



Non Target Species Report 2017

The Palk Bay Blue Swimming Crab Fishery

A sub project of the Sri Lankan blue swimming crab fishery improvement project



Field Report

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researched & written by
pelagikos pvt ltd

on behalf of
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Executive Summary

To understand the impact of Blue Swimming Crab fishery on Non target species series of studies have been done in related to Gulf of Mannar and Palk Bay fishery in Sri Lanka. Five studies were done in Palk Bay fishery from January 2015 to March 2017 by covering five major BSC landing centres known as Pesalei, Irainamadanagar, Talimannar, Delft Island and Pallikuda

Total number of 535 (7.77 mt) catches were recorded and 30.5% (2.36mt) from total catch were other captured species. A total of 121 NTS were provisionally identified in the Palk Bay fishery using the FAO UN Species Identification for Fisheries Purposes Fish Key, posters for Sri Lankan marine molluscs, reference books and the internet. 65 of the NTS identified were finfish. The next most common class of NTS were molluscs (22), crustaceans (19), echinoderms and others (15) and no reptiles (Annex A) . No birds or mammals were observed in the catch of 535 BSC fishermen assessed at five landing centres between January 2015 and March 2017.

One ETP species (according to Appendix 1 of the Convention on International Trade in Endangered Species (CITES)) were recorded from Palk Bay fishery and it was observed below a negligible and or sporadic level ($\geq 0.5\%$ of the TC). No Out of Scope species were recorded and no turtles, seabirds or dugongs were recorded in the study period. One primary species was recorded and the percentage weight from total catch does not exceed more than 2% (for less resilient species) or 5% (for resilient species) based on MSC guidelines for resilience. There were no Secondary Main species were recorded which was weight percentage more than 5% from total catch. All the main species were analysed by using the PSA method described in Marine Stewardship Council (MSC) 2014



A. Non Target Species Studies in the Palk Bay Fishery

The BSC fishery in the Palk Bay is a coastal, near shore day fishery. Small scale fishermen use bottom-set crab nets with mesh sizes ranging from 3½” to 6” (88.9 mm - 152.4 mm). The maximum height of the stretched net is 4 ft (1.22 m or half a full net piece), but in the water the net is set with a reduced number of floats to billow with the current, reducing net actual set net height to closer to 2ft – 2½ft. The number of net sets and length of nets set varies depending on vessel type, from 0.5 and 1.5 km per net (REF). Bottom-set crab nets set in the evening (≈ 5pm) and hauled the next morning (≈6 am) at a distance of ≈2 to ≈15 km from the shore (REF), using non-motorised and motorised traditional and fibre-reinforced (FRP) boats. Three districts in the Northern Province, namely Jaffna, Kilinochchi and the northern coast of Mannar encircle the Palk Bay (see map below).

According to a field survey conducted by the Department of Fisheries and Aquatic Resources (DFAR) in 2015 (DFAR 2015), a total of over 13,959 fishermen from the 77 fish landing sites were reportedly targeting BSC either on a full time or part time basis (see Table 1). Sri Lanka’s leading crab manufacturing company Taprobane Seafood Pvt Ltd, the BSC fishery in the Palk Bay provides the lion share of raw materials sourced by the company from both fisheries. Between January 2013 and September 2016, the TSF sourced 83% of its raw materials from the Palk Bay fishery. It should be noted here that TSF’s data includes raw material caught by fishermen harvesting BSC from the south side of Mannar District, *i.e.*, from the Gulf of Mannar fishery.

Table 1 Overview of the BSC fishery in the Palk Bay¹

District	Fishery Inspector Divisions	Landing Sites	Resident		Migrant	
			Fulltime	Part-time	Fulltime	Part-time
Mannar	04	17	4,936	2,080	425	231
Kilinochchi	02	05	1,013	77		
Jaffna	07	19	8,010	225	20	
Total	13	41	13,959	2,382	445	231

¹ Technical report on Survey of Fishing Effort for Sri Lankan Blue Swimming Crab in the Northwest and Northern Coast of Sri Lanka and Development of a Management Plan. 2015. DFAR, New Secretariat, Maligawatte, Colombo 10, Sri Lanka

