Risk Based Framework (RBF)
Endangered, Threatened and Protected (ETP) species
of the Blue Swimming Crab Fisheries
in Palk Bay, Tamil Nadu, India

CRAB MEAT PROCESSORS ASSOCIATION (CMPA), INDIA

November 2023

Contents

1.1. Introduction

Portunus pelagicus, commonly known as the Blue swimming crab (BSC) is a highly valuable sea food, mainly exploited for export from India. The state of Tamil Nadu is the major contributor for BSC. The Unit of Assessment is Palk Bay area of Tamil Nadu, India and Unit of Certification is gill net (*nanduvallai*). The targeted fishery of BSC is by gill nets operated by traditional sector, whereas trawl boats also harvest it as by catch. Gill net fishery contributes to 70% of BSC landings.

The Crab Meat Processors Association (CMPA) comprising of 12 members are the major crab exporters from India and it is under their initiative, the current Fishery Improvement programme (FIP) for BSC is active in Palk Bay, Tamil Nadu along with the financial support from NFI-CC.

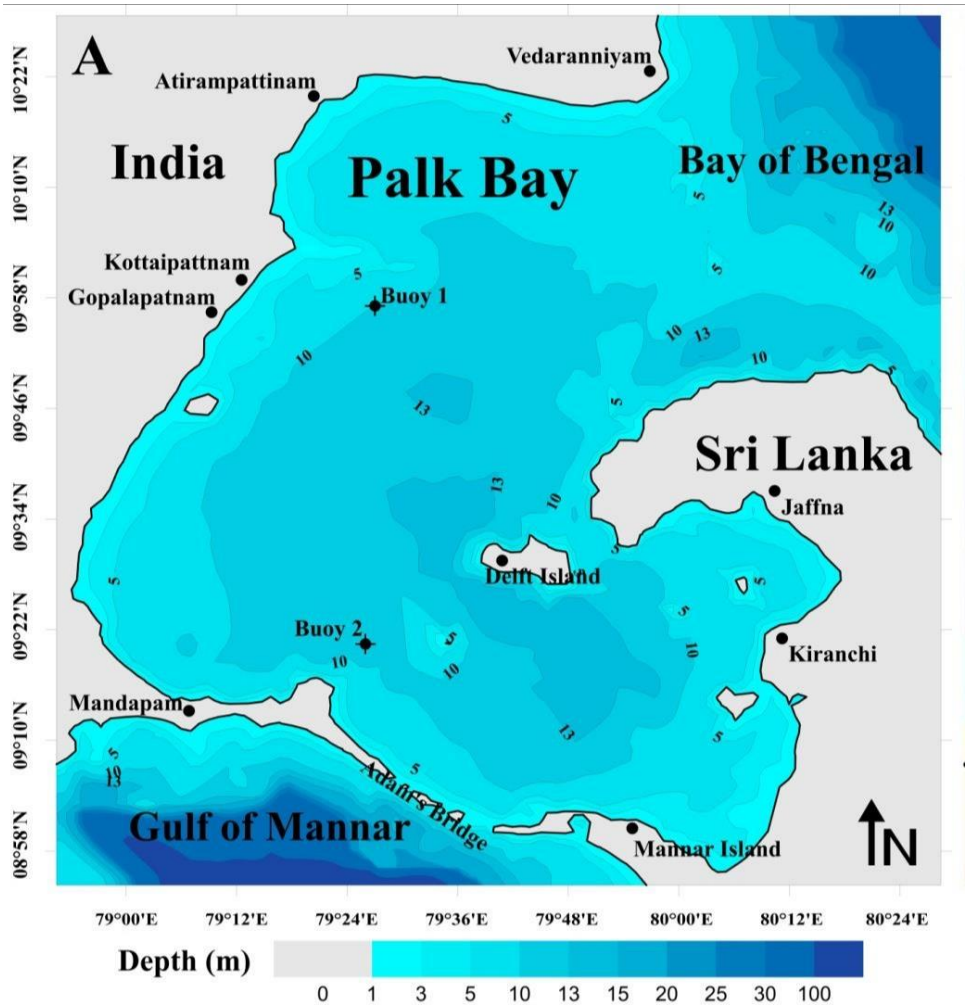

Figure:1. Bathymetry of Palk Bay developed by interpolation of National Hydrographic datasets (Source: https://en.wikipedia.org/wiki/Palk_Bay)

