

Report on the survey of the Marine Aquarium Fishery Batticaloa and Ampara Districts, Sri Lanka.

2008

1. Introduction

The marine aquarium fishery in the eastern coastal waters has been in existence since the beginning of the industry in Sri Lanka. The present value of the marine ornamental sector of the aquarium fish industry is believed to be about 60% of the total value of about US \$ 7 million. Marine aquarium species of the eastern coastal reefs is vital for the industry. A number of key species of butterflyfish (Chaetodontidae), angelfish (Pomacanthidae), wrasses (Labridae), gobies (Gobiidae), damselfish (Pomacentridae), groupers (Serranidae), blennies (Blennidae), surgeonfish (Acanthuridae) and invertebrates such as the scarlet shrimps (*Lysmata debelius*) and painted shrimps (*L. amboinensis*) are harvested from the eastern coastal reefs. Prior to late 1980's the collecting areas were widespread in Trincomalee and Batticaloa Districts. Since mid 1990's the collecting areas diminished due to restrictions placed by the defense authorities as a result of the internal conflict that prevailed at the time.

The fishery is conducted during the calm season from March to October and divers, also called collectors from the southern and western coastal areas migrate to the east to join local divers from the east coast. Aquarium species are collected by snorkeling in shallow inshore reefs and by scuba diving in offshore reefs to a depth of about 35m. About 250 species of reef fish and about 50 species of invertebrates are collected for export.

The earliest comprehensive study of the marine aquarium fish industry in Sri Lanka was carried out by Wood (1985). Mee (1993) and Beets (1994) followed with an overview of the industry. Wood (1996) published management needs for the industry in Sri Lanka based on a study conducted with the National Aquatic Resources Research and Development Agency through a project funded by the Darwin Initiative of the United Kingdom. Presently, species conservation is by protecting several species through the Fauna and Flora Protection Ordinance and the Fisheries and Aquatic Resources Act and by restricting the export of additional species through the Fisheries and Aquatic Resources Act.

This is the first survey conducted under the CIDA-IFAD funded project managed by the FAO to assess the ornamental fish stocks in three selected areas of the coastal waters in Sri Lanka.

2. Objectives

To assess the stocks of selected marine aquarium species

Assess the current levels of harvesting

Identify management issues pertaining to the marine aquarium fishery

Develop management plans for selected coastal areas through co-management.

3. Methods

3.1 Survey sites

The coastline along the study area is characterized by having long sandy beaches and coastal headlands or rock outcrops. Almost the entire length of this coastal stretch contains reef habitats. The survey sites were located from Kathiraveli in the Batticaloa District to Akkraipattu in the Ampara District (figure 1). Survey sites were determined using a combination of satellite images, previous knowledge of reef sites and information from local divers and fishermen. Locations of study sites varied from inshore fringing coral reefs to offshore sandstone/limestone reefs to a depth of about 20m. Handheld global positioning system units were used to record the positions of sampling sites. The survey was conducted in July and September 2008. The total reef areas where sampling was done was 661 ha in the Batticaloa District and 777 ha in the Ampara District.

3.2 Fishery independent data

Reef substrate was sampled using the Point Intercept Transect method (PIT) along a 50m tape laid on the reef. Substrate was recorded at 75 points along the 50m transect by dividing the transect into three 10m sections and by recording the substrate at 25 points along the first, third and fourth sections of the transect (modified from English et al. 1997). Large invertebrates (Megabenthos) such as starfish, lobsters, large molluscs occurring within 1m on either side of the 50m long transect were also recorded.

Marine aquarium fish were recorded using the belt transect method (English et al. 1997) along the 50m transect used for the PIT in an area of 250 square meters (2.5m on either side of the 50m tape). A pair of divers collected data at each site. One diver collected PIT and megabenthos data while the other recorded the abundance of aquarium fish along the transect. Thirty minutes were allocated to complete each fish belt transect in order to standardize the time spent to record fish.

The list of aquarium reef fish species (annex 1) was based on previous studies conducted by NARA and Wood (1985) to identify species that required management. Species that are included in the currently protected and restricted export categories were given special consideration in the study. Their presence was noted even if they occurred outside the belt transect.