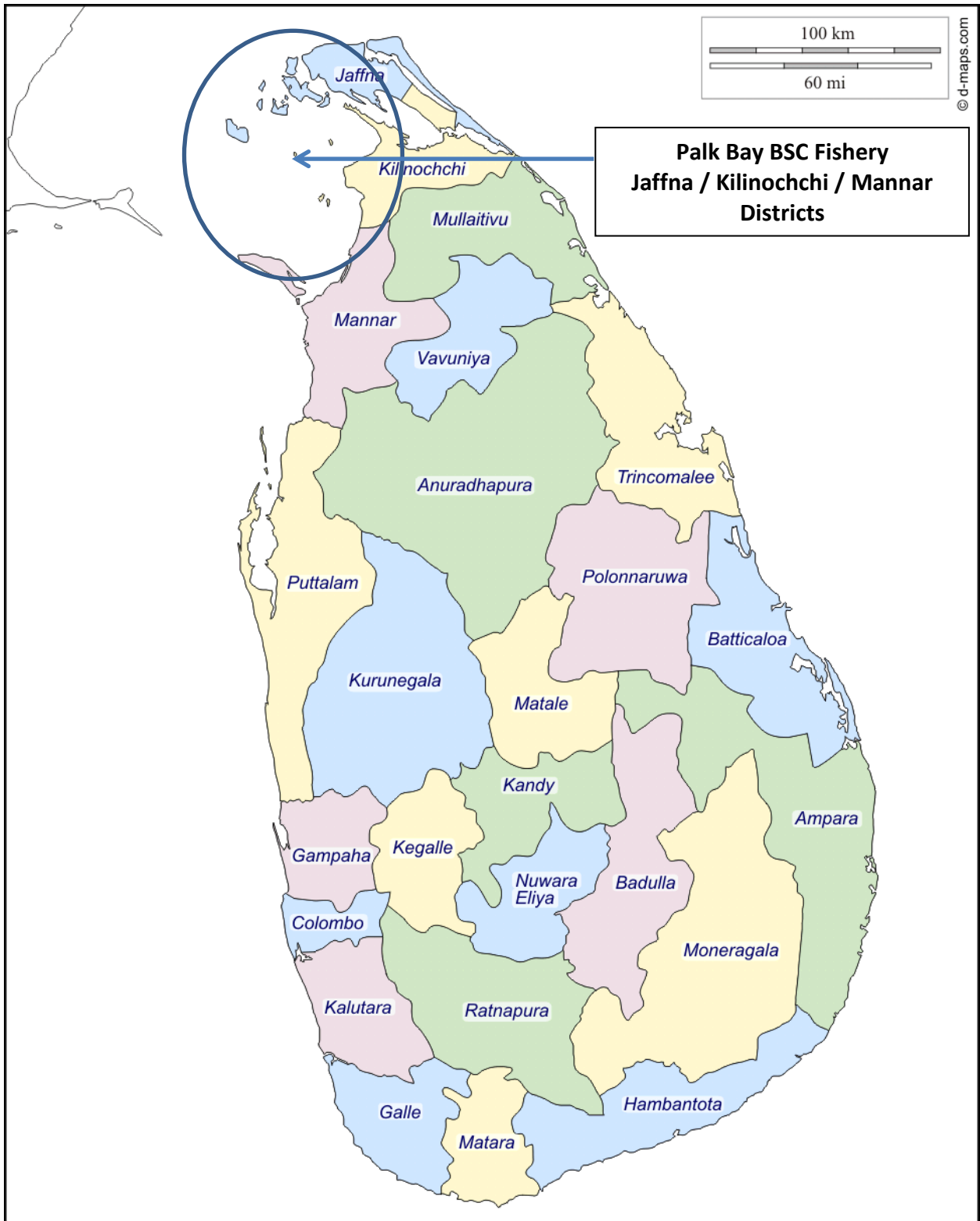


Figure 1: Blue Swimming Crab Fishing area of Palk Bay



Field Surveys

To better understand the impact of BSC fishing on NTS in the Palk Bay fishery a series of non-target species (NTS) studies were designed and implemented with assistance from the FIP over period 20 months between June 2015 and March 2017. Scientific studies to better understand the impact of the BSC fishing on NTS in the Palk Bay were initiated by the SLBSC FIP in collaboration with Faculty Animal Science and Export Agriculture², at the UWU in 2015.

Wathsala Dolawaththa a final year undergraduate student in the Department of Animal Science (Aquatic Resources Technology) completed the first study of NTS caught together with BSC in the fishery at Pesalai, Mannar District in the Palk Bay between May and December 2015. Wathsala used a simple alphanumeric field key and photographs to record each NTS. Each NTS was then provisionally identified to species level using the FAO UN Species Identification Guide for Fishery Purposes³, posters for Sri Lankan marine molluscs, reference books and the internet.

The number and aggregate weight of each NTS in each BSC fishermen's catch was recorded using a quantitative field data sheet. Wathsala submitted his dissertation in March 2016. He was supervised by Dr. Sepalika Jayamanne, Dean Faculty Animal Science and Export Agriculture⁴.

Further studies to better understand the impact of the BSC fishing on NTS in the Palk Bay recommenced in October 2016 after Eranga Gunasekera joined the FIP as a Research Assistant, following the successful completion of her undergraduate studies at Ocean University. Eranga conducted a four more field studies to assess the impact of the BSC fishing on NTS in the Palk Bay, at landing centres in Kilinochchi (twice), Jaffna (once) and again in Mannar District (see Table 2). The most recent scientific study to better understand the impact of the BSC fishing on NTS in the Palk Bay was completed in March 2017.

Table 2 NTS Studies completed in the Palk Bay 2015 - 2017

Survey	Lead Researcher	Institution	District	Landing Centre	Mesh Size
JUN – AUG 2015	W. Dolawaththa	UWU	Mannar	1. Pesalai	4½" & 5"
Oct 2016	E. Gunasekera	FIP	Kilinochchi	2. Irainamadanagar	4½"
Nov 2016	E. Gunasekera	FIP	Mannar	3. Talaimannar	5" & 6"
DEC 2016– JAN 2017	E. Gunasekera	FIP	Jaffna	4. Delft Island	5" & 6"
MAR 2017	E. Gunasekera	FIP	Kilinochchi	5. Pallikuda	4½"

² <http://www.uwu.ac.lk/academic/faculties/animal-science-and-export-agriculture/>

³ <http://www.fao.org/docrep/t0726e/t0726e00.htm>

⁴ sepalikauwu@yahoo.com



B. Non-Target Species Survey Results

Catch Data

A summary of the catch landed by fishermen targeting BSC at five landing centres in the Palk Bay is presented in Table 3. NTS caught along with BSC at five landing centres in the Palk Bay was studied over a period of 37 days. A total of 535 catches landed by BSC fishermen were assessed. On average 14.5 catches were assessed every day.

The total catch (TC) landed by 535 fishermen was 7.77 mt. The lowest total catch was landed at Delft Island in Jaffna District, where fishermen only fish two days per week and the sampling period coincided with rough weather and the 'ray fishing season'. BSC comprised 69.5% of the TC (5.40 mt), ranging from 80.6% in Taliamannar (Mannar District) to 54.5% in Pesalai (Mannar District).

NTS comprised 30.5% of the TC (2.36 mt), ranging from 19.4% in Taliamannar (Mannar District) to 45.5% in Pesalai (Mannar District). 15.8% of the TC (1.23 mt) was discarded. The balance NTS (14.6% / 1.13 mt) was retained. For the fishery overall 6,537.81 mt of the catch landed by fishermen was retained (*i.e.*, BSC + Retained NTS), equivalent to 84.1% TC.

The average TC for small scale BSC fishermen in the Palk Bay was 14.52 kg, ranging from 6.45 on Delft Island (Jaffna District) to 20.94 kg at Irainamathanagar (Kilinochchi District). The average BSC catch was 10.10 kg per day, with NTS comprising the balance 4.42 kg. The average bycatch from the BSC fishery in the Palk Bay was 2.30 kg per boat, per day.



Table 3 A summary of the catch landed by fishermen targeting BSC at five landing centres in the Palk Bay

District	03	Mannar		Kilinochchi		Mannar		Jaffna		Kilinochchi		
Field Study	05	PES - 1		IMNR - 2		TALAI - 3		DELFT - 4		PALA - 5		
Landing Centres	5											
No. Days	37	11	30%	12	32%	5	14%	4	11%	5	14%	
No. Samples / Net Sets	535	99	19%	150	28%	151	28%	77	14%	58	11%	
Av. Samples / day	14.5	9		12.5		30.2		19.3		11.6		
Total Catch	7,769.13	1,842.87		3,140.84		1,542.53		496.96		745.92		
Total BSC Catch	5,401.56	69.5%	1,005.01	54.5%	2,247.00	71.5%	1,243.45	80.6%	301.00	60.6%	605.1	81.51%
Total NTS Catch	2,367.57	30.5%	837.86	45.5%	893.84	28.5%	299.08	19.4%	195.96	39.4%	140.827	18.88%
Discarded NTS	1,231.31	15.9%	291.89	15.8%	655.30	20.9%	145.09	9.4%	40.09	8.1%	98.954	13.33%
Retained NTS	1,136.25	14.6%	545.97	29.6%	238.54	7.6%	154.00	10.0%	155.87	31.4%	41.873	5.61%
Average TC	14.52	18.61		20.94		10.22		6.45		12.86		
Av. BSC	10.10	10.15		14.98		8.23		3.91		10.43		
Av. NTS	4.42	8.46		5.96		1.98		2.54		2.43		
Av. Bycatch	2.30	2.95		4.37		0.96		0.52		1.71		
Av. Retained	2.12	5.51		1.59		1.02		2.02		0.72		



