76 ha^{-1} yr^{-1}

3.4 Management and Conservation of Seagrass

Despite the recognized ecological and economic role of seagrasses as a critical coastal habitat in providing ecosystem services that support health and wellbeing of coastal communities (Barbier et al., 2011; Costanza et al., 1997), seagrass meadows are continuing to decline at an accelerated rate internationally (Short et al., 2011; Waycott et al., 2009). This could point to: (i) a failure of scientists to effectively engage with government and/or the local communities leading to other activities being prioritized higher than the protection and preservation of seagrass habitat, (ii) an inability of managers to act at the appropriate spatial or temporal scale, or (iii) that decision makers do not understand the consequences of their cumulative actions on seagrass (Kilminster K, et al., 2015). It is important to note that issues of competing pressures and threats in complex systems are not unique to seagrass ecosystems; they are common across environmental decision-making.

Informed environment decision-making requires an understanding of the drivers for change, effects of management actions, and societal benefits. Critical to achieving desired outcomes is combining scientific understanding with cultural and societal values, to prioritize actions (Kilminster K, et al., 2015). Information should address the three main components of decision-making: (i) understanding the science, (ii) addressing community values, and (iii) understanding the effect that various decisions will have on the ecosystem and its ability to meet community values in the future (Dietz, 2013). Each of these components has inherent variability and uncertainty that cross multiple disciplines. Good decisions require a multi- and trans-disciplinary approach to provide coherent synthesis both within and across these components (Kilminster K, et al., 2015).

Several challenges have been identified in relation to management of seagrass and include (Borum J et al., 2004; Nadiarti et al., 2012; Kilminster K, et al., 2015):

1) Converting science knowledge into management interventions
2) Low institutional capacities to support seagrass conservation
3) The time frame within which managers make decisions in relation to seagrass conservation, is often shorter than the rate with which knowledge gapes are filled so decisions are frequently made with incomplete information

4) The abilities of stakeholders to integrate and apply new information effectively, is low
5) Characterising the aspects of the seagrass system that contribute to its resilience is challenging
6) Inter-departmental conflicts can often create barriers to conservation efforts; seagrass conservation required cumulative actions and the appropriate temporal and social scales
7) Often, other conservation activities are prioritised over the protection and preservation of seagrass

Seagrass in India are given the highest protection as an Ecologically Sensitive Area under Coastal Regulation Zone I rules (2011) in recognition of their role in maintaining the integrity of the coast. However, there are no specific laws or policies pertaining to the protection of seagrass alone in the country. Further to this there is no prescribed management regime for the Palk Bay marine ecosystem. Unlike other seagrass areas in the country, Palk Bay is not yet being impacted to a large extent by multi-sector anthropogenic disturbances. However, the continuing measurable decline/damage of seagrass is already having an observed impact on biodiversity and fisheries productivity within the habitat, as well as on the adjacent habitats including coral reefs and mangroves. Discussions with artisanal fishermen in the region, during previous projects, indicate that whilst the fisher communities used to target their catch, diminishing abundance of targeted species has now forced them to catch and sell everything within their nets.

3.5 Participatory management

Conventional approaches to wetland conservation in India have centered on the implementation of Protected Areas (PAs). Wetlands within PAs are regulated by provisions under the Wildlife Protection Act (1972); those outside of Protected or notified areas are regulated by the relevant provisions of the Environment (Protection) Act (1986). Typically the responsibility for on-ground management has been with the state apparatus. However, over time, the functioning of the state apparatus has become highly compartmentalized with little coordination between the different ministries and departments. Additionally, the link between seagrass and the services they provide towards food, water and livelihood security is one that not all land-managers and decision-makers understand. It has been realized that the relationships between wetland communities and their environments are extremely complex, and the long-term integrity of PAs, especially coastal/marine PAs, in low-income nations depends on the support of the local communities.

Over the last couple of decades, the concept of participatory management of wetlands, like seagrass, in India has gained momentum in scope and application. The basis of community-based resource management is the recognition that humans are part of the ecological system, and not separate from it. Participatory management is generally defined as *a partnership in which government agencies, local communities and resource users, and perhaps other stakeholders, such as NGOs, share the authority and responsibility for management of a specific area or set of resource.* According to Addun and Muzones (1997), there are five basic principles that are required for this: Empowerment (the transfer of economic and political power from few to the impoverished many, and the operationalization of community management and control), equity (community as a whole benefit), sustainability (i.e. inter-generational equity based on the carrying and assimilative capacity of the ecosystem), systems orientation (the community functions in the context of other communities and stakeholders), and gender considerations (women are involved in the control and management of community resources, and their practical and strategic needs are addressed).

4. Methodologies

4.1 Economic Valuation Methodology

Palk bay is an integrated ecosystem, comprising of seagrass, mangroves and corals. As such an integrated ecosystem assessment will be beneficial to understand the drivers and pressures in this region. All natural and anthropogenic activities, which can potentially restrict the flow of ecosystem services will be considered as drivers of change in flow. Please refer to Annex 3 for the potential pressures on resources due to human activities that can affect future flow of services.

The valuation methodologies were discussed during the expert consultation meeting held in New Delhi on 8 June; kindly refer to Annex 1 for more details. Table 3 provides a summary of methodologies.

Table 3: Valuing Ecosystem Services of Seagrass in Palk Bay –

Category	Services	Method of valuation
Fishing Intensity Index		**Catch per unit effort** Estimation of fishing intensity index will be done by using Catch per Unit effort (CPUE). The Catch per Unit of Effort (CPUE) is already a standard tool among biologists to determine developments in fish stocks and among economists as an indicator for the efficiency of the fishing operation. $U = \frac{C}{f}$ $C = fqB$ Where, U = Catch per unit effort (CPUE) C= Catch f= effort q= catchability coefficient B= stock biomass (if stock biomass needs to be related to CPUE)
Provisioning	Seahorse habitat	Illegal trade in seahorse can be used to calculate the worth of seahorses to humans as a proxy for the value of the services offered by seagrass as a habitat
	Food (subsistence and commercial)	Total economic benefit/ Marshallian surplus will be used to evaluate the revenue associated with fishing. Total economic benefit will comprise of producers and consumers surplus and the surplus will be then compared to seagrass cover over a period of time.
	Ornamental Chank collection	Direct market price of chank (price of chank depending on size) will reflect the revenue generated from the chank industry. Chank collection per hectare of seagrass habitat over a period of time will reflect the change in size of chank collection over a period of time
	Pharmaceutical use	Marine resources that are being used as raw material for Pharmaceuticals company. Direct market price will reflect the benefit derived from marine resources to the pharmaceuticals company
Regulating	Carbon storage	Average amount of carbon sequestered per hectare of seagrass habitat. Benefit transfer method for amount of carbon sequestered by various species of seagrass

	Coastal protection	Analyzing erosion in the area with and without seagrass cover. Each 300m area of erosion will be compared with the area having seagrass. Analysis will help in estimating the effect of seagrass presence in reducing erosion. Not attempted due to lack of data.
Cultural	Aesthetic value	Not attempted
	Recreational value	
Habitat	Grazing area for Dugongs, turtles etc. Breeding areas of juveniles	Not attempted due to limited time series and project/valuation relevant data

PROVISIONING SERVICE

The value of fisheries was calculated using the market value-based methodology. Annual (2014) craft-specific catch composition & price data was sourced from CMFRI (2014) and BOBLME (2015). Elasmobrachs were not included in the final calculation because price-specific data was unavailable. To ensure benefits derived from fisheries were attributed to seagrass as much as possible, craft-specific (*Thallumadi*, country trawl boat; *Chalvalai*, sardine gill-nets) catch data was used.

SUPPORTING SERVICE

The supporting services of seagrass as habitat to seahorses was calculated based on the illegal trade of seagrass, based on data collected by BOBLME (2015). IUCN in no way supports the trade in seahorses in India, as they are protected under the Wildlife Protection Act (1972). However, the revenue generated can be used as a proxy value for services offered by seagrass as a habitat for vulnerable species like seahorses.

REGULATING SERVICE

The present study attempts to value the seagrass in terms of its monetary value of carbon dioxide equivalent (CO_2e). CO_2e provides a universal standard of measurement against which the impacts of releasing (or avoiding the release of, or actively sequestering) different greenhouse gases can be evaluated. This model can be applied by measuring the wet and dry biomass of different parts of seagrass species. For the purposes of this analysis only vegetative carbon is being used as a surrogate for total carbon in the seagrass ecosystem since it is easy to derive from existing information. The focus of this valuation exercise is therefore on the amount of stored carbon that is at risk of being released from the seagrass (i.e. carbon pollution), in Devipattinam region of Palk Bay.