Palk Bay is one of the three marine biodiversity hotspots of India. Palk Bay is a shallow water area on India's southeast coast; it is unique in that it is almost an enclosed bay with an inflow from several rivers along the coast. The site harbors charismatic species such as the Dugong, sea horses, sea turtles, and pipe fishes and more than 50 species of mollusc, 20 hard corals, four species of mangrove, 16 species of coastal vegetation, including halophytes, and seven species of seagrass (Sivakumar, 2013). Based on various studies the Tamil Nadu government declared about 448-square -

kilometer area in the northern part of the Palk Bay as a 'Dugong conservation reserve' notified by gazette order G.O. Ms. No.165, Environment, Climate Change and Forests (FR.5) dated 21st September 2022.

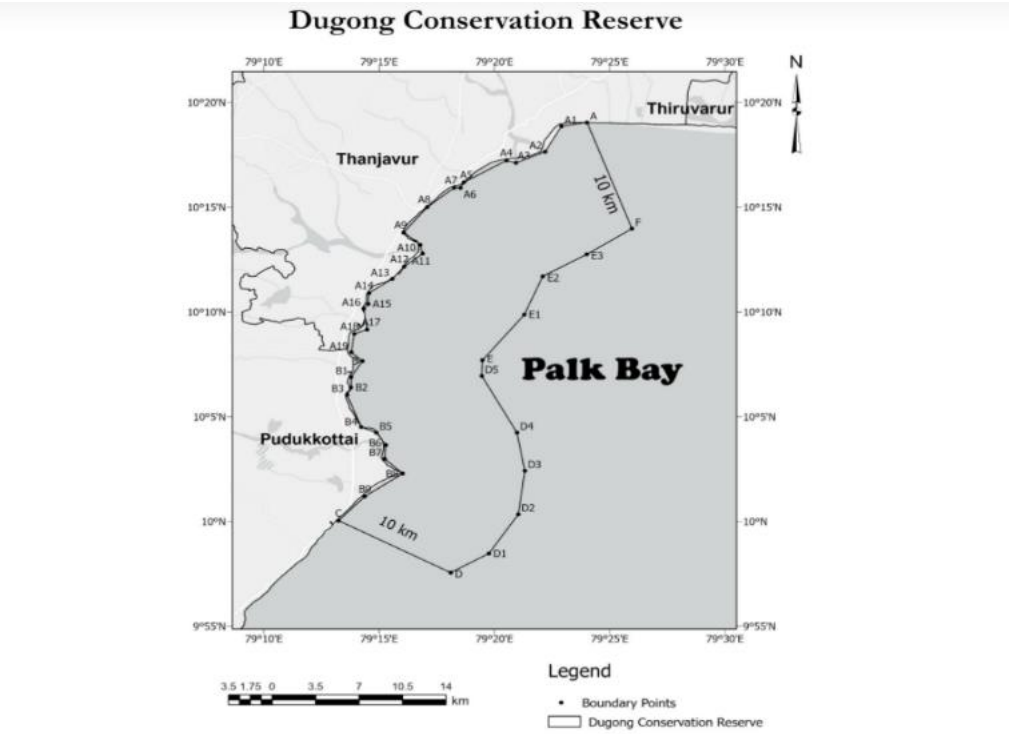

Figure 2. Dugong conservation reserve of Palk Bay, Tamil Nadu (Source:https://www.researchgate.net/publication/370561039)

1.2. Risk Based framework (RBF) assessment

This Risk-Based Framework (RBF) was developed based on Marine Stewardship Council (MSC) Fisheries Process to assess the fishery which is data deficient for certification program against the MSC standard for sustainable fishing. The RBF may be used for evaluating the BSC stock status, and the impact of the fisheries on primary species, secondary species, Endangered, threatened and protected) ETP species, habitat, and ecosystem components of MSC standard Principle 2. In this paper RBF is used to assess the ETP species.