NTS Data

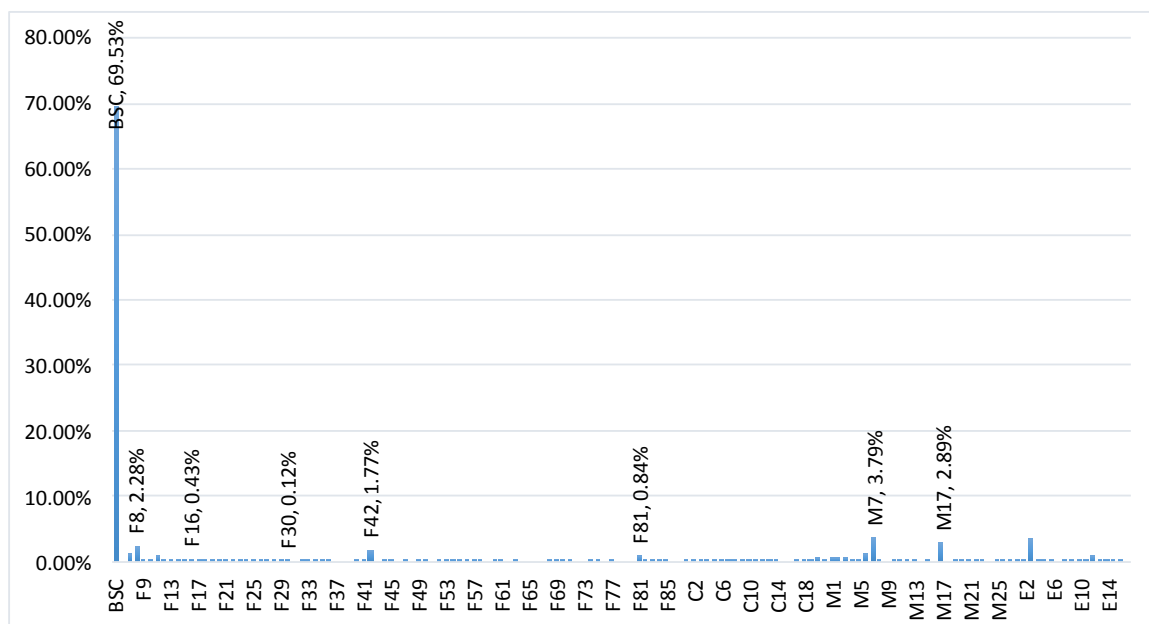
A total of 121 NTS were provisionally identified in the Palk Bay fishery, using the FAO UN Species Identification for Fisheries Purposes Fish Key, posters for Sri Lankan marine molluscs, reference books and the internet (see Table 4). 65 of the NTS identified were finfish. The next most common class of NTS were molluscs (22), crustaceans (19), echinoderms and others (16). No reptiles, birds or mammals were observed in the catch of 535 BSC fishermen assessed at five landing centres between June 2015 and March 2017.

Table 4 Summary of the NTS recorded from 535 BSC catches sampled in the Palk Bay

Class	No.	Category of Non Target Species			
		ETP	Out of Scope	Primary	Secondary
Finfish	65	01	00	00	64
Crustaceans	19	00	00	01	18
Molluscs	22	00	00	00	22
Echinoderms ⁵ +	15	00	00	00	15
Reptiles	00	00	00	00	00
Birds	00	00	00	00	00
Mammals	00	00	00	00	00
Totals	121	01	00	01	119

Figures 1 and 2 show the number and weight of each NTS observed in the bycatch from the BSC fishery in the Palk Bay.

Figure 2 Weight (kg) of each NTS observed in the bycatch from the BSC fishery in the Palk Bay



⁵ Includes sea urchins, starfish, brittlestars, sea anemones, sea cucumbers, featherstars and jelly fish

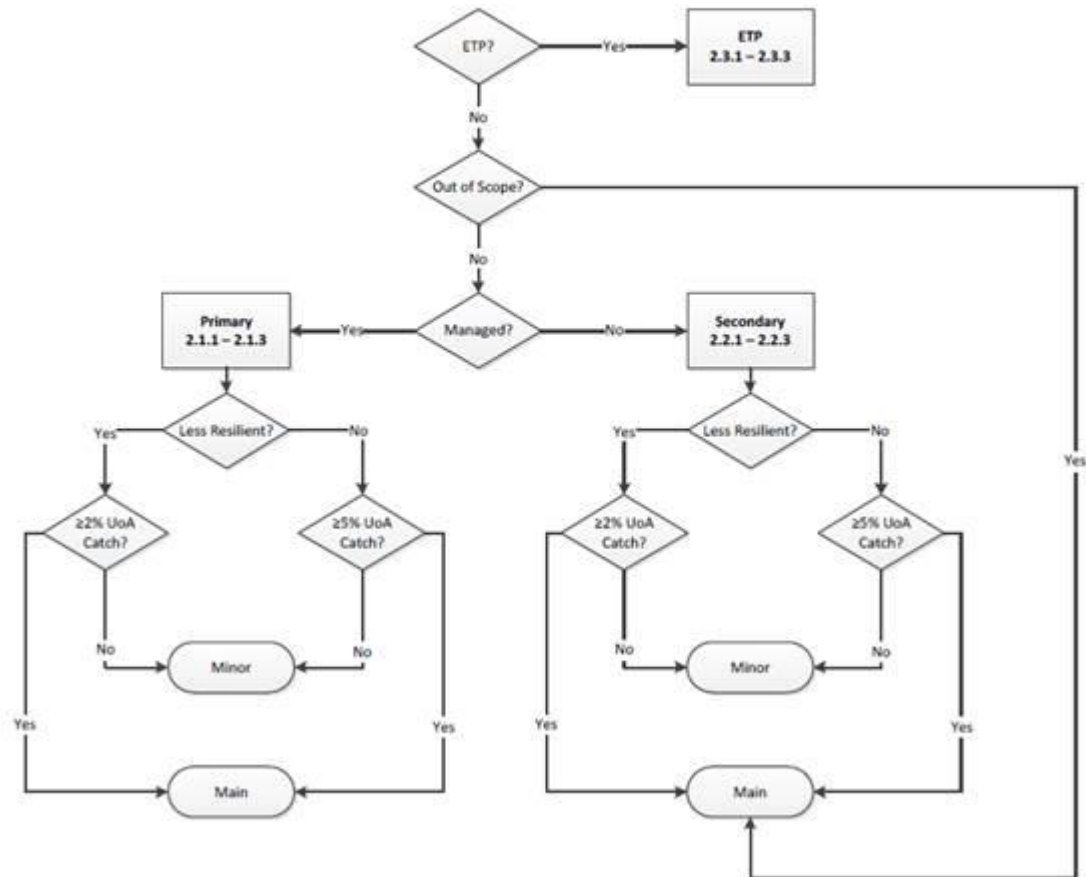


C. Non Target Species Analysis

Data were analysed by using the Marine Stewardship Council's (MSC) Fishery Assessment Methodology - Principle 2 (Ecological Impacts of a Fishery). Endangered, Threatened and Protected (ETP) species, Out of Scope species, Primary and Secondary non-target species were identified in accordance with MSC guidelines (MSC, 2014). Thereafter NTS under each category (i.e., ETP, Out of Scope, Primary Major / Minor and Secondary Major / Minor) were analysed according to MSC Principle 2 decision tree for 'Main' and 'Minor' species (Figure 1)

The decision tree outlined in [Figure GSA4](#) provides an overview of the intent of the separation between primary, secondary and ETP species. Teams may use the decision tree as a guide on the designation of P2 species, but should primarily be guided by the definitions of 'primary', 'secondary', 'ETP' and 'less resilient' in the FCR and GFCR.