Dry biomass estimations in Devipattinam were calculated as follows. Four collection stations were identified from the seagrass area, and each station was further divided into 3 zones: near shore zone (0-3 m depth, 0-3 km from shore); middle zone (3-6 m depth, 3-6 km from shore); offshore zone (6-9 m depth, 6-9 km from shores). Up to 3 perpendicular transects were laid down within each zone in each station, depending upon the extent of beds, and parallel to the shore. The biomass was estimated by removing all the plants along with roots, rhizomes and shoots from five quadrants (each of $0.25m^2$) along transects in each station. Plant and material collected from four stations were thoroughly washed to remove any debris and sediments. The various vegetative parts (above and below ground) were separated and sun dried and weighed and the results were expresses as $g/0.25m^2$ on an average basis for different tidal zones. Collection was done for five species of seagrass; *Cymodocea serrulata, Syringodium isoetifolium, Thalassia hemprichii, Halodule pinifolia* and *Enhalus acoroides.* Dry biomass data was collected by the Suganthi Devadason Marine Research Institute (SDMRI) in Tuticorin, Tamil Nadu. Wet biomass data was collected using a similar methodology by the Centre of Advanced Study in Marine Biology, Annamalai University, Chennai, Tamil Nadu.

The process of calculating carbon dioxide equivalents for Devipattinam was adapted from the Blue Carbon Initiative (eds. Howard et al., 2014). The blue approach identifies carbon in the ecosystem in two parts 1) total vegetative carbon and 2) soil carbon. In the present analysis only vegetative carbon is being used as the proxy for total carbon pool of seagrass ecosystem.

Vegetative carbon per hectare was calculated by multiplying total carbon content in each part of seagrass, and conversion factors for various parts. It must be noted that since wet biomass (g wt m^{-2}) and dry biomass (g dry wt m^{-2}) were from two different sources, the results may vary accordingly.

Vegetative carbon from roots & rhizomes

$C_{R\&R}$ = [$B_{per\ core}$ (g/m^2)/ Area of the microplot] * Carbon conversion factor

$$\mathbf{C_{R\&R}} = \frac{\frac{D_B}{W_B}}{\pi r^2}(0.34)$$

r = radius of the area sampled (0.5m)

Vegetative carbon for leaf litter

$$L_B = \left(\frac{d_B}{w_B}\right) * (W_B)$$

$$W_B = \sum_{i=1}^{5}(W_B * \%\ of\ dry\ leaf\ biomass\ from\ all\ microplots)$$

Carbon in leaf

$$C_{Leaf} = \frac{L_{B*(conversion\ factor)}}{Area\ of\ microplot}$$

Conversion factor= 0.45

Area of microplot = 0.1m * 0.1m

<u>TOTAL VEGETATIVE CARBON OF ALL 5 MICROPLOTS</u>

$$C_{vegetative} = \sum_{i=1}^{5}(C_{r\&r} + C_{leaf})$$

Converting vegetative carbon into Mg/ha

1 Mg = 1,000,000 g

1 hectare = 10,000 m^2

$C_{vegetative}$ * (Mg/1,000,000g) * (10,000 m^2/ha)

$C_{\text{average per plot}} = \sum_{i=1}^{5} \frac{C_{vegetative}}{Number\ of\ microplots}$

Potential CO_2 equivalent = $\sum_{i=1}^{4} C_{average\ per\ plot} * (hactare\ of\ strata) * (3.67)$

*To convert carbon into carbon dioxide, values must be multiplied by a conversion factor of 3.67. This signifies the amount of CO_2 which will have an equivalent global warming impact

Scientists predict that climate change will lead, and in some cases has already led, to negative consequences such as the spread of disease, decreased food production, coastal destruction, and many more. The social cost of carbon pollution (i.e. the risk of releasing stored stocks of carbon) calculates the economic cost of these problems and estimates the damage done by each ton of carbon dioxide that is spewed into the air. This allows us to compare the costs of limiting our pollution to the costs of climate change. The current social cost of carbon pollution estimates by the Interagency Working Group (IWG) on Social Cost of Carbon, United States Government, for a unit of emission in 2015 is approximately USD 40. The floor price for the social cost of carbon pollution by the European Union Emissions Trading System (EU ETS) is approximately USD 11.34. India does not yet have a value for the social cost of carbon pollution.

For the purposes of this study the social costs of carbon pollution of the seagrass in Devipattinam village were calculated by multiplying estimates from IWG and EU ETS respectively to the carbon equivalents of one hectare of seagrass

4.2 Approach taken to develop management and conservation strategies

The first steps towards establishing the management and conservation strategies were discussions with experts on 8 June 2015 in New Delhi (kindly refer to Annex 1. for a summary of the proceedings)

The management and conservation surveys were conducted in 30 villages by SDMRI, across the five districts of Palk Bay. 10 surveys were conducted amongst randomly chosen artisanal fishermen in each village; a total of 300 surveys were completely. Villages were also randomly chosen. The survey was developed, based on a socio-economic questionnaire developed by a GIZ consultant in 2012. It was refined following discussions with the expert committee constituted for this project, and following pilot socio-economic surveys conducted by IUCN between 8and 10 July in 2 villages in Ramnathapuram. The final survey used is provided in Annex 2. The SDMRI team completed the surveys between August and October (weather, and political climate willing).

Between 11 and 12 July IUCN visited Palk Bay, Tamil Nadu, and with the support of implementing partners SDMRI met with several stakeholders including Mr. DH Dange (Trust Director, GOMBRT); Mr. Deepak S Bilgi (Wildlife Warden, Gulf of Mannar Marine National Park); and Mr. K. Nanthakumar (District Collector, Ramnathapuram). The purpose of these meetings was towards establishing support for the project, and identifying challenges in management of natural resources in the region. In addition to this, Dr. Beela Rajesh (Commissioner of Fisheries Government of Tamil Nadu, Fisheries Department) and Dr. VK Melkani (Principle Chief Conservator of Forests and Chief Wildlife Warden, Tamil Nadu Forest Department) were also briefed about the project.

On 7 January 2016, a final expert-stakeholder workshop was held in Chennai to discuss the outcomes of the survey, and to draft the recommendations for community-led strategies for conservation of seagrass in Palk Bay ((kindly refer to Annex 5. for a summary of the proceedings)

5. Results

5.1 Economic Valuation

Table 6: Summary of results

Services	Description	Valuation	Assumptions, challenges and limitations
PROVISIONING (Fisheries)	Gross income generated from fishing in Palk bay in 2014, based on catch data from gear and artisanal crafts used in seagrass beds only (data from CMFRI, 2014)	Size of catch: 3373.3 tonnes Average price of catch per kg: INR 106.37 – 141.68 Approximate income generated: INR 358,805 - 477,933	Sharks, rays and skates were not included in the calculations, as reliable price data was unavailable for 2014.
	Approximate income received by fishermen through the sale of sardines. This is based on catch landed in Tuticorin port from the Palk Bay/Gulf of Mannar ecosystem in 2014 (data from CMFRI, 2014)	Size of catch: 460,400 tonnes Average price of catch per kg: INR 2,823.63 – 3,048.83 Approximate revenue received: INR 1.3 - 1.4 billion	Data was unavailable for sardines caught in the Palk Bay seagrass. Sardines are sold through two channels (i.e. from the fishermen to the vendor, and from the fisherman through a middle man to the vendor) which is the reason for the variation in prices.
SUPPORTING (Habitat Support)	Income generated from illegal trading of seahorses in Palk Bay between January and May 2015 (data from BOBLME, 2015)	Size of catch: 64 kg Average price of catch per kg: INR 47,60.05 – 11,423.75 Approximate revenue generated: INR 304,633 - 731,120	IUCN in no way supports the trade in seahorses in India, as they are protected under the Wildlife Protection Act. However these values can be used as a proxy for services offered by seagrass as a habitat for vulnerable species like seahorses.
REGULATORY (Social Cost of Carbon)	Total vegetative carbon (above ground biomass) for 1,639 ha of seagrass in Devipattinam is 1,24,635 ± 76.3 MgC. This is equivalent to 4,57,410.4 ± 279.9 Mg CO_2e (279 CO_2e ha^{-1}) (Per hectare of carbon stored in seagrass in Devipattinam = 76 MgC ha^{-1}, which is approximately 279 CO_2e	The social cost of carbon pollution per hectare in Devipattinam is between INR 714,432 and 202,496 (USD 11,163 and 3,164) per ha^{-1}.	The first value (upper limit) was calculated using USD 40 as the social cost of carbon pollution per hectare, as estimated by IWG. The second value (lower limit) was calculated using USD 11.34 which is the floor price of the social cost of carbon pollution per hectare, as

	ha^{-1})		set by the EU ETS. India does not yet have a value for the social cost of carbon pollution. Conversion rate: USD 1 to INR 64

5.2 Management & Conservation Surveys and Stakeholder Consultations

The most significant results of the management and conservation surveys are as given below (for more details refer to Annex 4.)