Sampling was carried out by snorkeling in shallow reefs less than 3m depth while all other sites were sampled using scuba. A total of 89 sites (Fish Belt transects) were sampled for aquarium fishes within Batticaloa and Ampara Districts.

3.3 Fishery dependent data

Fishery dependent data such as number of collectors, crafts and types of fishing gear was recorded by visiting fish collecting centers at Kayankeni, Batticaloa, Kattankudi and Kalmunai during the study period. Fish collectors and Suppliers were interviewed to obtain the information on collecting periods, methods and gear.

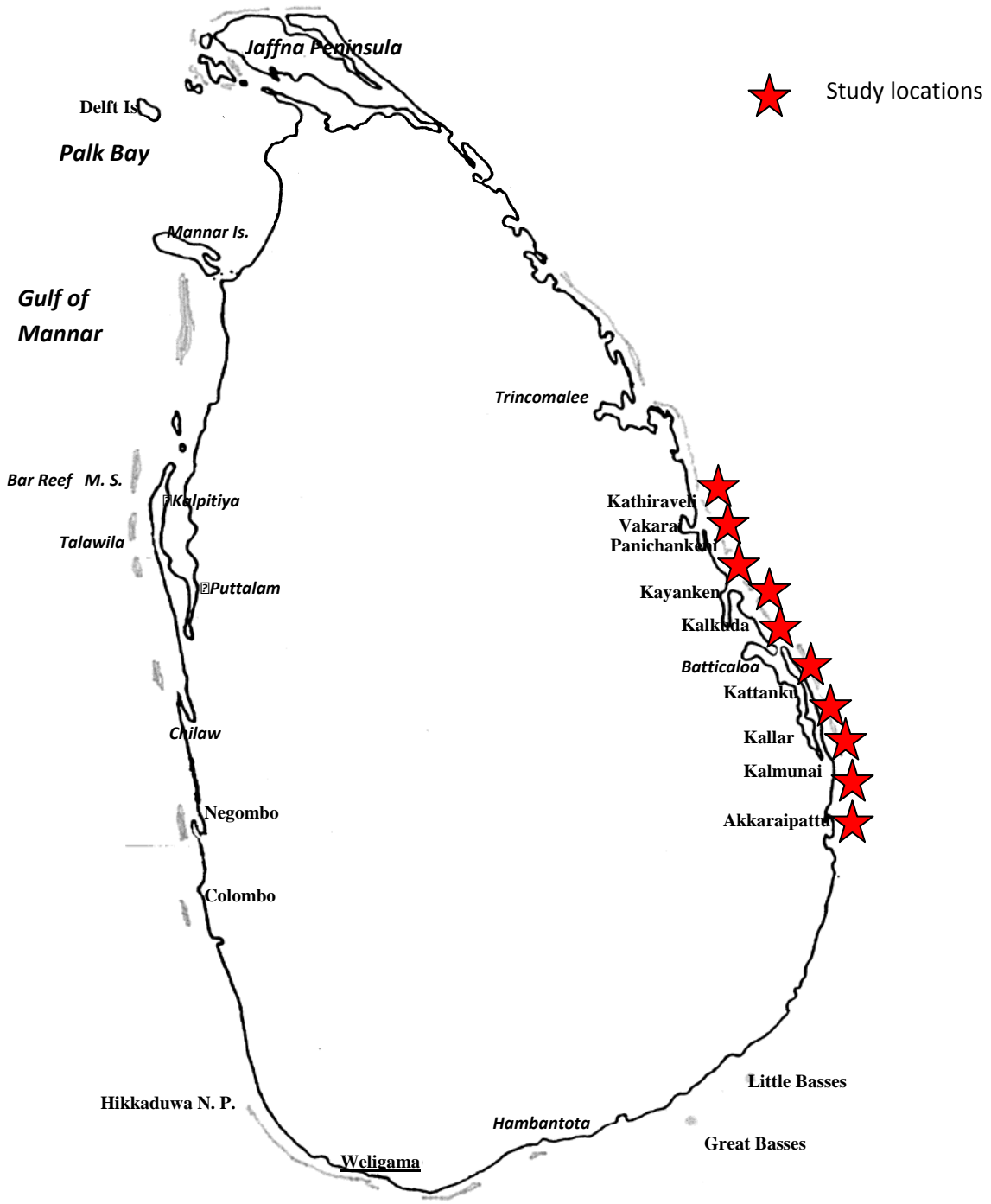


Figure 1. Survey locations within the study area

4. Results

4.1 Reef habitats

Coral, sandstone/limestone and rock boulder reefs described for Sri Lanka (Swan 1983, Rajasuriya and De Silva 1988) were found within the survey area. All coral reef habitats were in shallow water less than 8m in depth and the majority were fringing reefs located around headlands or rock outcrops along the coast at Palchanai, Panichchankeni, Kayankeni, Passikuda, Kalkuda and Punnakuda. The nearshore reefs have a width of about 100m. The seaward margins of some reefs have a spur and groove structure whilst others have large massive corals. Coral patches were also found along the coast from Batticoola to Kalmunai. These were parallel to the coast and occur about 50m offshore and has a width of about 75m. The largest coral reefs were at Kayankeni; at the southern end of the Kayankeni Bay and about 1 km offshore where a small island existed before the tsunami in 2004. Sandstone/limestone platform reefs was the dominant form of reef habitat within the survey area. Rock boulder reef habitats occur mainly in the northern section of the survey area from Kalkudah to Kathiraveli and around Kalmunai. These reefs were similar to those found elsewhere in Sri Lanka (Rajasuriya et al. 1998a and 1998b).