Figure GSA4: Decision tree to assist teams in the designation of P2 species components





ETP Non Target Species

Definition: Species that are recognised by national ETP legislation (MSCP2, SA3.1.5.1) and species listed in following binding international agreements (MSCP2, SA3.1.5.2)

- Species that are recognised by national ETP legislation;
- Species listed in the binding international agreements given below:
 - a. Appendix 1 of the Convention on International Trade in Endangered Species (CITES), unless it can be shown that the particular stock of the CITES listed species impacted by the UoA under assessment is not endangered.
 - b. Binding agreements concluded under the Convention on Migratory Species (CMS), including:
 - i. Annex 1 of the Agreement on Conservation of Albatross and Petrels (ACAP);
 - ii. Table 1 Column A of the African-Eurasian Migratory Waterbird Agreement (AEWA);
 - iii. Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS);
 - iv. Annex 1, Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS);
 - v. Wadden Sea Seals Agreement;
 - vi. Any other binding agreements that list relevant ETP species concluded under this Convention

ETP in the Bycatch of the Palk Bay Fishery							
SLN	Other Capture Species	Conservation Status	No.	Per Catch	Total (kg)	% Total Catch	Status
F69	Hedgehog seahorse	CITES	1	0.00	0.01	0.00%	Main

01 endangered species were identified in the bycatch from the Palk Bay fishery (see below) according to Appendix 1 of the Convention on International Trade in Endangered Species (CITES). It was Hedgehog seahorse and it observed below a *negligible and or sporadic* level ($\geq 0.5\%$ of the TC) and therefore deemed likely to significantly contribute to a conservation concern.



Out of Scope Species

Definition: Amphibians, reptiles, birds and mammals that are not listed in the IUCN Red List as Near Threatened (NT) , Vulnerable (VU), Endangered (EN) or Critically Endangered (CE) (MSC P2,SA3.1.5.3)

Marine Reptiles: No marine reptiles were observed in the bycatch of the BSC fishery in the Palk Bay (see Annex A). Six turtle species are commonly found in Sri Lankan waters (see Annex C). No turtles were observed in the catch landed by 535 BSC fishermen at five landing centres in the Palk Bay fishery between January 2015 and March 2017 (37 days).

Seabirds: No seabirds were observed in the bycatch of the BSC fishery in the Palk Bay Fishery

Marine Mammals: No dugongs (*dugong dugon*) were observed in the catch landed by 535 BSC fishermen at five landing centres in the Palk Bay fishery, conducted between January 2015 and March 2017 (37 days)

Primary Non Target Species

Species where management tools and measures are in place, intended to achieve stock management objectives reflected in either limit or target reference points (MSC P2, SA3.1.3.3)

The only one species which has management tools and measures in the bycatch of the Palk Bay is Spiny legged lobster(Liyanage and Long,2009; www.intrafish.com) and the percentage weight of the Spiny legged lobster from total catch does not exceed more than 2% (for less resilient species) or 5% (for resilient species) based on MSC guidelines for resilience.

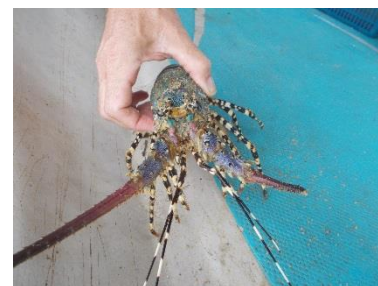
Low reproductive rate (Dayton *et al.*, 1995), life history traits such as late or moderate age of maturity, low fecundity and slow growth rate are the characters of species with low resilience for fishing mortality (e.g. Most Shark species, Rock fish, some rays). Low resilience to fishing implies that these species are more susceptible to overfishing (Barker and Schluessel, 2004).

The Productivity analysis for Longlegged spiny Lobster was done according to the MSC guidelines.

Long-legged spiny lobster (C19)

SLBSC FIP Species Code	C19					
Species Name	Longlegged spiny lobster					
Scientific Name	<i>Panulirus longipes</i>					
Local Names	Pokirissa (S), Singi (T)					
Conservation Concern	Least Concern					
NTS Status	Primary Minor					
Justification	<i>Panulirus longipes</i> is a Least Concerned species and there are management measure in place for the species in Sri Lanka. <i>Panulirus longipes</i> was not present above 5% of the total catch in the Palk Bay fishery					
Non Target Species Survey Results						
Total Catch	C19	C19 (% TC)		No. Catches	C19 (n=)	Per Catch
7,769.13 kg	0.92kg	0.01%		535	2	<0.001

Key Relevant Information: The age at maturity of the *Panulirus longipes* is less than 5years (wikipedia.org) and their life span is 10years (www.spc.int). Spiny lobsters feed on sea snails, clams, crabs, sea urchins,plants (coralline algae) and dead animals(www.spc.int) and the trophic level of lobster is 2.52 (Cortes,1999). Male deposits a sperm packet (spermatophore) on the underside of a female and the female releases many thousands of eggs which are fertilised as they pass over the sperm packet. The fertilized eggs are carried for about a month before they hatch into very small floating forms (the larval stages) (www.spc.int). Usually they carried 8000-10000 eggs (www.spc.int). According to *Chittleborough* *Panulirus longipes* are highly density dependence and have Depensatory dynamics at low population sizes.They are live in clear or slightly turbid water at depths of 1 to 18 m (also reported from 122 m), in





rocky areas and coral reefs. (Froese and Pauly, 2016) Fishermen rarely caught spiny lobsters less than their size of maturity and mostly they are retained.

Productivity -Susceptibility Analysis (PSA)

Score (Low Risk = 1; Medium Risk = 2; High Risk = 3)

Productivity Attributes	Relevant Information	Score
Average age at maturity	(<5yrs)	1
Average maximum age	(10yrs)<10yrs(www.spc.int)	1
Fecundity	(8000-10000eggs)100-20000(www.spc.int)	2
Average maximum size	-	
Average size at maturity	-	
Reproductive strategy	Live bearers(www.spc.int)	3
Trophic level	2.52 (Cortes,1999)	1
Density dependence	<i>Invertebrates only</i>	3
Total Productivity		1.83

Scoring Guidelines Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

According to the Productivity analysis Long-legged Spiny Lobster is highly resilient species and also the weight percentage form total catch is less than 2%. Therefore Long-legged Spiny Lobster is known as primary minor species.

Primary Non Target Species in the Bycatch of the Palk Bay BSC Fishery							
SLN	Non Target Species	No.	Per Catch	Total (kg)	% Total Catch	Resilience	Status
C19	Longlegged spiny lobster	02	0.00	0.92	0.01%	High	Minor

Secondary Non Target Species

Species that comprise a percentage of the weight of the total catch more than 2% (for less resilient species) or 5% (for resilient species) based on MSC guidelines for resilience.