- Whilst the community may not have been collectively, and generally aware of the decrease in Palk Bay habitat (i.e. coral, seagrass and mangrove) cover, they almost unanimously agreed (94.98%) that the fish abundance had decreased in coastal waters of Palk Bay

- Discussions indicate that whilst the artisanal fisher communities used to target their catch, diminishing abundance of targeted species has now forced them to catch and sell everything within their nets. Five years ago (2000) the highest average fish catch ranged from 25 to 45 kg per fishing trip; the average present day (2015) catch ranges from 5 to 15 kg. It is noteworthy that the community claim that their fishing practices and gears have not changed much in the last five years. 39% spend the same amount of time (i.e. 1 to 3 hours fishing now as they did 5 years ago); 43.9% now spend less time on fishing as they did 5 years ago. This is suggestive of the fact that the artisanal fishermen themselves may not be the cause of depleting fish abundance in Palk Bay.

- 72.04% of the community indicated that destructive fishing practices (off-shore) were the highest threat in Palk Bay (42.32% classified it as an extremely high intensity threat, 29.72 classified it as high); several respondents cited mechanized trawling as the most destructive practices. A few community members also suggested that crab and similar nets are similarly destructive.

- 40.6% of the community surveyed cited pollution as a significant threat; many blamed unregulated prawn/shrimp farming, and crab-processing units for discharging waste into the sea.

- There was generally no opinion on any other of the threats indicated.

- An overwhelming number of respondents indicated that they were not at all well informed of the conditions of Palk Bay by any authority or organization, including the causes of, and ways in which to prevent coastal and marine degradation.

- The community generally agreed (52.71%) that if they work together they can protect the environment, however they conveyed that they would still need direction and leadership from local government officials.

- A large portion (65.42%) is of the opinion that the government should take charge in reducing environment pollution, at no cost to the community.

- 81.77% agreed people should take more responsibility on themselves to protect coastal areas.

- The community surveys indicate that the highest levels of trust (59.7%) are placed in local leaders (Panchayat/village); there is high mistrust of the coast guard (68.76%) and marine police (72.07%)

- The highest incidence of conflicts between fishermen (45.79%) have been over the theft of nets and gear, with the village head stepping into resolve these (53.33%)

- Although 68.13% of the respondents disagreed with the existence of rules, there was a prevailing understanding of the need for them. As such, 94.06% strongly supported the prohibition of certain fishing gears and practices (particularly those trawling-related).

- There was considerable opposition to the annual ban on fishing (47.92%).

- 61.33% said that trawl nets and mechanized boats should be disallowed from operating near the shore line/in shallower waters.

- 100% said they would be willing to participate in conservation activities, although 78.01% opinioned that there is no need for marine conservation in Palk Bay.

- Although 42.15% of the community surveyed said that they would be unwilling to take up alternate/supplementary livelihoods, 45.07% admitted that they did not know. When questioned further it became apparent that they were unsure what exactly this entailed for themselves in terms of time, resources, and returns. Several said that they did not have any other skills apart from fishing.

6. Community-led management Strategies

Community-based adaptive management of marine resources is the recommended solution for the Palk Bay seagrass ecosystem. Community based conservation efforts will not only safeguard Palk Bay from all potential threats but will require the support of ongoing and future policies to have a holistic and substantial positive impact on seagrass and their rich biodiversity at the ecosystem level.

1. **Recommendation:** The community, particularly fisher-youth, should be capacity-built by local NGOs and the Tamil Nadu Forest Department to recognise the need for their involvement in restoration efforts of degrading habitats, and to be able to actively restore/rehabilitate seagrass habitats.

Restoration/rehabilitation should be science-supported, and build on traditional knowledge of seagrass species ecology. Dimensions such as patch distribution, corridor dynamics, and diversity of flora and fauna, need to be considered at ecosystem and individual levels.

- *Pilot sites:* Thanjavur district has the fewest villages, and small population of ca 2580 fishermen (Marine Fisheries Census, Tamil Nadu, CMFRI, 2010); there is also significantly less mechanised boat use in this district due to its shallow continental shelf. The Government of Tamil Nadu has also identified this district for priority conservation as dugong habitat, and as such resources have been allocated towards its conservation. Based on these factors it is recommended that community-based restoration efforts be piloted in this district.
- *Potential lead agencies*: Tamil Nadu Forest Department; Central Marine Fisheries Research Institute (CMFRI); Suganthi Devadason Marine Research Institute (SDMRI)

In addition to this, a Payment for Ecosystem Services (PES) framework should be instituted based on the ecosystem service valuations calculated through this study to compensate communities for their contributions to conservation efforts.

2. **Recommendation:** A monitoring and evaluation protocol should be developed with the communities to easily and efficiently track seagrass ecosystem health on a regular basis.

The data generated will provide a better understanding of seagrass ecosystem health, and the changing nature of fisheries resources in Palk Bay. Data must be analysed to evaluate any regressions or improvements in functionality of the ecosystem. This will allow for retention or modification of conservation interventions until they successfully meet the ecological and social needs of the ecosystem and communities.

- *Pilot sites:* As Thanjavur district has been recommended for pilot restoration interventions, monitoring protocols should be tested here too.
- *Potential lead agencies:* Tamil Nadu Forest Department; Central Marine Fisheries Research Institute (CMFRI); Suganthi Devadason Marine Research Institute (CMFRI); M.S. Swaminathan Research Foundation (MSSRF); fishermen cooperatives; local-level governance institutions; fisherwomen groups

3. **Recommendation:**A livelihood diversification programme be developed and piloted for local artisanal fishermen community (particularly women) to enhance their socio-economic resilience

The resilience of the Palk Bay artisanal fisher-community is somewhat diminished by the fact that they have only one livelihood to depend on, fishing (as indicated in our surveys). The sustainability of this livelihood is predicated on healthy natural marine/coastal habitats. However, as indicated by studies, the seagrass habitat in Palk bay has already degraded by 20%, and catch size has decreased significantly. A livelihood diversification programme is recommended to increase the self-sufficiency of the people in an uncertain future. A large part of the artisanal community (45.07%) is unwilling to take up additional livelihoods as they are unsure what this entails. At the onset it is recommended that pilot livelihood initiatives be developed and demonstrated with the communities. Awareness and

education will play a large role in establishing willingness to uptake new/supplementary livelihoods. Additionally, establishing market linkages within the existing administrative/management set-up is necessary to ensure that local communities benefit from secured incomes. Institutions like MSSRF have already piloted several additional livelihoods like pickle making in Palk Bay, for which market linkages have been established, and can be leveraged in the future. The majority of fishing allied activities in Palk Bay are being conducted by women, including curing, processing and marketing of fish (Table 1, Annex 6). It is recommended that these livelihoods be strengthened in order to improve the quality of the products being marketed.

- *Pilot sites:* Villages which are most willing to pilot such livelihood interventions
- *Potential lead agencies:* Tamil Nadu Forest Department; Tamil Nadu Fisheries Department; South Indian Federation of Fishermen Societies (SIFFS); International Collective in Support of Fisher workers (ICSF); Social Need Education and Human Awareness (SNEHA, based in Karaikal); Central Marine Fisheries Research Institute (CMFRI); M.S. Swaminathan Research Foundation (MSSRF)
- *Potential funding sources:* Micro-financing institutions (particularly for women's Self-Help Groups); private-sector companies (e.g. sea food export or pharmaceutical companies).

A case-study on eel farming, which can be piloted in Palk Bay, is provided in Annex 7.

4. **Recommendations related to policy and governance:** The following policy and governance related recommendations are based on the perceptions of the investigators, analyses of the survey results, and direct observations.

4.1 100% of the respondents said they would be willing to participate in conservation activities. However 78.01% opinioned that there is no need for marine conservation in Palk Bay; the majority seemed wary of restrictive policies, which to some extent seems to be a result of the neighbouring Gulf of Mannar National Park and Sanctuary. Policies that are developed should ensure that benefits go back to the community (and hence they continue to be incentivized to participate in conservation) and ensure the sustainability of conservation efforts.

It is recommended that seagrass areas supporting critical fish-habitats (breeding/spawning grounds, and migratory routes) be made no-go fishing zones on a *rotational basis* (i.e. a periodic, temporal and spatial shifting of fishing effort in a systematic way among demarcated fishing grounds as informed by scientific studies for all fishing communities). This will go some way in ensuring inter-generational equity.