1.3. Method

1.3.1. Data collection

CMPA is collecting data from landing centres on non-target species regularly. The data is collected from nine major gill net landing centres monthly.

The present analysis focuses only on the Endangered, threatened and protected (ETP) species interacted by the bottom set gill net fishery from the project area. Based on the regular data recorded at landing centres the following five species were identified as ETP in the BSC gill net fishery.

Table 1: List of ETP species from BSC gillnet fishery (as recorded by FIP)

Species	IUCN status	CITES	Wildlife Protection Act, India
Hippocampus kuda (spotted seahorse)	Vulnerable	Appendix II	Protected under Schedule 1
Hippocampus trimaculatus (Flat-faced/longnose seahorse)	Vulnerable	Appendix II	Protected under Schedule 1
Dugong dugon (Dugong)	Vulnerable	Appendix I	Protected under Schedule 1
Holothuria scabra (Sand fish)	Endangered	Not evaluated	Protected under Schedule 1
Chiloscyllium indicum (Slender Bamboo shark)	Vulnerable	Not evaluated	Not listed

1.3.2. RBF Methodology

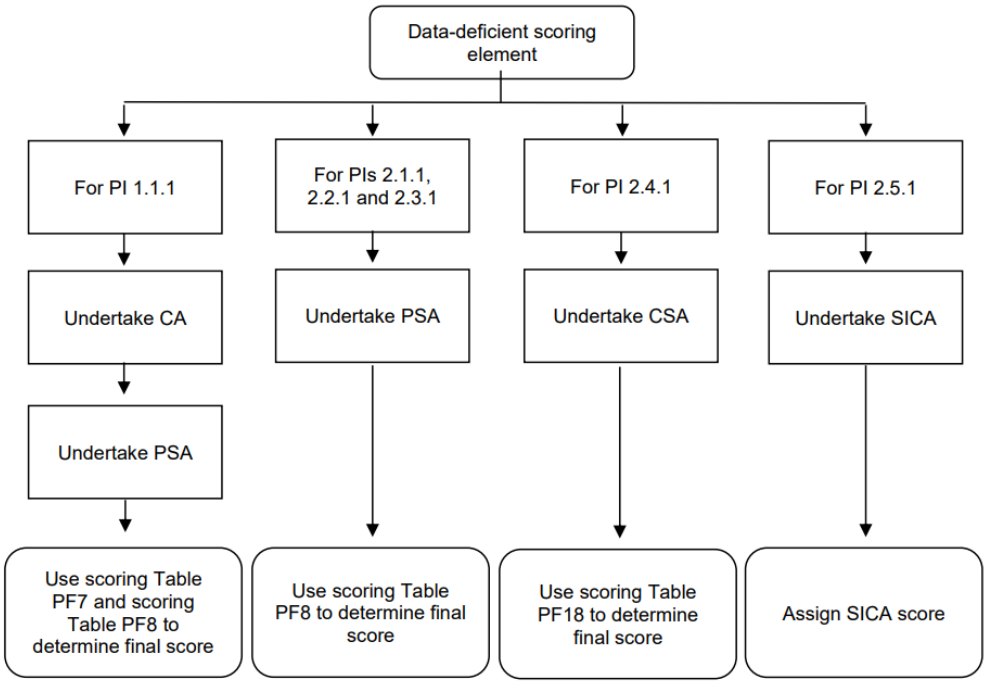

Figure 3. RBF Methodology (Source: Figure PF1: How to apply the RBF in scoring. MSC Fisheries certification process v2.2. Pg.63)