There are only one secondary species with Species that comprise a percentage of the weight of the total catch more than 2% but less than 5%. It was Pale edged sting ray and according to the PSA analysis these species are more susceptible to overfishing

Secondary species in the Bycatch of the Palk Bay Fishery							
SLN	Other Capture Species	Conservation Status	No.	Per Catch	Total (kg)	% Total Catch	Status
F08	Pale-edged stingray	Near Threatened	736	1.38	176.89	2.28%	Main

Pale-edged Stingray (F8)

Scientific Name	<i>Telatrygon (Dasyatis) zugei</i>						
Local Names	Appa maduwa (S), Senthirikka(T)						
Conservation Concern	<i>Near Threatened</i>						
Non Target Species Status	ETP Species						
Justification	<i>Telatrygon (Dasyatis) zugei an ETP species and there is no management in place for the species in Sri Lanka. Telatrygon (Dasyatis) zugei was not present above 5% of the total catch in the Palk Bay fishery</i>						
Non Target Species Survey Results							
Total Catch	F8	F8 %		No. Catches	No. F8	F8 / Catch	
7,769.13Kg	176.89 kg	2.28		535	736	1.38%	

Key relevant information: Benthic and inshore coastal waters are the major habitats of pale-edged stingrays and their maximum size is 20cm (De Bruin et al, 1995). In accordance with the Productivity Analysis, the average age at maturity of the pale-edged stingray of the family Dasyatidae is 3½ years. The average maximum age is around 14 years (Froese and Pauly, 2016). Pale-edged stingray of the family Dasyatidae produce small batches of eggs within which a single young is contained. A maximum number of three eggs are produced per batch (*ibid*). The average maximum size of the pale-edged stingray is 20cm (Froese and Pauly, 2016; De Bruin et al, 1995) and the average size at maturity is around 12cm (*ibid*). Pale-edged stingrays are internal live bearers and their trophic level is 3.3 +/- s.e. 0.26 (*ibid*).





The distribution of Family Dasyatididae mostly can be found in the North and North western coast of Sri Lanka (Froese and Pauly, 2016). They are common down to a depth of 100 m (FAO UN Reference). BSC fishing takes place mainly in depths not more than 3 m. Therefore the availability of Pale-edged stingray is in medium risk. There are high overlap of the *P. pelagicus* fishing gear with Dasyatididae (pale-edged stingray) because pale-edged stingray are benthic and common on inshore substrates, mostly in brackish water (Froese and Pauly, 2016; De Bruin et al, 1995; NARA, 2002)..Size at maturity of the Dasyatididae (Pale-edged stingray) is 12cm (Froese and Pauly, 2016) and NTS which were caught for the gear is around 18-20cm. Medium and large sized pale-edged stingray are salted and dried. Small rays are discarded dead on the beach

Productivity -Susceptibility Analysis (PSA)

Score (Low Risk = 1; Medium Risk = 2; High Risk = 3)

Productivity Attributes	Relevant Information	Score
Average age at maturity	< 5 years (Froese & Pauly, 2016).	1
Average maximum age	< 14 years (Froese & Pauly, 2016)	1
Fecundity	<100 per year (Froese and Pauly, 2016)	3
Average maximum size	<100 cm (20 cm) (Froese & Pauly, 2016; De Bruin et al, 1995)	1
Average size at maturity	<40 cm (18 cm)	1
Reproductive strategy	Live Bears (Froese and Pauly, 2016)	3
Trophic level	> 3.5 (Froese and Pauly, 2016)	3
Density dependence	<i>Invertebrates only</i>	-
Total Productivity		1.86

Scoring Guidelines Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only)

Susceptibility Attributes	Relevant Information	Score
Areal Overlap (Considers all fisheries)	10 – 30% (Gunasekera, 2016)	2
Vertical Overlap (Considers all fisheries)	High overlap due to bottom-set nets (Gunasekera, 2016)	3
Selectivity of Fishery (Specific to fishery under assessment)	The mesh sizes used to catch pale-edged stingrays and BSC ranges from 5" (127 mm) to 6" (152.4 mm). A study of the size of female pale-edged stringays found that the majority of rays caught using large mesh nets were above the size on maturity (pelagikos pvt ltd 2017)	1
Post-capture Mortality (Specific to fishery under assessment)	Large and medium rays are retained for salted, dry fish. Small rays are discarded, dead.	3
Total Susceptibility		1.43

Scoring Guidelines Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: $S = [(s1 * s2 * s3 * s4) - 1/40] + 1$.



Productivity – Susceptibility Analysis (PSA) Score = **2.34**

MSC PSA Derived Score = **88**

Risk Category = **Low Conservation Concern**

MSC Scoring Guidepost = **≥ 80**



D. Main Species Productivity Selectivity Analysis

Following Species was analyzed by using Productivity Selectivity Analysis described in Marine Stewardship Council (MSC) 2014.

Table 7: Main specie sin the Bycatch of Palk Bay

SLN	Other Capture Species	Conservation Status	No.	Per Catch	Total (kg)	% Total Catch	Status
F69	Hedgehog seahorse	CITES	1	0.00	0.01	0.00%	Main

Hedgehog seahorse (F69)

SLBSC FIP Species Code	F69					
Species Name	Hedgehog seahorse					
Scientific Name	<i>H. spinosissimus</i>					
Local Names	Muhudu ashwaya (S)					
Conservation Concern	<i>Endangered</i>					
Non Target Species Status	ETP Species					
Justification	<i>H. spinosissimus</i> an ETP species and there is no management in place for the species in Sri Lanka. <i>H. spinosissimus</i> was not present above 5% of the total catch in the Gulf of Mannar fishery					
Non Target Species Survey Results						
Total Catch	F69	F69%		No. Catches	No. F69	F69/ Catch
13,648.52 Kg	0.00	0.00%		557	01	0.00%

Key Relevant Information: Life span of Hedgehog seahorse is 2.6-3.5yrs and they mature at age of 0.7-1.0 years (Froese and Pauly, 2016). They are live bearers and they give birth to 600-700 young and Male carries the eggs in a brood pouch. (Froese and Pauly, 2016). Maximum size of Hedgehog seahorse is 17.2cm and they mature at 10.4cm. (Froese and Pauly, 2016). They feed on small prey and organic debris and the trophic level is 0.0 (Froese and Pauly, 2016).



The areal distribution of Hedgehog seahorse is Indo-Pacific: Sri Lanka to Taiwan and Australia therefore the areal overlap with the fishery is in low risk. Major habitats of Hedgehog sea horse are continental shelf, on muddy or sandy bottoms and in coral reefs. (Froese and Pauly, 2016). So there are moderate risk to overlap with bottom set crab net. The size of maturity is 10.4cm and fishermen regularly caught sea horses with less than size of maturity and there are very less number of seahorse as a bycatch

Productivity -Susceptibility Analysis (PSA)

Score (Low Risk = 1; Medium Risk = 2; High Risk = 3)

Productivity Attributes	Relevant Information	Score
Average age at maturity	0.7-1.0yrs (Froese and Pauly, 2016)	1
Average maximum age	2.6-3.5yrs (Froese and Pauly, 2016)	1
Fecundity	600-700(Froese and Pauly, 2016)	2
Average maximum size	17.2 cm(Froese and Pauly, 2016)	1
Average size at maturity	10.4cm (Froese and Pauly, 2016)	1
Reproductive strategy	Live bearers (Froese and Pauly, 2016)	3
Trophic level	0.0 (Froese and Pauly, 2016)	1
Density dependence	<i>Invertebrates only</i>	-
Total Productivity		1.43

Scoring Guidelines Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))



Susceptibility Attributes	Relevant Information	Score
Areal overlap (Considers all fisheries)	They are distributed in Indo-Pacific Ocean	2
Vertical overlap (Considers all fisheries)	Major habitats of Hedgehog sea horse are continental shelf, on muddy or sandy bottoms and in coral reefs	2
Selectivity of fishery (Specific to fishery under assessment)	Individual less than size at maturity are regularly caught	2
Post-capture mortality (Specific to fishery under assessment)	Mostly retained for export market	3
Total Susceptibility		1.58

Scoring Guidelines Susceptibility score (S) = product of the susceptibility attribute scores (s_1, s_2, s_3, s_4), rescaled as follows: $S = [(s_1 * s_2 * s_3 * s_4) - 1/40] + 1$.