Whilst the Departments of Fisheries, and Forests have overall governance of the system, it is suggested that local villages leaders and Panchayats retain daily monitoring of implementation of rules and regulations. It is further recognised that whilst some district panchayat heads desire to make changes in fishing regimes for the benefit of the communities, decision-making can be hindered by the fact that all villages within a district must reach a consensus before rules can be established and implementation policed. A multi-stakeholder governing council should be established (perhaps 70% could be community, with the relevant Government representative acting as Member Secretary) to ensure equity and empowerment of all stakeholders. This will also ensure that all stakeholders function in the context of other stakeholders/communities.

4.2 It is suggested that the ban on collection of certain species (e.g. sea cucumbers) should be re-assessed in lieu of the fact that scientific studies (including recent studies by CMFRI) indicate that populations have reached levels to support sustainable harvesting. In particular the harvest of some marine species provides a lucrative livelihood option for artisanal fishermen.

4.3 It is highly recommended that stringent waste-management strategies (including domestic waste, and that created by shrimp farming) in Palk Bay be put into place to maintain healthy seagrass habitats. The MS Swaminathan Research Foundation has developed and successfully piloted bioremediation methods to address waste management; i.e. low-cost technology that incorporates the filtration services provided by wetlands.

7. Next steps

The recommendations will be presented to relevant Government officials, particularly the Fisheries Department, in Tamil Nadu, fishing community representatives and other key stakeholders for review and further action (particularly the feasibility of establishing a governing council for Palk Bay).

IUCN will facilitate a national-level stakeholder workshop to bring together seagrass experts, NGOs and coastal environment managers to present current knowledge on the status of seagrass and seagrass-associated species in India, improve seagrass knowledge, and develop networks for consensus on seagrass protection and conservation.

Potential livelihoods need to be piloted and marketed to the local communities. IUCN will explore funding opportunities to pilot the community-based strategies developed through this project, with support from the Forest and Fisheries Departments, State of Tamil Nadu.

Annex 1.

Community-supported management and conservation strategies for seagrass beds in Palk Bay

Expert consultation workshop to identify economic valuation methodologies for seagrass beds

8 June 2015, IUCN India Country Office, New Delhi

Participants

Representative	Organisation
Dr. RamachandraBhatta	Professor of Fisheries Economics, College of Fisheries (Mangalore)
Dr. Ruchi Badola	Scientist-G/Senior Professor, Wildlife Institute of India, Dehra Dun
Dr. Saudamini Das	Associate Professor, Institute of Economic Growth, New Delhi
Dr. J.D. Sophia	Principal Scientist, M.S. Swaminathan Research Foundation, Chennai
Ms. Neena Koshi	Advisor & Coordinator for Tamil Nadu, CMPA Project, GIZ
Dr. Edward J.K. Patterson	Director, SuganthiDevadason Marine Research Institute, Tuticorin
Ms. Jagriti Kumari	Project Associate (Economist), IUCN India Country Office, ND
Dr. N.M. Ishwar	Programme Coordinator, IUCN India Country Office, ND
Ms. Nisha D'Souza	Small Grants Office, MFF, IUCN India Country Office, ND

*Dr. K. Kavi Kumar (Associate Professor, Madras School of Economics), Dr. Pranab Mukhopadhyay (Associate Professor, Department of Economics, Goa University), and Dr. E. Vivekanandan (Central Marine Fisheries Research Institute) were unable to attend the workshop due to various professional and personal commitments. However, they have shown interest in contributing to this project and the project will continue to consult them and keep them abreast of developments.

Summary of Discussions

IUCN welcomed and thanked the group for attending the workshop, and began proceedings with a synopsis of the project, including an introduction to the project site, the diversity of habitats present, and the threats they face. A brief summary of the projects already undertaken in Palk Bay, through the Mangroves for the Future Initiative was provided.

IUCN has been working in the Gulf of Mannar and Palk Bay landscape since 2007, particularly on seagrass and coral reef ecosystems; funding has been provided for three Small Grant projects, and a Regional Grant project (with Sri Lanka). It was revealed through studies conducted in 2012 that there was approximately 254 km^2 of seagrass cover, with 44.35% along 130 km between Pamban and Athiramapattinam, 135 km^2 of mangroves, and 11.34 km^2 of coral reefs. It was estimated that 20% of the seagrass is degraded as a consequence of anthropogenic threats; a recent survey in 2014 indicated that seagrass has cover has decreased to 209 km^2. Based on the recommendations of this study, the MFF National Coordination Body (NCB) India, chaired by Additional Secretary (Ministry of Environment and Forests), advised IUCN and SDMRI to develop a seagrass conservationstrategy for Palk Bay in December 2013. In 2013, as a consequence of this study the NCB India sanctioned a further small grant project on *Rehabilitation of degraded seagrass areas in Tuticorin coast of Gulf of Mannar, Tamil Nadu, to support long term conservation of seagrass habitats*. Through this project seagrass restoration protocols have been established for the region.

The challenges associated with the availability of data specific to one habitat (i.e. seagrass) were discussed. Even though the seagrass habitat is the dominant amongst marine habitat types in Palk Bay, the influence of coral reefs and mangroves on the direct and indirect services provided cannot be ignored. As such, it was decided that an integrated Ecosystem Assessment should be carried out. With respect to this it was decided to concentrate only on the following services - fisheries, carbon sequestration, and coastal protection. The possibility of economically valuating the threat of pollution

was discussed, however it was decided that time considerations will not allow for a robust study, as data is not readily available and primary surveys would need to be done.

Since the seagrass patches in Palk Bay do not extend beyond 9 km off the coastline, and that artisanal fishermen fish/harvest within them primarily, it was decided that they would constitute the primary stakeholder group in this project. The committee proceeded to identify the logical steps to be taken to carry out the economic valuation through robust means. The following was decided:

Ecosystem services	**Activities to do**	**Data sources**
Provisioning services – food and livelihoods (fisheries)	Identify from existing datasets with IUCN the dominant faunal species in seagrass (keep in mind seasonal variations in species)	Correlate: IUCN project results/Dep. of Fisheries data/fishermen surveys (take into consideration perception of important species)
	Develop a fishing intensity index	Dep. of Fisheries data/fishermen surveys
	Determine present day harvest size and composition	IUCN project results; fishermen surveys
	Map spatial distribution of fishing areas	
	Develop a case-study on Chank collection - Once the association between seagrass and chanks are cemented through secondary data reviews, determine how many shells are collected per hectare in seagrass habitats, and determine market prices for the shells.	Through fishermen surveys, and primary ecological surveys
Provisioning services – medical resources	Investigate if there is a market for marine organisms (from seagrass habitat)-related pharmaceutical uses.	Primary stakeholder surveys (fishermen communities; pharmaceutical companies; CBOs)
Provisioning services – lime industries/chicken feed	Investigate if seagrass associated marine fauna (e.g. gastropods) are sold to lime industries/for chicken feed	Primary stakeholder surveys (fishermen communities; lime industries; farmers; CBOs)
Regulating services – carbon sequestration and storage	Investigate data availability (carbon stock – check Universities, study per species carbon content); Ruchi to send a 2012 paper on available protocols	Dr. Badola suggested requesting the help of Universities and their students (including WII) to measure the carbon storage potential of seagrass species through primary studies.
Regulating services – coastal protection (erosion)	Identify the impacts of erosion on the Palk Bay coastline, and analyse against presence of seagrass (consider the geomorphology of Palk Bay)	Request Ministry to send for data from NCSCM Investigate the costs of sea wall construction/maintenance (use replacement cost methods to value protection from erosion)

It was stressed that the importance of seagrass as foraging and nursery grounds to endangered and protected species like dugongs, marine turtles, sea cucumbers, and sea horses, should be highlighted through this study (even though this service cannot be economically valued through this project)

The group briefly discussed the management component of the project. It was agreed that stakeholder, and conflict maps would be developed for Palk Bay. The policies and existing governance structures pertaining to Palk Bay and the conservation and management of its recourse, should be review and evaluated. It was also suggested that the capacity of existing governance structures, and institutions, to manage resources in a sustainable manner, should be examined. Gender concepts must be taken into consideration when formulating strategies; consequently the present condition, position, and practical and strategic needs of all stakeholder groups (men and women) need to be investigated and assessed. To this end, IUCN has already collected a large amount of information through stakeholder surveys under a project implemented in 2014 in the Gulf of Mannar and Palk Bay. It was suggested by the participants that the possibilities of designating Palk Bay as a community reserve be investigated.

MSSRF and SDMRI indicated that the local/fishing panchayat heads would be most receptive towards implementing community-based conservation strategies, and therefore should be approached from the outset. In addition, strategies should be developed together with the State Fisheries and Forest departments, and local fishing community leaders. It was decided that in addition to MSSRF and SDMRI, IUCN should work with organisations with strong community relationships in the field, including OMCAR Foundation, and Society for People, Education and Economic Development (SPEED).