Kayankeni had the most extensive areas of branching *Acropora* species. Branching *Acropora* species contributed to coral cover in other fringing coral reefs together with massive corals such as *Porites lutea*, *P. lobata*, *Goniastrea retiformis*, *G. edwardsi*, *Platygyra* spp, *Leptoria Phrygia*, *Favites* spp, and *Favia* spp. Foliose coral species of *Echinopora lamellosa* and *Montipora* species were also common.

Sandstone/limestone reefs supported many species of hermatypic corals but had very low hard coral cover than the coral reef habitats. Species belonging to families of Faviidae, Poritidae, Mussidae and Acroporidae were common. The maximum hard coral cover was about 12%. Soft corals of the genera *Sarcophyton*, *Sinularia*, *Lobophyton* were found in patches and the bottom was about 30% in the areas of dense growth. Rock boulder reef habitats in shallow water to a depth of about 5m had good coral growth around them especially at Palchanai in Kathiraveli and at Kayankeni. Rock habitats in deeper water had very little hard corals.

Most coral reef habitats were highly degraded except the reef at Kayankeni where large patches of *Acropora formosa* was present. The impact of the 1998 coral bleaching event when most corals in the area were affected and the tsunami in 2004 could be the main reasons for the degraded status of coral reef habitats. Small patches of bleached *Acropora formosa* was observed at Challitivu in Panichchankeni. Large scale bleaching was not observed at any of the survey sites.

Crown of Thorns Starfish (*Acanthaster planci*) were also present on several sampling sites deeper than 10 meters. However, a population explosion of the species was not observed. Abandoned fishing nets entangled on reefs were seen at Kayankeni, Panichchankeni and Kalmunai.

4.2 Abundance of aquarium fishes in selected families

The sampled reef areas and the estimated extent of reefs varied between Batticoola and Amparai Districts. More shallow coral reefs were present in the Batticoola District while sandstone/limestone and rock boulder reefs were dominant type of substrate in the Amparai District. The abundance (mean) of species recorded and the total allowable catch (TAC) is presented in table 1.

Table 1. Marine aquarium species and their total allowable catch in Batticaloa and Ampara Districts.