Productivity – Susceptibility Analysis (PSA) Score = 2.13

MSC PSA Derived Score = 93

Risk Category = Low Conservation Concern

MSC Scoring Guidepost = ≥80



E. Principle 2 Score for the Palk Bay Fishery

Two MAIN SPECIES in the bycatch from the BSC fishery in the Palk Bay were evaluated using the PSA method described in Marine Stewardship Council (MSC) 2014. As information and data on each of the ten MAIN SPECIES is limited, the fishery's potential impacts on each species was scored according using the Productivity - Susceptibility Analysis to generate the Vulnerability (PSA) Score for each species.

The Vulnerability (PSA) was scored according to the PSA method described in Marine Stewardship Council (MSC) 2014. A summary of the evaluation of each MAIN SPECIES is given below

Table 8: Conservation concern for Main Species in the bycatch of the Palk Bay

	Main Species	Justification	Productivity – Susceptibility Analysis			PSA Score	Conservation Concern
			Productivity	Susceptibility	Vulnerability		
F69	Hedgehog seahorse	ETP	1.43	1.58	2.13	93	Low
F08	Pale-edged stingray	2° MAIN	1.86	1.43	2.88	88	Low



F. Unwanted Catch of the Blue Swimming Crab Fishery of Gulf of Mannar

Among 121 total Non-Target Species (weight percentage of 30.5% from the total catch) in Palk Bay Blue Swimming Crab fishery, 104 species were having discarded proportions with the discarded weight percentage of 14.6 % from the total catch).

Non Target Finfish in the Blue Swimming Crab fishery of Palk Bay

Total number of Non-Target Fish species of Palk Bay Fishery was 65 and 51 of them have discarded proportions. Discarded weight percentage of 50 species from total catch were less than 0.5 %(reference point) and discarded weight percentage of one species was higher than 0.5%. The fishing grounds of the Palk Bay are situated in the sea area and mostly the fishermen were set their nets for more than one day in the sea. Therefore some fish which was entangled in the net were consumed by predators and they cannot consume or sell after landing. Therefore some fish in the catch were discarded and rest will retain by consuming, selling or drying. The discarded percentage of the Pale edged Stingray in Palk bay fishery also having high discarded weight percentage which is higher than 0.5% from total catch. As a solution fishermen need to be put rays back to the water as soon as possible or they must target Blue Swimming Carb when they setting their nets.

SLN	Non Target Species	No.	Per ton	Total (kg)	% Total Catch
F08	Pale-edged Stingray	325	23.8	72.76	0.53%

Non Target crustaceans in the Blue Swimming Crab fishery of Palk Bay

Total number of crustacean species in the Palk Bay fishery were 19 and 16 were having discarded proportions and each discarded weight percentages less than 0.5% from total catch. Among them Ridged swimming crab, Bloodspotted crab and Longlegged spiny lobster are mostly retained and some of them were discarded due to their small size. As mentioned earlier in Palk Bay fishery fishermen were set their nets for more than one night and almost clean their net in the sea. During our study period we gave our plastic buckets to fishermen and said to bring all the unwanted things in the catch to examine. Otherwise they threw back all the unwanted crustaceans in live.

Non Target Molluscs in the Blue Swimming Crab fishery of Palk Bay

Total number of Mollusc species in the Palk Bay fishery were 22 and all of them were having discarded proportions. Among those 22, 20 species having each discarded weight percentage less than 0.5% of and only two species have higher than 0.5% of discarded weight percentage. Cuttle fish, Indian chank, Octopus spp, are mostly retained and other molluscs are mostly discarded. Murex (mostly from Pesalei) and spider conch (Mostly from Iranamadanagar) are the only species which having high weight percentage of discards with higher than 0.5%. Palk Bay fishery fishermen were set their nets for more than one night and almost clean their net in the sea. During our study period we gave our plastic buckets to fishermen and said to bring all the



unwanted things in the catch to examine. Otherwise they threw back all the unwanted molluscs in live.

SLN	Non Target Species	No.	Per ton	Total (kg)	% Total Catch
M6	Murex	2273	166.5	95.41	0.70%
M17	Spider conch	888	65.1	208.53	1.53%

Non Target Echinoderms in the Blue Swimming Crab fishery of Palk Bay

There were 15 species of Non-Target echinoderm species in the Palk Bay Fishery and all of them are mostly discarded. Chocolate chip sea star fish was the only one Echinoderm species which was had discarded weight percentage higher than 0.5% (Highly recorded from Iranamadanagar and Pallikuda landing sites). Those star fish also brought because of our study and otherwise they throw back all the unwanted things in live.

SLN	Non Target Species	No.	Per ton	Total (kg)	% Total Catch
E03	Chocolate chip sea star	1134	83.1	260.60	1.91%



Annex A

Non Target Species in the Bycatch of the Palk Bay Fishery

SLN	Non Target Species List	Non Target Species								
		No	/catch	Total (Kg)	% of TC	ETP?	OoS?	1° Main?	2° Main?	Note
	Finfish									
F1	Spiny Flathead	278	0.52	90.67	1.17%	No	No	No	No	<2.0%
F2	Goatee croaker	375	0.70	33.22	0.43%	No	No	No	No	<2.0%
F3	Largetooth flounder	26	0.05	4.65	0.06%	No	No	No	No	<2.0%
F4	Bengal tonguesole	78	0.15	21.62	0.28%	No	No	No	No	<2.0%
F5	Coastal trevally	181	0.34	20.14	0.26%	No	No	No	No	<2.0%
F6	Silver silago	224	0.42	18.30	0.24%	No	No	No	No	<2.0%
F7	Talang Queenfish	40	0.07	11.31	0.15%	No	No	No	No	<2.0%
F8	Pale-edged stingray	736	1.38	176.89	2.28%	No	No	No	No	<5.0%
F9	Largescale tonguesole	37	0.07	6.21	0.08%	No	No	No	No	<2.0%
F10	Scorpion fish	128	0.24	20.56	0.26%	No	No	No	No	<2.0%
F11	Spotted catfish	339	0.63	76.69	0.99%	No	No	No	No	<2.0%
F12	Splendid Pony fish	63	0.12	2.03	0.03%	No	No	No	No	<2.0%
F13	Striped Goat fish	142	0.27	12.49	0.16%	No	No	No	No	<2.0%
F14	Painted sweetlips	28	0.05	15.28	0.20%	No	No	No	No	<2.0%
F15	Black blotch emperor	75	0.14	17.27	0.22%	No	No	No	No	<2.0%
F16	Boxfish	225	0.42	33.07	0.43%	No	No	No	No	<2.0%
F17	Deepbody silverbidy	102	0.19	7.28	0.09%	No	No	No	No	<2.0%
F18	Jarboa terapon	198	0.37	6.46	0.08%	No	No	No	No	<2.0%
F19	Puffer fish	12	0.02	3.74	0.05%	No	No	No	No	<2.0%
F20	Kelee shad	124	0.23	12.09	0.16%	No	No	No	No	<2.0%
F21	Bluetail mullet	16	0.03	5.47	0.07%	No	No	No	No	<2.0%