At the end of the workshop the participants present agreed to be part of the advisory committee for this project, to ensure that the study outcomes are technically accurate. It was strongly agreed that Dr. K. Kavi Kumar, Dr. Pranab Mukhopadhyay, and Dr. E. Vivekanandan should also be part of the committee (should they agree to be so).

IUCN thanked the group for coming, and the meeting was brought to an end.

Annex 2.

Community-supported management and conservation strategies for seagrass beds in Palk Bay

Community surveys

Please ask all the questions; do not assume you know any of the answers. Where possible please interview the men and women of the household. Please tell them the following about the project before you start the interview: studies have shown that there is a connection between sea grass and fisheries. Over the last few years, there has been a decrease in seagrass cover in Palk Bay. Through this project we are trying to conserve the seagrass without affecting community livelihoods.

Name:

Age:

Date:

Address (District/Village):

Individuals interviewed & their gender:

1. Household Activities

1.1 What kind of livelihood activities do you do?

1.2 Indicate traditional fishing ground locations:

1.3 In your opinion how has your fishing activity changed over the last 5 years?

5 years ago			**Now**		
What was the average weight of one catch 5 years ago?	**What species would you catch?**	**How much time did you spend fishing per catch?**	**What is the average weight of one catch now?**	**What species do you catch?**	**How much time do you now spend fishing per catch?**

1.4 Over the last few years has the size of the mature (adult) fish that you catch gotten bigger, smaller, or not change at all?

The adult fish are getting bigger	
The adult fish are getting smaller	
There is no change in the size of the adult fish	

1.5 What species do you target in the summer and monsoon, and what gear do you use to catch them?

	Species caught	**Gear used**
Summer		

Monsoon		

1.6 Apart from fishing do you use marine resources (by resources we mean, all marine animals, and seagrass, coral reefs, and mangroves) for any other uses, or in other activities?

Other uses	**Yes**	**No**	**If yes, provide details (including how much they sell it for)**
Your own consumption			
Pharmaceuticals; medicines; home remedies			
Lime industry			
Chicken feed			
Beach space for net mending/fish drying/boat parking/sanitation/recreation			
Ornamental shell industry			
Other uses (specify)			

2. Coastal conditions and pressures

2.1 Has abundance of marine resources increased or decreased over the last 5 years? Please indicate on a scale from 1 to 3, where 1 means that the resource is decreasing; 2 means it has remained the same; and 3 means the resource is increasing.

What is the abundance of coral compared to 5 years ago?	
What is the abundance of seagrass compared to 5 years ago?	
What is the abundance of mangroves compared to 5 years ago?	
What is the abundance of fish compared to 5 years ago?	

2.2 What are the major threats to the marine habitats that you fish in? Please indicate on a scale from 1 to 5, where 1 is extremely low; 2= low; 3 = medium; 4 = high; and 5 = extremely high.

Pollution (domestic and industrial)	
Habitat degradation	
Illegal harvesting	
Destructive fishing practices	
Thermal power plants	
Oil refineries	
Desalination plants	
Climate change (wind pattern change, stronger waves, water levels receding etc.)	
Any other perceived threats	

3. Awareness, Attitudes and Values

3.1 Why are marine resources important to you? Please tick the appropriate boxes. *Do not give them the options; let them answer on their own.*

Provides food	
Provides an income	
Protects the land from erosion	
Protects from storms, winds, and strong waves	
Helps to control the climate/weather	
Health and recreation	
Habitat & breeding grounds for species	
Religious *(eg. use of scared shells in worship)*, or cultural importance *(eg.*	

scattering of ashes in the ocean)	
Others	

3.2 Do you think you have been informed about habitat conditions? Please indicate on a scale of 1 to 5, where 1 = not at all informed; 2 = not very well informed; 3 = fairly well informed; 4 = very well informed; and 5 = don't know.

The causes of coastal and marine degradation?	
The consequences of coastal and marine degradation?	
Ways in which we can slow down coastal and marine degradation?	
Ways in which we can adapt to coastal and marine degradation?	

3.3 To what extent do you agree with the following statements? Please indicate on a scale from 1 to 5, where 1 = strongly disagree; 2 = disagree; 3 = neither; 4 = agree; and 5 = strongly agree.

If our community works together we will be able to protect our resources	
The government should reduce environmental pollution but it should not cost me any money	
Human activities do not influence the number of fish in the ocean	
Unless mangroves, seagrass and corals are protected we will not have any fish to catch	
We have to take care of the land and the sea or it will not produce for us in the future	

3.4 Tell us your views on the following statements. Please indicate on a scale from 1 to 5, where 1 = strongly disagree; 2 = disagree; 3 = neither; 4 = agree; and 5 = strongly agree.

Community-based protection of marine resources should be increased (*please specify that the Government will continue to maintain overall administration)*	
Women are present in decision-making positions at the village level	
People should take more responsibility to protect coastal areas for themselves	

3.5 Tell us which of these institutions you trust the most. Please rank them from 1 to 9, with 1 being the most trusted, and 9 being the least.

Please also indicate on a scale from 1 to 5, where 1 = complete distrust, 2 = some distrust, 3 = neither, 4 = some trust, and 5 = complete trust.

E.g. you completely trust both Fisheries and Forestry departments but you rank the fisheries department slightly higher (Rank 1) than the forestry (rank 2)

Institution	**Rank**	**Trust level**
Fisheries department		
Forest department		
Local leaders		
Coast Guard/Navy		
(Marine) Police		
Cooperatives; Self Help Groups; Associations; CBOs		
Panchayats		
NGOs		
Others:		

3.6 Please indicate if there have been any conflicts between you (or you village) and other stakeholders as mentioned in the table below.

Please indicate reasons for the conflict from a list of 5, where 1 = ownership of resources, 2 = access of fishing grounds, 3 = use of gears, 4 = stealing of nets/gear, and 5 = any others.

Please also indicate who resolved the conflict from a list of 10, where 1 = Panchayat, 2 = Village head, 3 = police, 4 = fisheries department, 5 = forest department, 6 = NGO, 7 = coast guard/navy, 8 = Cooperatives/Self Help Groups/Associations/CBOs, 9 = no resolution, and 10 = others.

Stakeholders	**Reason**	**Resolution**
Fellow fishermen		
Fisheries department		
Forestry department		
Police		
Navy/Coast Guard		
Panchayats		
Non-Governmental Organisations (NGOs)		
Traders		
Aquaculturalists		
Others (specify)		

3.7 Please indicate if you are willing to actively participate in conservation activities. If not, please let us know why.

Conservation activities	**No = 0**	**Yes = 1**	**If no, please indicate why.**
Community monitoring of habitat health; including maintenance of biodiversity registers			
Participating in community-led conservation activities			
Participating in decision-making processes related to conservation (e.g. being part of village-level management institutions)			

3.8 Which of these rules apply to you? Please tick where appropriate. Please indicate whether you support them on a scale from 1 to 5, where 1 = strongly support, 2 = somewhat support, 3 = neither, 4 = somewhat oppose, 5 = strongly oppose.

Please also indicate who monitors the implementation of the rules, from a list of 1 to 5, 1 = no monitoring, 2 = community monitoring, 3 = fisheries department, 4 = forest officials, 5 = others. Who declared this rule?

Please indicate from a list of 1 to 5, where 1 = fisheries officials, 2 = forest department, 3 = panchayat, 4 = associations/cooperatives/CBOs, and 5 = others.

Rules	**Support**	**Monitoring**	**Rule origins**
No rules			
Forbidden from fishing/hunting/collecting			
Certain fishing techniques/gear forbidden			
Collection of certain species forbidden			
Ban periods/limit of the number of days you can fish			
Certain people/outsiders excluded			
Others (specify)			

3.9 Is there a need for conservation in local marine areas in Palk Bay? *Please do not mention bans, regulations, control – please do not influence their answers in any way.*

No (0)	**Yes (1)**	**Don't know (2)**	**Why?**

3.10 Who in your opinion should be responsible for conservation of marine areas? Please read from the following list and tick all that apply.

Fisheries department	
Forest department	
Panchayat	
NGOs	
Cooperatives; Self Help Groups; Associations; CBOs	
No one	
Others (specify)	

3.11 In your opinion what are the benefits of a conserved marine area? *Please let them first give their opinion on conserved marine areas, and then read from the following list and tick all that apply.*

Improved fish catch	
Improved habitat conditions	
Pride/prestige for the village	
Protect future generations	
Exclude people from other villages	
Stops unsustainable fishing practices	
More benefits and funds from NGOs and Government in the future	
Reduced conflict	
Reduced pollution	
Others (specify)	

3.12 In your opinion what are the potential disadvantages of a conserved marine area? *Please let them first give their opinion on conserved marine areas, and then read from the following list and tick all that apply.*

Loss of income	
Reduced access to marine resources	
Increased number of conflicts	
Decreased fish catch	
Others (specify)	

3.13 Would you be willing to take up any other livelihoods, which will reduce the pressure on natural resources, but still provide an income? Please indicate yes, no, don't know, and if you have an idea of any alternate livelihoods that you would like to take up.