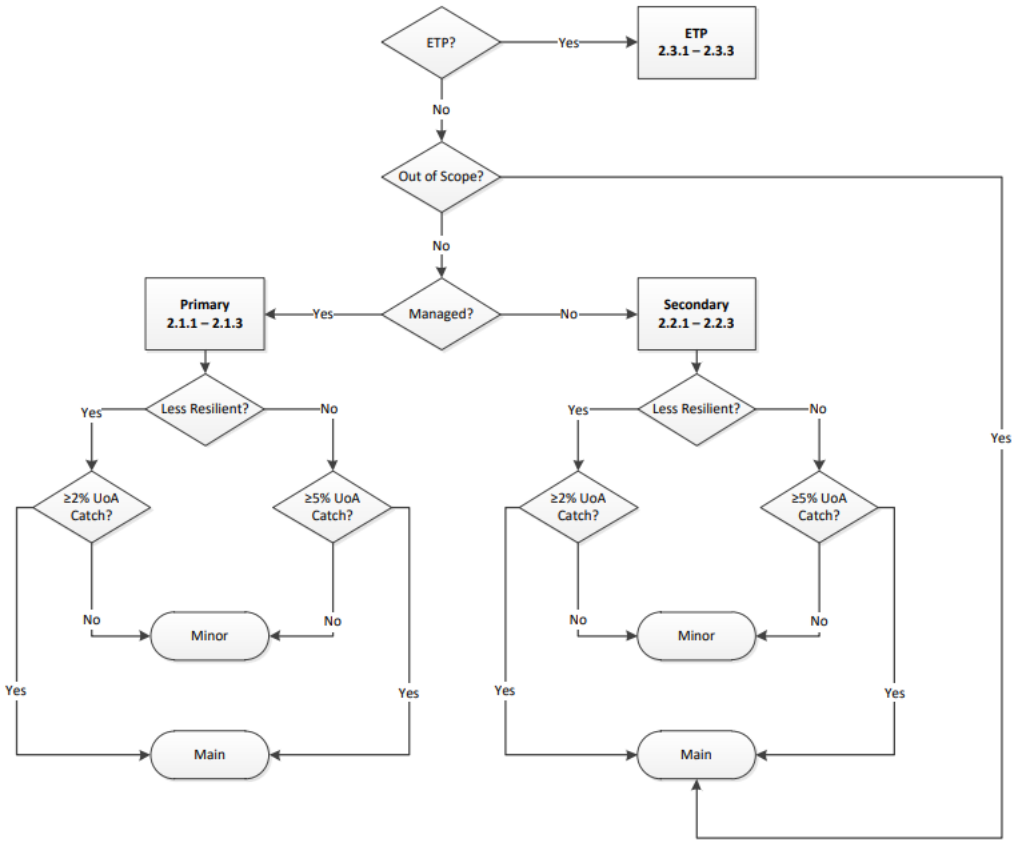

Figure 4. Decision tree to assist in designation of P2 Species components (Source: Figure GSA3: Decision tree to assist teams in the designation of P2 species components. MSC Fisheries standard v2.01. Pg180)

1.3.2.1. Productivity Susceptibility Analysis (PSA)

The Productivity Susceptibility Analysis (PSA) requires information about the productivity and susceptibility of each species in each PI, and uses this information to individually score a set of attributes using pre-established PSA tables. Any attribute for which there is insufficient data is automatically assigned the highest risk score: at least some of information is thus needed to demonstrate low risk in the fishery. The Productivity Susceptibility Analysis attributes and score can be seen in Table 1 and Table 2.

Table 2: The PSA-Productivity Attributes and Scores

Productivity determinant	High productivity (Low risk, score=1)	Medium productivity (medium risk, score=2)	Low productivity (high risk, score=3)
Average age at maturity	<5 years	5-15 years	>15 years
Average maximum age	<10 years	10-25 years	>25 years
Fecundity	>20,000 eggs per year	100-20,000 eggs per year	<100 eggs per year
Average maximum size (not to be used when scoring invertebrate species)	<100 cm	100-300 cm	>300 cm
Average size at maturity (not to be used when scoring invertebrate species)	<40 cm	40-200 cm	>200 cm
Reproductive strategy	Broadcast spawner	Demersal egg layer	Live bearer
Trophic Level	<2.75	2.75-3.25	>3.25
Density dependence (to be used when scoring invertebrate only)	Compensatory dynamics at low population size demonstrated or likely	No depensatory or compensatory dynamics at low population size demonstrated or likely	Depensatory dynamics at low population size (Allee effect) demonstrated or likely

Source: Table PF4: PSA productivity attributes and scores. MSC Fisheries certification process v2.2. Pg.71.