<i>Species</i>	<i>Batticaloa</i>		<i>Ampara</i>	
	<i>Mean</i>	<i>TAC</i>	<i>Mean</i>	<i>TAC</i>
<i>Abudefduf vaigiensis</i>	896	108	0	0
<i>Acanthurus leucosternon</i>	129539	10816	119187	10935
<i>Acanthurus lineatus</i>	16136	1134	65294	882
<i>Acanthurus spp.</i>	15240	922	36274	1971
<i>Acanthurus tennentii</i>	6723	222	4146	13
<i>Acanthurus triostegus</i>	3586	128	0	0
<i>Acanthurus tristis</i>	896	10	3109	116
<i>Amphiprion clarkii</i>	11654	639	23837	1190
<i>Amphiprion nigripes</i>	30032	928	15546	581
<i>Anampses lineatus</i>	23308	1543	38347	1940
<i>Apolemichthys xanthurus</i>	71269	6482	111933	10771
<i>Arothron hispidus</i>	1345	48	0	0
<i>Arothron spp</i>	896	10	2073	77
<i>Balistapus undulatus</i>	896	10	0	0
<i>Balistoides conspicillum (R)</i>	448	16	0	0
<i>Bodianus axillaris</i>	3138	3	7255	311
<i>Bodianus diana</i>	6723	427	0	0
<i>Bodianus neilli</i>	4931	240	4146	110
<i>Cantherhines pardalis</i>	3586	8	2073	77
<i>Canthigaster solandri</i>	8516	551	22801	1013
<i>Canthigaster valentini</i>	17929	1016	19692	946
<i>Caranx heberi</i>	4034	143	0	0
<i>Centropyge eibli</i>	23308	1624	46639	2745
<i>Centropyge flavipectoralis (R)</i>	96370	7414	115042	8532
<i>Centropyge multispinis</i>	65890	5634	154425	13697
<i>Cephalopholis argus (R)</i>	12999	985	12437	508
<i>Cephalopholis formosa (R)</i>	5827	368	3109	13
<i>Cephalopholis miniata (R)</i>	21515	1657	29020	1125
<i>Chaetodon auriga</i>	896	32	8291	256
<i>Chaetodon citrinellus</i>	2689	85	6218	27
<i>Chaetodon collare</i>	4931	255	4146	44
<i>Chaetodon decussatus</i>	82027	8021	77731	6728
<i>Chaetodon falcula (R)</i>	896	10	0	0
<i>Chaetodon guttatissimus</i>	39445	3547	87059	8038
<i>Chaetodon interruptus (R)</i>	0	0	4146	155
<i>Chaetodon kleinii</i>	28239	2217	65294	5882

<i>Chaetodon melannotus</i>	0	0	6218	232
<i>Chaetodon mertensii</i> (R)	17033	898	20728	908
<i>Chaetodon meyeri</i> (R)	26446	2154	18655	1312
<i>Chaetodon plebeius</i>	8068	555	2073	77
<i>Chaetodon triangulum</i> (R)	896	10	0	0
<i>Chaetodon trifascialis</i>	11654	729	0	0
<i>Chaetodon trifasciatus</i>	177949	13385	55966	4819
<i>Chaetodon vagabundus</i>	4931	270	9328	93
<i>Cheilinus chlorourus</i>	896	32	0	0
<i>Chromis dimidiata</i>	0	0	16583	823
<i>Chrysiptera kuiteri</i> (P)	0	0	2073	77
<i>Cirrhitichthys oxycephalus</i>	3586	430	19692	494
<i>Coris frerei</i>	4482	538	5182	43
<i>Ctenochaetus strigosus</i>	2689	323	13473	342
<i>Dascyllus carneus</i>	63649	7638	316106	15415
<i>Dascyllus trimaculatus</i>	26894	3227	0	0
<i>Ecsenius bicolor</i>	6723	807	0	0
<i>Epinephelus caeruleopunctatus</i> (R)	448	54	0	0
<i>Epinephelus quoyanus</i> (R)	1793	215	0	0
<i>Forcipiger flavissimus</i>	34514	4142	30056	1489
<i>Gomphosus caeruleus</i>	12999	1560	9328	538
<i>Halichoeres argus</i>	3586	430	0	0
<i>Halichoeres hortulanus</i>	6275	753	13473	524
<i>Halichoeres leucoxanthus</i>	896	108	2073	77
<i>Halichoeres marginatus</i>	29135	3496	89131	6807
<i>Hemigymnus fasciatus</i>	3586	430	0	0
<i>Hemigymnus melapterus</i>	896	108	0	0
<i>Hemitaenichthys zoster</i>	2689	323	0	0
<i>Heniochus acuminatus</i>	448	54	0	0
<i>Heniochus pleurotaenia</i> (R)	0	0	2073	77
<i>Heniochus singularis</i>	1793	215	6218	153
<i>Labroides bicolor</i> (P)	1345	161	0	0
<i>Labroides dimidiatus</i>	182879	21946	250812	24831
<i>Macropharyngodon ornatus</i>	3586	430	0	0
<i>Meiacanthus smithi</i>	1345	161	0	0
<i>Naso lituratus</i>	17929	2152	25910	1740
<i>Neopomacentrus azysron</i>	697003	83640	404201	21611
<i>Neopomacentrus cyanomos</i>	47064	5648	0	0
<i>Novaculichthys taeniourus</i>	448	54	2073	77
<i>Odonus niger</i>	188258	22591	100532	2909
<i>Ostracion cubicus</i>	0	0	1036	39