No (0)	**Yes (1)**	**Don't know (2)**	**Why?**

3.14 What in your opinion is the best way to conserve the seagrass without affecting community livelihoods?

Annex 3.

Pressures on coastal and marine resources from anthropogenic factors

Pressures / Use category	Economic Activities				Coastal Development		Climate Change	Alteration of natural processes	
	Pollution	Replacement of species (endemic species at risk)	Pressure on resources	Reduced ecosystem resilience	Habitat destruction	Land use change	Sea level rise	Change in water quality	Nutrient enrichment
Living Resources									
Food (subsistence & commercial Fishing)		✓	✓		✓				
Illegal harvesting/hunting of species (all marine resources)	✓				✓		✓		
Ornamental fishing		✓	✓						
Pharmaceutical		✓	✓						
Non-living resources									
Unsustainable extraction (Lime factory)	✓		✓		✓	✓	✓		
Development Activities									
Solid waste dumping (industrial and domestic)	✓							✓	✓
Discharge of effluents	✓								✓
Offshore navigation and oil spill	✓							✓	✓

Annex 4. Quantifiable results of conservation and management survey (in percentage value)

1. **Has the abundance of Palk Bay marine resources increased or decreased over the last five years?**

	Resource is decreasing	Resource remained constant	Resource is increasing	Don't know
Coral cover	2.61	2.81	0.63	93.95
Seagrass cover	39.61	39.00	20.77	1.25
Mangrove cover	22.09	25.67	19.47	42.45
Fish abundance	94.98	2.83	0.94	1.25

2. **Indicate the intensity of threats prevailing in the Palk Bay region.**

	Extremely low	Low	Medium	High	Extremely high	No opinion/don't know
Pollution	3.36	2.74	7.23	24.30	16.30	46.08
Habitat degradation	1.36	0	0	0	0	98.65
Illegal harvesting	1.04	0.31	0.31	0.31	0.63	72.71
Destructive fishing practices	0.94	1.84	8.92	29.72	42.32	16.26
Thermal power plants	1.36	0	0.31	0	0	98.33
Oil refineries	1.36	0	0	0	0	98.65
Distillation plants	0.94	0	0	0	0	74.06
Climate change	1.56	6.70	13.06	3.44	5.63	73.33
Any other	1.04	0	0	0.31	0.31	98.33

3. **Have you been informed about the conditions of the Palk Bay habitat by anyone?**

	Not at all informed	Not very well informed	Fairly well informed	Very well informed	Don't know
The causes of coastal and marine degradation	64.68	12.92	4.48	4.27	13.65
The consequences of coastal and marine degradation	62.05	13.48	4.71	3.33	16.42
Ways in which we can slow	67.29	9.61	4.07	3.35	15.69

down marine degradation					
Ways in which we can adapt to marine degradation	70.83	8.42	2.71	3.36	14.69

4. To what extent do you agree with the following statements?

	Strongly disagree	**Disagree**	**Neither**	**Agree**	**Strongly agree**
If our community works together we will be able to protect our resources	6.36	26.15	11.88	19.58	33.13
The government should reduce environmental pollution but it should not cost me any money	4.38	13.33	16.88	25.11	40.31
Human activities do not influence the number of fish in the ocean	30.94	33.65	12.81	14.27	8.33
Unless mangroves, seagrass and corals are protected we will not have any fish to catch	1.56	3.33	11.98	40.42	42.71
We have to take care of the land and the sea or it will not produce for us in the future	1.56	0.42	10.94	40.42	40.04

5. Do you agree with the following statements

	Strongly disagree	**Disagree**	**Neither**	**Agree**	**Strongly agree**
Community-based protection of marine	17.39	18.44	13.75	20.11	24.69

resources should be increased					
Women are present in decision-making positions at the village level	15.31	20.83	35.42	24.69	8.58
People should take more responsibility to protect coastal areas for themselves	1.67	6.98	8.96	41.56	40.21

6. **Please indicate level of trust (you place in these institutions) on a scale of 1 (complete distrust) to 5 (complete trust)**

	Complete distrust	**Some distrust**	**Neither**	**Some trust**	**Complete trust**
Fisheries dep.	29.23	6.21	24.72	22.01	20.47
Forest dep.	33.33	7.57	27.87	21.06	10.17
Local leaders (village and panchayat)	27.38	3.36	9.51	21.96	37.74
Coast guard	47.25	21.51	17.60	12.40	1.26
Marine police	50.35	21.72	16.46	10.11	2.94
Fishermen cooperatives/associations; SHGs; CBOs	39.71	9.05	9.56	15.00	26.69

7. **Indicate whether you have conflicted with the following stakeholders on the following issues.**

	Ownership of resources	**Access to fishing grounds**	**Use of certain gears/practices**	**Stealing of nets/gears**	**Retail price of fish**	**No conflicts**
Fellow fishermen	0	4.49	7.78	45.79	0.32	30.66
Fisheries dep.	0	0	0.31	7.59	0	99.38
Forest dep.	0	0.63	0	0	0	99.38
Police	0	0.31	0	0	0	99.69
Coast guard	0	0	0	0	0	100
Local leaders (village and Panchayat)	0	0	0	0	0	100
NGOs	0	0	0	0		100
Aquaculturists	0	0	0	0	0.42	99.58
Others	0	0.31	0	0	13.33	78.23

8. **Who resolved the conflicts?**

	Local leaders (Panchayat)	Village head	Police	Fisheries dep.	Forest dep.	NGO	Coast guard	Fishermen cooperatives/associations; SHGs; CBOs	No resolution	Others
Fellow fishermen	5.49	53.33	3.75	0.31	0	0	0	0	0.27	27.51
Fisheries dep.	0	0	0	0.31	0	0	0	0	0	99.69
Forest dep.	0	0	0	0	0.93	0	0	0	0	99.06
Police	0	0	0	0	0	0	0	0	0	100
Coast guard	0	0	0	0	0	0	0	0	0	100
Local leaders (village and Panchayat)	0	0	0	0	0	0	0	0	0	100
NGOs	0	0.31	0	0	0	0	0	0	0	99.68
Aqua culturists	0	0	0	0	0	0	0	0	0.42	99.58
Others	3.33	26.21				0.32		2.68	4.03	64.66

9. Are you willing to participate in conservation activities

	Yes	No
Willing to participate in conservation activities?	100	0

10. Which of the stated rules apply to you, and how strongly?

	Strongly support	Somewhat support	Neither	Somewhat oppose	Strongly oppose
No rules	68.13	0	4.17	0	2.71
Forbidden from fishing/hunting (in some areas)	75	12.5	0	0	12.5
Prohibition of certain fishing gears and practices	86.43	7.63	1.99	1.25	0.63
Forbidden from collecting of certain species	0	8.33	8.33	33.33	0
Ban periods/limits of no. of fishing days	19.14	7.21	24.43	32.77	15.15
Outside fishermen are excluded	0	0	0	12.5	12.5
Others	0	0	0	0	0

11. Please indicate who monitors the implementation of rules/laws.

	No	Community	Fisheries dep.	Forestry dep.	Others

	monitoring	monitoring			
No rules	69.50	19.00	8.25	3.26	0
Forbidden from fishing/hunting (in some areas)	0	0	50	25	0
Prohibition of certain fishing gears and practices	4.66	8.32	55.32	29.87	1.82
Forbidden from collecting of certain species	0	0	0	25	0
Ban periods/limits of no. of fishing days	24.06	20.70	31.18	24.06	0
Outside fishermen are excluded	0	0	0	25	0
Others	0	0	0	0	0

12. Who declared this rule/law?

	No monitoring	Community monitoring	Fisheries dep.	Forestry dep.	Others
No rules	24.63	8.96	66.41	0	0
Forbidden from fishing/hunting	50	25	0	0	0
Prohibition of certain fishing gears and practices	48.55	44.61	6.79	0	
Forbidden from collecting of certain species	25	25	0	0	0
Ban periods/limits of no. of fishing days	22.79	41.48	34.78	0	0.96
Outside fishermen are excluded	25	0	0	0	0
Others	0	0	0	0	0

13. Is there a need for conservation in marine areas of Palk Bay?

	Yes	No	Don't know
Is there a need for marine conservation in Palk Bay?	17.71	78.01	4.21

14. **Would you be willing to uptake alternate/supplementary livelihoods to reduce pressure on marine resources of Palk Bay?**

	Yes	No	Don't know
Willing to uptake alternate/supplementary livelihoods?	12.78	42.15	45.07

Annex 5.