Table 3. The PSA-Susceptibility Attributes and Scores

Susceptibility attribute	Low susceptibility (Low risk, score = 1)	Medium susceptibility (medium risk, score = 2)	High susceptibility (high risk, score = 3)
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	<10% overlap	10-30% overlap	>30% overlap

Encounterability: The position of the stock/species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Low overlap with fishing gear (low encounterability).		Medium overlap with fishing gear.		High overlap with fishing gear (high encounterability). Default score for target species (Principle 1).	
Selectivity of gear type: Potential of the gear to retain species	a	Individuals < size at maturity are rarely caught.	a	Individuals < size at maturity are regularly caught.	a	Individuals < size at maturity are frequently caught.
	b	Individuals < size at maturity can escape or avoid gear.	b	Individuals < half the size at maturity can escape or avoid gear.	b	Individuals < half the size at maturity are retained by gear.
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Evidence of majority released post-capture and survival.		Evidence of some released post-capture and survival.		Retained species or majority dead when released. Default score for retained species (Principle 1 or Principle 2).	

Source: Table PF5: PSA susceptibility attributes and scores. MSC Fisheries certification process v2.2. Pg.72.

1.4. Results

Following the methodology of MSC standards, PSA was conducted and results are summarised as below.

Table 4. *Hippocampus kuda*

Performance Indicator	**2.3.1**	
Productivity		
Scoring element (species)	*Hippocampus kuda (spotted seahorse)*	
Attribute	Rationale	Score
Average age at maturity	14 weeks	**1**
Average maximum age	1 to 5 years (from studies conducted in captivity)	**1**

Fecundity	20-1000	**2**
Average maximum size **Not scored for invertebrates**	17cm	**1**
Average size at maturity **Not scored for invertebrates**	14 cm	**1**
Reproductive strategy	Live bearers	**3**
Trophic level	3.6 ±0.5 se; based on size and trophs of closest relatives	**3**
Productivity score		**1.71**
Susceptibility		
Attribute	Rationale	Score
Areal Overlap	The vessels are operating in and around seagrass areas (as evident from seagrass bycatch on the gill nets) and therefore there is overlap with seahorse habitat; however, the enumerators who collect data on non-target species reports that sea horse is a rare in the catch maybe one or two in a month. According to Fishbase, the area of *H. kuda* is 20 km from shore and the gill net fishers who use small boats fish within 15 km from shore. Therefore, areal overlap is high.	**3**
Encounterability	Seahorses are found in the catch, though not targeted and according to animaldiversity.org., the depth at which *H. kuda* is found is 0-8 m. Fishing happens at 4.8-9 mt and therefore assuming medium encounterability	**2**
Selectivity of gear type	Individual half the size of maturity may not be able to escape the gear, but according to fishers, the sea horse is not found caught in the gill net but is attached to the sea grass that gets caught in the net. Seahorse might attach to the net as a holdfast and get entangled while net is retrieved. Assuming medium risk	**2**
Post capture mortality	Sea horses fetch good price if available, though fishers do not target them. Therefore, post capture mortality is 100%	**3**
Susceptibility score		**1.88**
Overall PSA score		**2.54**
MSC score		**83**
Performance Indicator	**2.3.1**	
Productivity		