<i>Ostracion meleagris</i>	4034	484	0	0
<i>Paracirrhites forsteri</i>	11654	1398	46639	3723
<i>Parupeneus macronema</i>	38548	4626	10364	387
<i>Parupeneus sp 1</i>	3586	430	0	0
<i>Parupeneus spp.</i>	9413	1130	62185	3982
<i>Plagiotremus phenax</i>	0	0	1036	39
<i>Plectorhinchus vittatus</i>	25549	3066	10364	70
<i>Plectropomus areolatus (R)</i>	1345	161	1036	39
<i>Plectropomus laevis (R)</i>	448	54	0	0
<i>Pomacanthus annularis</i>	1345	161	3109	101
<i>Pomacanthus imperator</i>	11206	1345	10364	755
<i>Pomacanthus semicirculatus</i>	12551	1506	6218	254
<i>Pomacentrus similis</i>	404306	48517	1527672	89086
<i>Pseudanthias spp</i>	0	0	103641	3873
<i>Pseudanthias squamipinnis</i>	103542	12425	63221	703
<i>Pseudochromis fuscus</i>	0	0	1036	39
<i>Ptereleotris evides</i>	896	108	2073	77
<i>Ptereleotris heteroptera</i>	0	0	2073	77
<i>Pterois antennata</i>	1793	215	0	0
<i>Pterois volitans</i>	1793	215	1036	39
<i>Rhinecanthus aculeatus</i>	1345	161	0	0
<i>Rhinecanthus rectangulus</i>	1345	161	0	0
<i>Sargocentron diadema</i>	22412	2689	10364	387
<i>Scarus spp</i>	3138	377	6218	27
<i>Sufflamen bursa</i>	8965	1076	7255	141
<i>Sufflamen chrysopterus</i>	13447	1614	36274	1708
<i>Sufflamen fraenatus</i>	448	54	0	0
<i>Synchiropus stellatus</i>	0	0	11401	116
<i>Thalassoma hardwicke</i>	8516	1022	7255	116
<i>Thalassoma janseni</i>	8068	968	13473	688
<i>Thalassoma lunare</i>	30032	3604	16583	754
<i>Valenciennea puellaris</i>	1345	161	0	0
<i>Valenciennea strigata</i>	4931	592	0	0
<i>Zanclus cornutus</i>	79337	9520	38347	2835
<i>Zebrasoma desjardini</i>	448	54	2073	77
<i>Zebrasoma scopas</i>	13895	1667	10364	296

(P) = Protected category, (R) = Restricted Export category

The abundance of individual species in seven of the most important reef fish families are shown in Figures 2 to 7. Results are based on all 89 fish belt transects in Batticaloa and Ampara Districts.