Community-supported management and conservation strategies for seagrass beds in Palk Bay

Final expert consultation workshop

7 January 2016, The Raintree Hotel, Chennai

Participants

Representative	Organisation
Dr. RamachandraBhatta	Professor of Fisheries Economics, College of Fisheries (Mangalore)
Dr. Ruchi Badola	Scientist-G/Senior Professor, Wildlife Institute of India, Dehra Dun
Dr. Saudamini Das	Associate Professor, Institute of Economic Growth, New Delhi
Dr. J.D. Sophia	Principal Scientist, M.S. Swaminathan Research Foundation, Chennai
Ms. Neena Koshi	Advisor & Coordinator for Tamil Nadu, CMPA Project, GIZ
Dr. Edward J.K. Patterson	Director, SuganthiDevadason Marine Research Institute, Tuticorin
Dr. E. Vivekanandan	Emeritus Scientist, Central Marine Fisheries Research Institute
Dr. Y. Yadava	Director, Bay of Bengal Inter-Governmental Organisation
Ms. Jagriti Kumari	Project Associate (Economist), IUCN India Country Office, ND
Dr. N.M. Ishwar	Programme Coordinator, IUCN India Country Office, ND
Ms. Nisha D'Souza	Small Grants Office, MFF, IUCN India Country Office, ND

*Dr. Pranab Mukhopadhyay (Associate Professor, Department of Economics, Goa University), was unable to attend due tolast-minute flight cancellations by AirIndia

Summary of Discussions

IUCN welcomed and thanked the group for attending the workshop. IUCN presented the group with a summary of the project objectives, activities and analyses of the management and conservation surveys, and the evaluation results of the study.

The majority of the data used in the economic valuation studies on fisheries was sourced from CMFRI. It was discussed that even though landings in Palk Bay are predominantly by fishermen from Palk Bay districts (as they do not allow foreign fishermen to land in Palk Bay; it was estimated by the experts that approximately 5% of the fishermen are not from Palk Bay), the fish are not necessarily caught in Palk Bay. On average about 50% of the catch landed is from India, the rest from Sri Lankan waters. As such, the annual landing data collected by CMFRI cannot be used to give a quantitative estimate of the value of fisheries in Palk Bay. It was similarly noted, that the economic value of revenue generated by fisheries does not include the costs borne by fisherfolk in gear maintenance, and other associated fishing activities.

Several possible alternate methodologies were discussed by the economists and biodiversity and fisheries experts. It was noted, there is a large volume of available data on fisheries, however application of the available data to the current needs of this study is challenging. It was further observed that since Palk Bay and the Gulf of Mannar are continuous habitats, a number of other factors would affect biodiversity, catch sizes and composition, and ultimately the valuation assessments.

It was eventually decided that catch data from gears used solely in seagrass beds in Palk Bay be used to provide an indicative value of fisheries associated with seagrass, to the artisanal fishermen. The majority of the artisanal fishers in Palk Bay are non-motorized boat users; the two most popular traditional crafts that operate almost exclusively in the seagrass (operating between 4 – 7m) are the *Thallumadi* (country trawl boat), and the *Chalavalai* (sardine gill-nets). CMFRI collects annual data on catch size and composition. It was further decided that based on recent studies conducted by CMFRI

and BOBLME, cast-study valuations would be conducted for sea horses and sea cucumbers in Palk Bay. Trade-related data could also be sourced from TRAFFIC reports, given that both species are protected in India under the Wildlife Protection Act (1972). It was similarly suggested that fisheries and biodiversity be considered separately, and valuated as such; i.e. assessing changes in species population trends, catch sizes, biomass of seagrass, and what changes livelihoods underwent as catch and fish prices decreased. Everybody acknowledged that a year is not long enough to address all these aspects, and as such the project team should focus on assessing the information already available, and that collected through the management and conservation surveys.

With respect to the valuation of carbon sequestration potential, the experts stressed the importance of defining CO_2 emissions, sequestration and storage. It was mentioned that the Ministry of Environment, Forest and Climate Change (MoEFCC) has possibly priced carbon at USD 6/tone, although the information could not be found online (Dr. Bhatta has agreed to look into it).

With respect to the recommendations for the study the following was suggested:

- Existing livelihoods should be strengthened (e.g. by providing better storage facilities for fish)
- Informal governance systems, including fisheries organizations and institutions at the village levels should be involved in all livelihood interventions, and conservation efforts
- Integrate Payment of Ecosystem Services into participatory conservation efforts towards providing a incentives/benefits to the local communities
- Assess opportunities to leverage the National Mission for Green India (GIM), which aims to improve and enhance ecosystem services like carbon sequestration and storage in forests and other ecosystems, hydrological services and biodiversity.
- Integrate lessons-learned from efforts in Gulf of Mannar to link conservation and human welfare. It could be argued that the GOMBRT interventions were somewhat unsuccessful because it was a top-down administration, and the revolving fun system did not quite work i.e. Sustainability was not fully achieved.
- Gender considerations must be integrated into livelihood and conservation programmes (i.e. who is earning, and how much are they earning? What are the natural resource dependency levels of women and men?)
- Identifying
- In the future, there should be an assessment of global experiences in translating economic valuations into management interventions
- Ensure that the community's long-term interests are addressed; i.e. there must be policy directives (e.g. if Thanjavur's marine habitats are passed on to the community for restoration and conservation, in addition to having access to, they must retain some amount of control over the resources as well). This would involve the Fisheries and Forestry departments reaching a consensus. A multi-stakeholder governing council could be established (perhaps 70% could be community, and the Member Secretary could be the Government)
- Involve the community in developing the monitoring protocols so that it is not cumbersome to them, but will yield valuable data that can be fed back into conservation efforts
- Put in place the groundwork for a sustainable social enterprise model that combines livelihood and conservation aspects to evolve organically. Conservation and livelihood benefits must be intricately linked (e.g. the Integrated Mangrove Fisheries Farming System (IMFSS) model)
- MSSRF has already established market linkages for pickles and dry fish production (value additions). These can be used when establishing additional livelihood options.
- MSSRF has developed bioremediation methods to address waste management; i.e. low-cost technology that incorporates the filtration services rendered by wetlands.
- Government of Tamil Nadu has identified two districts, including Thanjavur, in need of protection for dugongs, and intend to establish community monitoring; as such, they have resources for this which can be leveraged
- An exit strategy must be developed with the local communities at the beginning, for any projects being taken up in Palk Bay with respect to livelihoods and conservation

IUCN thanked the experts for coming, and the meeting was brought to an end.

Annex 6.

Table 1. Fishing community, and livelihood profile in the 5 districts of Palk Bay (Source: Marine Fisheries Census 2010: Tamil Nadu, Ministry of Agriculture, Government of India, Indian Council of Agricultural Research, ICAR)

District	No. of fishing villages	No. of traditional fishermen families	No. of fishermen families living below the poverty line	No. of active fishermen	No. of members involved in allied fishing activities					
					Marketing of fish	Making or repairing of nets	Curing or processing	Peeling	Labourer	Others
Ramnathapuram	178	37,680	33,429	48,798	3,876 (2,371)	2,148 (773)	1,975 (1406)	1,574 (1264)	5,776 (2270)	1,537 (904)
Pudukottai	33	6,015	2,689	8,227	2,443 (1564)	50 (16)	23 (15)	13 (12)	401 (164)	5 (4)
Thanjavur	31	6,528	6,483	7,523	812 (570)	47 (2)	47 (43)	2 (1)	1,061 (145)	43 (10)
Thiruvarur	13	2,577	2,080	2,634	685 (645)	81 (58)	304 (304)	779 (799)	2 (2)	1 (0)
Nagapattinam	57	20,854	13,927	23,389	6,718 (6,303)	696 (270)	1,965 (1,827)	63 (42)	1,385 (470)	388 (345)

*Numbers in brackets indicate the no. of female members involved in allied fishing activities

Table 2. Fishermen families engaged in Aquaculture (Source: Marine Fisheries Census 2010: Tamil Nadu, Ministry of Agriculture, Government of India, Indian Council of Agricultural Research, ICAR)

District	Type of Aquaculture						Acquired training
	Fish	Prawn	Crab	Lobster	Seaweed	Total	
Ramnathapuram	61	0	0	1	149	211	130
Pudukottai	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thanjavur	0	0	0	0	0	0	15
Thiruvarur	1	0	0	0	0	1	0
Nagapattinam	2	7	0	0	0	9	42

Annex 7. Eel farming as a livelihood option

Eels are becoming increasingly popular in non-traditiaonl consumber markets. Eel production had steadily increased worldwide over the last 30 years, mainly because of the expansion of eel farming, which accounted for 95 percent of total production in 2013, according to data from the Food and Agriculture Organization of the United Nations (FAO). Most of this expansion took place in East Asia, with mainland China responsible for nearly 85 percent of worldwide eel production in 2013.