Table 5. *Hippocampus trimaculatus*

Performance Indicator	**2.3.1**	
Productivity		
Scoring element (species)	*Hippocampus trimaculatus* (Flat-faced/longnose seahorse)	
Attribute	Rationale	Rationale
Average age at maturity	14 weeks based on studies on similar species *H. kuda*	**1**
Average maximum age	3 years	**1**
Fecundity	1783	**2**
Average maximum size **Not scored for invertebrates**	22 cm	**1**
Average size at maturity **Not scored for invertebrates**	14 cm	**1**
Reproductive strategy	Live bearers	**3**
Trophic level	3.8 ±0.50 se; based on food items.	**3**
Productivity score		**1.71**
Susceptibility		
Attribute	Rationale	Score
Areal Overlap	The vessels are operating in and around seagrass areas (as evident from seagrass bycatch on the gill nets) and therefore it can be assumed that there is overlap with seahorse habitat; however, the enumerators who collect data on non-target species reports that seahorse is rare in the catch maybe one or two in a month. Fishing of BSC is takes place within 15km from the shore by the traditional sector, that is within the sea grass area, hence a clear overlap exits.	**3**
Encounterability	Found at 10 m depth up to a maximum of 100 m. whereas fishing happens at a depth of 4.8-9 mts. Low encounterability	**1**
Selectivity of gear type	Individual half the size of maturity may not be able to escape the gear, but according to fishers, the sea horse is not found caught in the gill net but is attached to the sea grass that gets caught in the net. Seahorse might attach to the net as a holdfast and get entangled while net is retrieved. Assuming medium risk	**2**

Post capture mortality	Sea horses fetch good price if available, though fishers do not target them. Therefore, post capture mortality is 100%	**3**
Susceptibility score		**1.43**
Overall PSA score		**2.23**
MSC score		**91**

Table 6. *Dugong dugon*

Performance Indicator	**2.3.1**	
Productivity		
Scoring element (species)	*Dugong dugon* (Dugong)	
Attribute	Rationale	Score
Average age at maturity	9-12 years reported in Australia (Marsh 1980) but 20 years in Thailand (Cherdsukjai et al. 2020)	**3**
Average maximum age	35 years reported in Australia from aging tusks, some suggest as much as 60 years	**3**
Fecundity	The females have one calf which they nurse for ~1.5 years	**3**
Average maximum size **Not scored for invertebrates**	1-3 m	**2**
Average size at maturity **Not scored for invertebrates**	0.4-2 m	**2**
Reproductive strategy	Live birth	**3**
Trophic level	Herbivore	**1**
Productivity score		**2.43**
Susceptibility		
Attribute	Rationale	Score
Areal Overlap	The fishing nets (linked craft and gears) should not be deploying the nets in seagrass areas and therefore should not overlap with dugong habitat; however, it appears that this might not be the situation in practice. The demarcation of Dugong reserve by Government and its strict implementation might reduce overlap. Also, the FIP has reported live release incidences by fishers. Currently, assuming medium overlap.	**2**

Encounterability	Such a large, slow-moving animal in shallow water would not be able to avoid encountering a gill net. But according to fishers, they are rarely encountered in gill nets. Assuming medium encounterability	**2**
Selectivity of gear type	The mesh size is small compared to the size of dugong and may catch any size of dugong.	**3**
Post capture mortality	Unclear. We have evidence that one was released, and presumably a dugong in the gill net would be noticed immediately. Assume that some are released, but we cannot say if it is the majority.	**2**
Susceptibility score		**1.58**
Overall PSA score		**2.89**
MSC score		**71**

Table 7. *Holothuria scabra*

Performance Indicator	**2.3.1**	
Productivity		
Scoring element (species)	*Holothuria scabra* (sand fish)	
Attribute	Rationale	Score
Average age at maturity	2 years (PhD Thesis)	**1**
Average maximum age	10 years (PhD thesis)	**2**
Fecundity	1004160	**1**
Average maximum size **Not scored for invertebrates**	Not scored	
Average size at maturity **Not scored for invertebrates**	Not scored	
Reproductive strategy	Broadcast spawner	**1**
Trophic level	2.2-2.79	**1**
Density dependence **Invertebrates only**	Might exhibit allee effect, based on studies on similar species	**3**
Productivity score		**1.20**
Susceptibility		

Attribute	Rationale	Score
Areal Overlap	*H.scabra* is intertidal and the gill nets operate close to the shore at a distance of 8-13 mile. Therefore, areal overlap with the fishery is possible.	**3**
Encounterability	The fishery happens at a depth of 4-8.9 mt and the species is found at 0-10 m depth. Encounterability is high.	**3**
Selectivity of gear type	Individuals half the size of maturity can be retained by the gear.	**3**
Post capture mortality	*H.scabra* can be sold and post capture mortality is high	**3**
Susceptibility score		**3**
Overall PSA score		**3.35**
MSC score		**52**