Family: Pomacanthidae

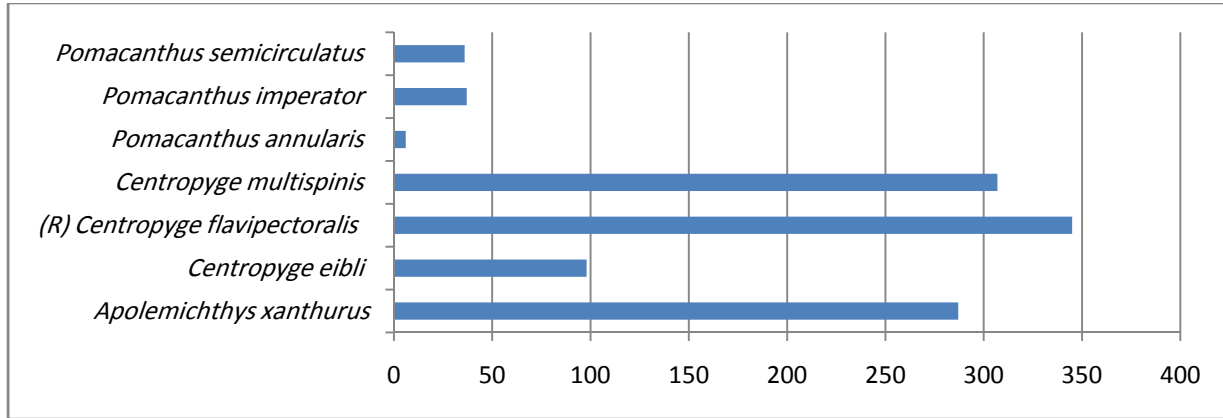


Figure 2. Number of individuals of each species of Pomacanthidae recorded in Batticaloa and Ampara Districts. (R) Species in Restricted Export Category.

Seven species of Pomacanthidae belonging to three genera were recorded. They include three species of large angelfish (*P. semicirculatus*, *P. imperator* and *P. annularis*), 3 species of pygmy angelfish (*C. multispinis*, *C. flavipectoralis* and *C. eibli*) and one species of a medium sized angelfish (*Apolemichthys xanthurus*). Results indicate that the *Centropyge flavipectoralis* is more common than *C. multispinnis* although the former is placed in the Restricted Export Category.