Global demand for eels has traditionally been driven by consumption in East Asia, particularly in Japan. Data indicates that the Japanese consumed 30-45% of the global eel production in 2012-2013. Combined trade and FAO production data from China indicate a significant increase in domestic eel consumption over the past decade, reaching an estimated 150,000 MT in both 2012 and 2013. The cost of eels varies significantly depending on annual catches and the interest from Asian eel producers, who buy European eels for farming in their home countries. Prices during 2004 varied between 300 and 750 euro/kg (FAO, 2004). Regionally, eel farming is commonly practiced in China, Phillippines and Japan.

Eel farming could be a low cost enterprise for artisanal and marginal fishermen in Palk Bay. A village fisherman head in Ramnathapuram district informed the project team that on occasion fishermen collect wild eel, the intestines of which are sold at ₹ 85 per piece. He went on to elaborate that the wild population of marine eels is not large and therefore eels are not a targeted fished species.

There are several methods used globally to catch eels. The method of fishing has a significant impact on the quality of the fish. In England, France, Spain, Portugal, Italy and Morocco, the fisheries take place in estuaries and at the mouths of rivers and dams where the natural concentration of eels can more easily be exploited. Hand-held or ship-based nets are used (moved manually or fixed) and include trawls, stow nets, and fyke nets. In Spain and Portugal, fishermen use hand-held nets and traps. In France, glass eels are caught by small trawlers using wing nets and trawls.

Two species, the Indian short-finned eel (*Anguilla bicolor*), and long-finned eel (*Anguilla nebulosa*) are commonly found in fresh and coastal waters of India. Eels typically undergo three stages of growth: 1. Marine larval phase (elvers), 2. Freshwater phase of growth (commonly known as yellow eels) and, 3. Adult marine phase of reproduction (commonly known as silver eels). Elvers generally spend their lives in near shore environments, lacking the energy to travel long distances in open water where they risk being preyed on. Since a large number of species of eel spend their lives in fresh and marine waters, either stage of the lifecycle can be taken advantage of for culturing purposes. The Central Marine Fisheries Research Institute (CMFRI) piloted experimental freshwater eel culture methodologies in Mandapam in the 1980's. Although there were some challenges related to disease, these were insignificant in the long run. The culture technology was developed, but was never replicated and adopted by the communities for unspecified reasons.

In 1980, the European Committee for the Conservation of Nature and Natural Resources of the Council of Europe classified the eel as "vulnerable" (Lelek, 1980). Matsuda (1999) considers the Japanese Eel to be "Critically Endangered" according to IUCN Red List criteria, and ICES (1999) considers the European Eel "outside safe biological limits" in the context of the Agreement for the implementation of the provisions of the United Nations Convention of the Law of the Sea of 10 December 1982 relating to the conservation and management of straddling fish stocks and highly migratory fish stocks (Anon., 2001d).

In India, eels are not protected, nor has there been systematic studies of their population sizes. However, although it is important that rigorous scientific studies be conducted on the wild popualtions, this project recommends farming eels. However, it remains to be determined if there is (national/regional/international) market potential for farmed eels from India at a larger scale. There are several distributers, suppliers and traders of eels and associated products, originating in India to be found online (http://www.tradeindia.com/suppliers/eel-fish.html), including Sun Exports, Benchmark Seafoods, Karunya Marine Exports Pvt. Ltd. and Ghosh Agri Tech Pvt. Ltd. It is unclear however, where the eels are sourced from, and a market chain analysis needs to be considered.

Annex 8. Traditional uses of seagrass in Tamil Nadu

S.no	SEAGRASS SPECIES	UTILITIES
1.	*Cymodocea rotundata* Asch. & Schweinf	• Branches and leaves are used as goats feed. • Paste made from leaves is used for treating wounds. • Biomass collected is used as green manure. • It can sooth pain during pregnancy and can be very effective in curing fever and malaria
2.	Cymodocea serrulate (R.Br.) Asch & Magnus	• Branches and leaves are used as goats feed. • Paste made from leaves is used for treating wounds. • Cymodocea Spp. used as a tranquilizer for babies. Local Indian fisherman consumes this species as it tastes like sugar cane. • Biomass collected is used as green manure • Local fishing markets use it for insulation during summers to keep stored ice and fishing cool
3.	*Enhalus acoroides (*L.f.) Royale	• Rhizome and root juice is used to treat sea sickness. • Rhizome (peeled of skin)consumed with seawater can treat heart condition and lower blood pressure. • Effectively used for treatment of various oxidative stress related disease. • Rhizome consumed fresh to treat indigestion and hangover. • Skin diseases can be cured using paste of fresh leaves. • Fruits are consumed by local fisherman • Seeds (tastes like almond) are consumed by people and are also fed to goats and pigs.
4.	*Halodule Pinifolia* (Miki) Hartog	• Branches are used as goat feed
5.	*Halodule Uninervis* (Forsk.) Boiss	• Branches are used as goat feed
6.	*Halophila Beccarii* Asch.	• Extract of the species showed Antifungal properties against *Trichophyton Mentagrophytes* and *Microsporum gypseum*
7.	*Halophila Ovata Gaud.*	• Local fisherman uses it to treat common ailments like dandruff (Paste of leaves are applied on scalp). • A handful of leaves toasted with sesame oil is consumed with daily meal to treat iron deficiency
8.	*Halophila ovalis* (R.Br Hook.f)	• Handful of leaves are toasted with sesame oil and consumed for 3 days to treat iron deficiency. • Halophila Spp. has antifungal properties and a strong medicine for Malaria. • It can cure early stage of Leprosy and can be very effective in curing skin diseases. • Leaf paste with turmeric powder is applied to cure various skin ailments (burns, boils etc.)
9.	*Syringodium isoetifolium*	• Fresh leaf juice is consumed to relax acid reflux. • Used as potential Larvicidal agent against ades aegypti mosquito larvae

	(Asch.) Dandy	• Branches are used as goat feed • Local fishers feed tube grass to their cattle which could apparently cure their illness
10.	*Thalassia Hemprichii* (Ehrenb. ex Solms) Asch.	• Dried rhizome powder is used to treat mental disorder. • Dried rhizome powder mixed with coconut oil is used to cure wounds. • Biomass used for green manure. • Local fishing markets use it for insulation during summers to keep stored ice and fishing cool

Annex 9. Magnitude of threats to ecosystem services of Palk Bay

Ecosystem function category	Ecosystem function	No threats	Negligible threat	Marginal threat	Significant threat	High level threat	Extremely High level of threat
Provisioning service	Food (subsistence & commercial Fishing)						
	Illegal harvesting/hunting of species (all marine resources)						
Regulating service	Climate regulation						
	Soil retention						
	Nutrient regulation						
	Carbon storage						
Supporting services	Supporting habitats						
	Raw materials						
Cultural service	Landscape opportunity						

GLOSSARY

CO_2e (Carbon dioxide equivalent) – It is a measure used to compare the emissions from various green house gases based upon their global warming potential.

Discount rate - Discount rate measures the trade off between what a dollar is worth today and what a dollar would be worth in the future

DUV (Direct use value) - Obtained through a removable product in nature

ETS – Charges the companies by the amount of carbon they emit and it doesn't limit the amount they can emit.

GDP (Gross domestic product) – Total dollar value of all goods and services produced over a specific period of time

Black (or hidden/invisible) markets – The illegal markets that are engaged in sale and purchase of banned goods.

IUV (Indirect use value) - Obtained through a non-removable product in nature

NPV (Net present value)- Formula to determine the present value of an investment by the discounted sum of all cash flows received.

NUV (Non-use value) - Values for existence of the natural resource

OV (Option value) - value that people place on having the option to enjoy something in the future, although they may not currently use it

Price floor- lowest legal price at which a commodity can be sold

Social cost of carbon - The social cost of CO_2 is an estimate of the economic damages associated with a small increase in CO_2 emissions, conventionally one metric tom, in a year

TEV (Total Economic value)- Refers to the value derived by people from an ecosystem or natural resource

UV (Use value) - the value derived from the actual use of a good or service

WTA (Willingness to accept) – The minimum amount of money that a person is willing to accept to abandon a good or to put up with something negative

WTP (Willingness to pay) – The maximum amount an individual is willing to sacrifice to procure a good or avoid something undesirable

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12

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