Table 8. *Chiloscyllium indicum*

Performance Indicator	**2.3.1**	
Productivity		
Scoring element (species)	*Chiloscyllium indicum* (Slender Bamboo shark)	
Attribute	Rationale	Score
Average age at maturity	11 years	**3**
Average maximum age	14 years	**3**
Fecundity	Fecundity assumed to be <100	**3**
Average maximum size **Not scored for invertebrates**	65 cm	**2**
Average size at maturity **Not scored for invertebrates**	males maturing at 39 and 42 cm TL and females at 43 cm TL	**2**
Reproductive strategy	Nonguarders open water/substratum egg scatterers	**3**
Trophic level	4.0 ±0.60 se; based on food items.	**1**
Productivity score		**2.43**
Susceptibility		

Attribute	Rationale	Score
Areal Overlap	The bamboo shark is an inshore species and as the fishery is inshore, there is possible areal overlap with the habitat. Based on fisher observation of the bamboo shark found to occur in very less numbers, it is assumed that there is medium overlap.	**2**
Encounterability	Moderate to high vulnerability (46 of 100). (fishbase)	**3**
Selectivity of gear type	Individuals half the age of maturity has a high chance of being retained by the gear	**3**
Post capture mortality	Retained species are dead	**3**
Susceptibility score		**2.33**
Overall PSA score		**3.36**
MSC score		**52**

Table 9. MSC RBF Worksheet (PI 2.3.1 PSA) of ETP species of the BSC fishery in Palk Bay, TN

					Productivity Scores [1-3]																
Scoring element	Family name	Scientific name	Common name	Species type	Average age at maturity	Average max age	Fecundity	Average max size	Average size at maturity	Reproductive strategy	Trophic level	Density dependance	Total Productivity (average)	Availability	Encounterability				PSA	MSC PS score	Risk Cat	MSC scoring guidepost
1	Syngnathidae	Hippocampus kuda	Spotted seahorse	Non-invertebrate	1	1	2	1	1	3	3		1.71	3	2	2	3	1.88	2.54	83	Low	≥80
2	Syngnathidae	Hippocampus trimaculati	Flat faced seahorse	Non-invertebrate	1	1	2	1	1	3	3		1.71	3	1	2	3	1.43	2.23	91	Low	≥80
3	Dugongidae	Dugong dugon	Dugong	Non-invertebrate	3	3	3	2	2	3	1		2.43	2	2	3	2	1.58	2.89	71	Med	60-79
4	Holothuriidae	Holothuria scabra	sand fish	Invertebrate	1	2	1			1	1	3	1.50	3	3	3	3	3.00	3.35	52	High	<60
5	Hemiscyllidae	Chiloscyllium indi	Slender Bamboo shark	Non-invertebrate	3	3	3	2	2	3	1		2.43	2	3	3	3	2.33	3.36	52	High	<60

1.5. Conclusion and recommendation

Based on the available data and information collected form the field and subsequent analysis, out of the five ETP species, two of the seahorse species were found to be of low risk from the fishery. The sea cow, *Dugong dugon*, was found to be at medium risk and the Sea cucumber, *H.scabra* and Bamboo shark, *C. indicum* were at high risk from the fishery.

The Wildlife Institute of India and Tamil Nadu Forest Department has developed an Integrated Management plan for the development of Gulf of Mannar Marine National Park and Biosphere reserve (2018-2027) with contributions from scientists from various organizations. It is under this plan the present Dugong conservation reserve is established. The establishment of Dugong reserve in Palk Bay is at an early stage and it is expected to improve the conservation of Dugong and other species in the region considerably, and the proposed reserve will act as a breeding ground for marine fauna of Palk Bay.