SLN Non Target Species List

		Non Target Species								
		No	/catch	Total (Kg)	% of TC	ETP?	OoS?	1° Main?	2° Main?	Note
F22	Hardyhead silverside	5	0.01	0.33	0.00%	No	No	No	No	<2.0%
F23	Striped ponyfish	6	0.01	0.22	0.00%	No	No	No	No	<2.0%
F24	Goldstripe sardinella	143	0.27	3.91	0.05%	No	No	No	No	<2%
F25	Unicorn leatherjacket	4	0.01	0.43	0.01%	No	No	No	No	<2%
F26	Longtail butterfly ray	13	0.02	4.00	0.05%	No	No	No	No	<2%
F27	Lesser Tigertooth croaker	110	0.21	7.43	0.10%	No	No	No	No	<2%
F28	Tigertooth croaker	27	0.05	3.64	0.05%	No	No	No	No	<2%
F29	Indian Halibut	1	0.00	0.05	0.00%	No	No	No	No	<2%
F30	Picnic seabream	19	0.04	9.32	0.12%	No	No	No	No	<2%
F31	Oriental sole	0	0.00	0.00	0.00%	No	No	No	No	<2%
F32	Indian longfin eel	1	0.00	0.10	0.00%	No	No	No	No	<2%
F33	Eel catfish	1	0.00	1.05	0.01%	No	No	No	No	<2%
F34	Tenpounder	3	0.01	0.73	0.01%	No	No	No	No	<2%
F35	Silver pomfret	2	0.00	0.23	0.00%	No	No	No	No	<2%
F36	Goldlined spinefoot	28	0.05	7.63	0.10%	No	No	No	No	<2%
F37	Grey largeeye bream	0	0.00	0.00	0.00%	No	No	No	No	<2%
F38	Darkbanded fusilier	0	0.00	0.00	0.00%	No	No	No	No	<2%
F39	Manyscaled flounder	0	0.00	0.00	0.00%	No	No	No	No	<2%
F40	Barramundi	24	0.04	4.26	0.05%	No	No	No	No	<2%
F41	Spotted sicklefish	7	0.01	0.71	0.01%	No	No	No	No	<2%
F42	Bluespotted stingray	277	0.52	137.65	1.77%	No	No	No	No	<2%
F43	Bigeye ilsha	0	0.00	0.00	0.00%	No	No	No	No	<2%
F44	Striped threadfin	3	0.01	0.65	0.01%	No	No	No	No	<2%
F45	Malabar thryssa	4	0.01	0.28	0.00%	No	No	No	No	<2%
F46	Harry hotlips	0	0.00	0.00	0.00%	No	No	No	No	<2%
F47	Malayan flounder	70	0.13	11.58	0.15%	No	No	No	No	<2%
F48	Indian threadfish	0	0.00	0.00	0.00%	No	No	No	No	<2%
F49	Blackspot snapper	8	0.01	0.74	0.01%	No	No	No	No	<2%



SLN Non Target Species List

		Non Target Species								
		No	/catch	Total (Kg)	% of TC	ETP?	OoS?	1° Main?	2° Main?	Note
F50	Shortnosed tripodfish	20	0.04	2.83	0.04%	No	No	No	No	<2%
F51	Striped eel catfis	0	0.00	0.00	0.00%	No	No	No	No	<2%
F52	Orangespotted grouper	1	0.00	0.20	0.00%	No	No	No	No	<2%
F53	Largespot flounder	1	0.00	0.11	0.00%	No	No	No	No	<2%
F54	Numbfish	1	0.00	0.35	0.00%	No	No	No	No	<2%
F55	Bignose shark	5	0.01	1.21	0.02%	No	No	No	No	<2%
F56	Sharpnose stingray	9	0.02	1.89	0.02%	No	No	No	No	<2%
F57	Honeycomb stingray	4	0.01	4.68	0.06%	No	No	No	No	<2%
F58	Grey bamboo shark	3	0.01	3.89	0.05%	No	No	No	No	<2%
F59	Great hammerhead	0	0.00	0.00	0.00%	END	No	No	No	<2%
F60	Spotted scat	19	0.04	7.05	0.09%	No	No	No	No	<2%
F61	Great barracuda	1	0.00	0.40	0.01%	No	No	No	No	<2%
F62	Cobia	0	0.00	0.00	0.00%	No	No	No	No	<2%
F63	Whiptail stingray	1	0.00	1.08	0.01%	No	No	No	No	<2%
F64	Bloch's gizzard shad	0	0.00	0.00	0.00%	No	No	No	No	<2%
F65	Lutke's halfbeak	0	0.00	0.00	0.00%	No	No	No	No	<2%
F66	Yellowfin seabream	0	0.00	0.00	0.00%	No	No	No	No	<2%
F67	Brushtooth lizardfish	0	0.00	0.00	0.00%	No	No	No	No	<2%
F68	Stargazers	7	0.01	6.84	0.09%	No	No	No	No	<2%
F69	Hedgehog seahorse	1	0.00	0.01	0.00%	END	No	No	No	Endangered
F70	Spotted eagle ray	1	0.00	0.10	0.00%	No	No	No	No	<2%
F71	Live sharksucker	3	0.01	1.02	0.01%	No	No	No	No	<2%
F72	Oriental silago	0	0.00	0.00	0.00%	No	No	No	No	<2%
F73	Crown squirrelfish	0	0.00	0.00	0.00%	No	No	No	No	<2%
F74	Indian mackerel	1	0.00	0.09	0.00%	No	No	No	No	<2%
F75	Annandale's guitarfish	4	0.01	1.51	0.02%	No	No	No	No	<2%
F76	Robust tuskfish	0	0.00	0.00	0.00%	No	No	No	No	<2%
F77	Pale snapper	3	0.01	0.17	0.00%	No	No	No	No	<2%



SLN Non Target Species List

		Non Target Species								
		No	/catch	Total (Kg)	% of TC	ETP?	OoS?	1° Main?	2° Main?	Note
F78	Ballonfish	0	0.00	0.00	0.00%	No	No	No	No	<2%
F79	Toadfish	0	0.00	0.00	0.00%	No	No	No	No	<2%
F80	Emperor red snapper	0	0.00	0.00	0.00%	No	No	No	No	<2%
F81	Cock grunter	103	0.19	65.36	0.84%	No	No	No	No	<2%
F82	Orbicular batfish	8	0.01	3.26	0.04%	No	No	No	No	<2%
F83	Onespot snapper	27	0.05	23.87	0.31%	No	No	No	No	<2%
F84	Mozambique largeeye	1	0.00	0.09	0.00%	No	No	No	No	<2%
F85	Blacktip reef shark	1	0.00	3.50	0.05%	No	No	No	NT	<2%
F86	Starry triggerfish	0	0.00	0.00	0.00%	No	No	No	No	<2%
F87	Eclipse Parrotfish	0	0.00	0.00	0.00%	No	No	No	No	<2%
Crustaceans										
C1	Flathead lobster	12	0.02	2.30	0.03%	No	No	No	No	<2%
C2	Mantis shrimp	122	0.23	7.17	0.09%	No	No	No	No	<2%
C3	Ridged swimming crab	176	0.33	27.75	0.36%	No	No	No	No	<2%
C4	Bloodspotted crab	67	0.13	5.88	0.08%	No	No	No	No	<2%
C5	Box crab	73	0.14	6.38	0.08%	No	No	No	No	<2%
C6	Curcifix crab	36	0.07	6.11	0.08%	No	No	No	No	<2%
C7	Spider crab	30	0.06	0.59	0.01%	No	No	No	No	<2%
C8	Spider crab	20	0.04	0.83	0.01%	No	No	No	No	<2%
C9	Spider crab	4	0.01	0.15	0.00%	No	No	No	No	<2%
C10	Indian white shrimp	163	0.30	2.99	0.04%	No	No	No	No	<2%
C11	Giant tiger prawn	110	0.21	3.40	0.04%	No	No	No	No	<2%
C12	Blunt toothed crab	32	0.06	2.01	0.03%	No	No	No	No	<2%
C13	Common moon crab	3	0.01	0.15	0.00%	No	No	No	No	<2%
C14	Indo-pacific swamp crab	27	0.05	23.29	0.30%	No	No	No	No	<2%
C15	Angular crab	0	0.00	0.00	0.00%	No	No	No	No	<2%
C16	Orange mud crab	0	0.00	0.00	0.00%	No	No	No	No	<2%
C17	Sentinel crabs	91	0.17	7.29	0.09%	No	No	No	No	<2%



SLN Non Target Species List

		Non Target Species								
		No	/catch	Total (Kg)	% of TC	ETP?	OoS?	1° Main?	2° Main?	Note
C18	Rock crab	2	0.00	0.24	0.00%	No	No	No	No	<2%
C19	Longlegged spiny lobster	2	0.00	0.92	0.01%	No	No	No	No	<2%
C20	Salt marsh mud crab	426	0.80	47.92	0.62%	No	No	No	No	<2%
C21	Helmet crab	11	0.02	0.67	0.01%	No	No	No	No	<2%
	Molluscs									
M1	Lace murex	84	0.16	50.10	0.64%	No	No	No	No	<2%
M2		1528	2.86	60.31	0.78%	No	No	No	No	<2%
M3	Woodcock murex	3096	5.79	50.47	0.65%	No	No	No	No	<2%
M4	Indian volute	93	0.17	37.57	0.48%	No	No	No	No	<2%
M5	Veined rapa whelk	120	0.22	16.18	0.21%	No	No	No	No	<2%
M6	Murex	2273	4.25	95.41	1.23%	No	No	No	No	<2%
M7	Cuttle fish	42	0.08	294.57	3.79%	No	No	No	No	>2% Resilient
M8	Spiral melongena	182	0.34	14.77	0.19%	No	No	No	No	<2%
M9	Cone snail	0	0.00	0.00	0.00%	No	No	No	No	<2%
M10	Screw shell	3	0.01	0.06	0.00%	No	No	No	No	<2%
M11	Indian chank	131	0.24	32.14	0.41%	No	No	No	No	<2%
M12	Common mussle	2	0.00	0.29	0.00%	No	No	No	No	<2%
M13		1	0.00	0.01	0.00%	No	No	No	No	<2%
M14	Java turrid	0	0.00	0.00	0.00%	No	No	No	No	<2%
M15	Spindle shell	33	0.06	3.78	0.05%	No	No	No	No	<2%
M16	Moon snail	0	0.00	0.00	0.00%	No	No	No	No	<2%
M17	Spider conch	957	1.79	224.34	2.89%	No	No	No	No	>2% Resilient
M18	Windowpane oyster	0	0.00	0.00	0.00%	No	No	No	No	<2%
M19	Clam shell	129	0.24	1.39	0.02%	No	No	No	No	<2%
M20		1	0.00	0.01	0.00%	No	No	No	No	<2%
M21		2	0.00	0.20	0.00%	No	No	No	No	<2%
M22	Octopus	10	0.02	0.44	0.01%	No	No	No	No	<2%
M23	Harp shell	1	0.00	0.04	0.00%	No	No	No	No	<2%



SLN Non Target Species List		Non Target Species								
		No	/catch	Total (Kg)	% of TC	ETP?	OoS?	1° Main?	2° Main?	Note
M24	Whelk	0	0.00	0.00	0.00%	No	No	No	No	<2%
M25		183	0.34	3.04	0.04%	No	No	No	No	<2%
M26	King's crown conch	15	0.03	0.98	0.01%	No	No	No	No	<2%
M27	Spotted stun	28	0.05	3.76	0.05%	No	No	No	No	<2%
Echinoderms +										
E1	S.virgulata	526	0.98	18.32	0.24%	No	No	No	No	<2%
E2	Long spined black sea urchin	29	0.05	0.83	0.01%	No	No	No	No	<2%
E3	Chocolate chip sea star	1134	2.12	260.60	3.35%	No	No	No	No	<2%
E4	Star fish	66	0.12	8.85	0.11%	No	No	No	No	<2%
E5	Common Star fish	30	0.06	1.23	0.02%	No	No	No	No	<2%
E6	Sea cucumber	3	0.01	0.67	0.01%	No	No	No	No	<2%
E7	Short spined black sea urchin	0	0.00	0.00	0.00%	No	No	No	No	<2%
E8	Red-knobbed starfish	46	0.09	9.20	0.12%	No	No	No	No	<2%
E9	P. alveolatus	47	0.09	10.81	0.14%	No	No	No	No	<2%
E10	Pentaceraster spp	86	0.16	20.33	0.26%	No	No	No	No	<2%
E11	Lytechinus spp	25	0.05	1.13	0.01%	No	No	No	No	<2%
E12	P. tuberculatus	272	0.51	61.48	0.79%	No	No	No	No	<2%
E13	A. gibbosa	19	0.04	1.70	0.02%	No	No	No	No	<2%
E14	L.maculata	72	0.13	9.73	0.13%	No	No	No	No	<2%
E15	Sea anemones	4	0.01	3.13	0.04%	No	No	No	No	<2%
E16	Feather star	69	0.13	1.04	0.01%	No	No	No	No	<2%
O1	Jelly Fish	0	0.00	0.00	0.00%	No	No	No	No	<2%
Reptiles										
R1	Hookednosed Seasnake	0	0.00	0.00	0.00	No	No	No	No	<2%