The present analysis can be improved with more data on interactions and therefore it would be imperative to the fishery to collect data and collaborate with NGOs and Governmental bodies working in the area for conservation. The fishery could also try to create awareness on the endangered status of the above-mentioned species among the fishers and devise methods with which they can be released live with some incentive programs.

1.6. References

- Anderson, S. C., Flemming, J. M., Watson, R., and Lotze, H. K. (2011). Serial exploitation of global sea cucumber fisheries. *Fish Fish.* 12, 317–339. doi: 10.1111/j.1467-2979.2010.00397.
- Anonymous, 2018. Integrated Management Plan of the Gulf of Mannar Marine National Park and Biosphere Reserve (2018-2027). Tamil Nadu Forest Department, Chennai and Wildlife Institute of India, Dehradun. Published by the Wildlife Warden, Ramanathapuram. 490 pp.
- Baskar B K., 1993. Studies on the Biology, Ecology and Fishery of the Sea Cucumber *Holothuria scabra* from South East coast of India. Cochin University of Science and Technology. PhD Thesis.
- Ignatius B & Joseph S. 2017. Hippocampus trimaculatus. Species profile. In. Ranjan, Ritesh and Muktha, M and Ghosh, Shubhadeep and Gopalakrishnan, A and Gopakumar, G and Imelda, Joseph (2017) *Prioritized Species for Mariculture in India.* ICAR-Central Marine Fisheries Research Institute, Kochi. ISBN 978-93-82263-14-2
- Jeyaraj A J, Sivakumar K et al., 2023. India's first Dugong Conservation Reserve notified in Palk Bay Tamil Nadu: bringing hope for extinction-prone Dugongs. Sirenews. Newsletter of the IUCN Sirenia Specialist Group via ResearchGate. https://www.researchgate.net/publication/370561039
- Murugan, S. Dhanya, A.B. Sarcar, V. Naganathan, S. Rajagopal & T. Balasubramanian. 2011. Fishery biology, demography of three spotted seahorse, *Hippocampus trimaculatus* inhabiting gulf of Mannar region, southeast coast of India. Indian Journal of Geo Marine Sciences Vol. 40(3), June 2011, pp. 411-423. https://www.researchgate.net/publication/281978035
- https://fishbase.mnhn.fr/summary/Chiloscyllium-indicum
- https://www.sharkwater.com/shark-database/sharks/slender-bamboo-shark/
- https://eol.org/pages/62690735
- https://www.sealifebase.ca/Ecology/FishEcologySummary.php?StockCode=106&GenusName=Holothuria&SpeciesName=scabra
- https://www.fishbase.se/summary/hippocampus-kuda
- https://animaldiversity.org/accounts/Hippocampus_kuda/
- https://www.inaturalist.org/projects/iseahorse/assessments/493-hippocampus-trimaculatus
- https://www.fishbase.se/summary/Hippocampus-trimaculatus.html

- Sivakumar, K. & Nair, A. (2013). Dugong distribution, Habitat, and Risks due to Fisheries and otheranthropogenic activities in India. Wildlife Institute of India-Technical Report, 74 *(1) (PDF) INDIA'S FIRST DUGONG CONSERVATION RESERVE NOTIFIED IN PALK BAY, TAMIL NADU: BRINGING HOPE FOR EXTINCTION-PRONE DUGONGS*. Available from: https://www.researchgate.net/publication/370561039_INDIA'S_FIRST_DUGONG_CONSERVATION_RESERVE_NOTIFIED_IN_PALK_BAY_TAMIL_NADU_BRINGING_HOPE_FOR_EXTINCTION-PRONE_DUGONGS [accessed Nov 29 2023].
- Uthicke, S., Schaffelke, B., and Byrne, M. (2009). A boom–bust phylum ecological and evolutionary consequences of density variations in echinoderms. *Ecol. Monogr.* 79, 3–24. doi: 10.1890/07-2136.1
- Wolfe, K., and Byrne, M. (2017). Population biology and recruitment of a vulnerable sea cucumber, *Stichopus herrmanni*, on a protected reef. *Mar. Ecol.* 38:e12397. doi: 10.1111/maec.12397