Family: Pomacentridae

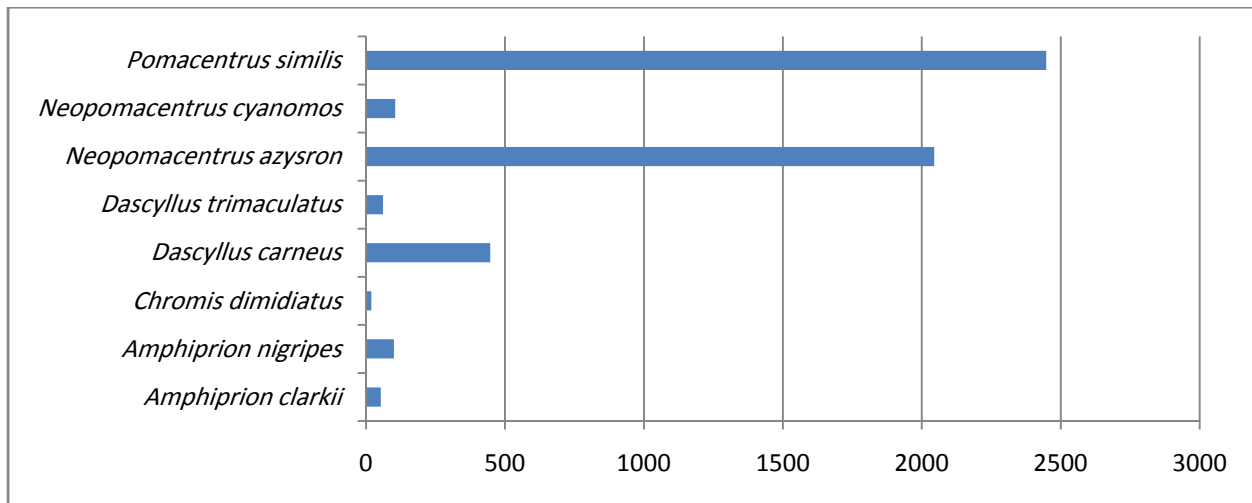
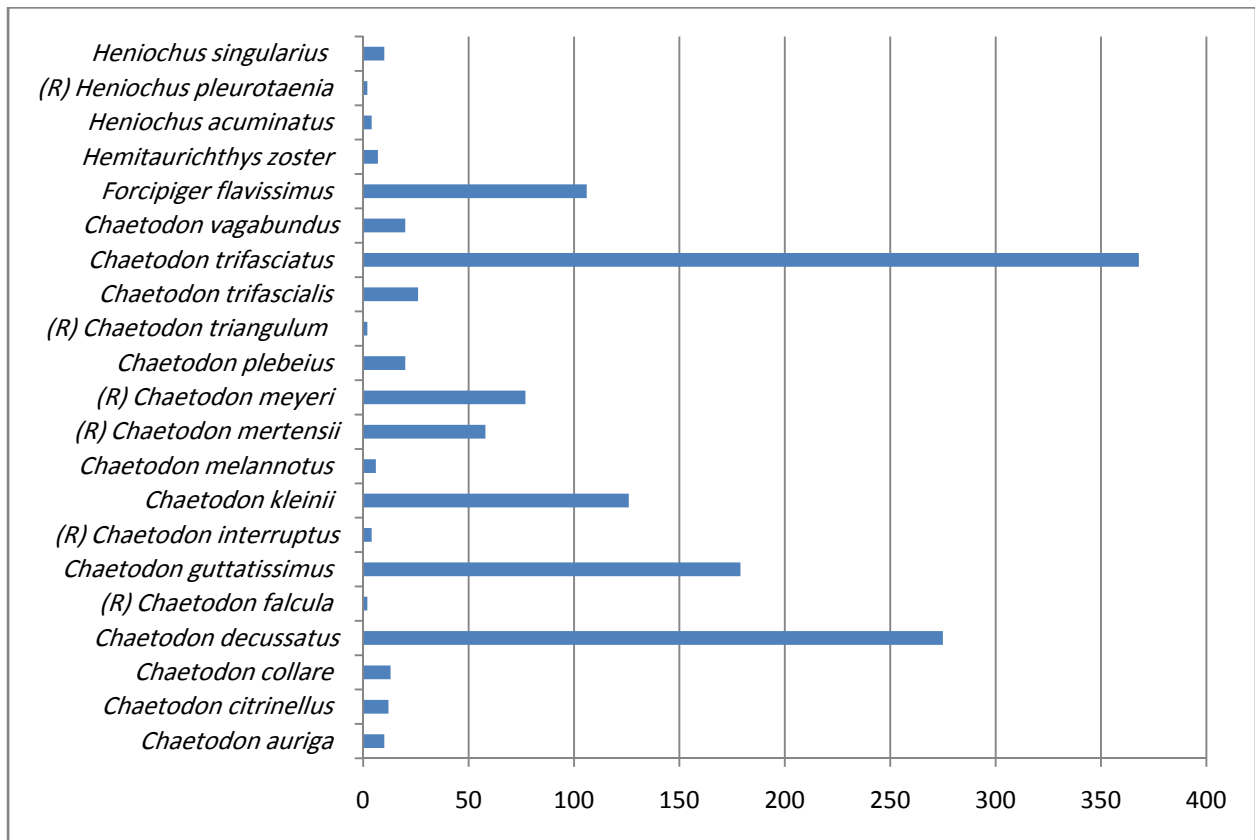


Figure 3. Number of individuals of each species of Pomacentridae recorded in Batticoloa and Ampara Districts.

Pomacentrus similis and *Neopomacentrus asyzron* were the most numerous among the 8 species of Pomacentridae recorded during the survey.

Family: Chaetodontidae



(R) Restricted export category.

Figure 4. Number of individuals of each species of Chaetodontidae recorded in Batticoloa and Ampara Districts.

Twenty one species of butterflyfish were recorded of which 6 species belonged to the Restricted Export Category. Except *Chaetodon meyeri* and *C. mertensii* (*C. madagascariensis*) the other four species were rare.

Family: Labridae

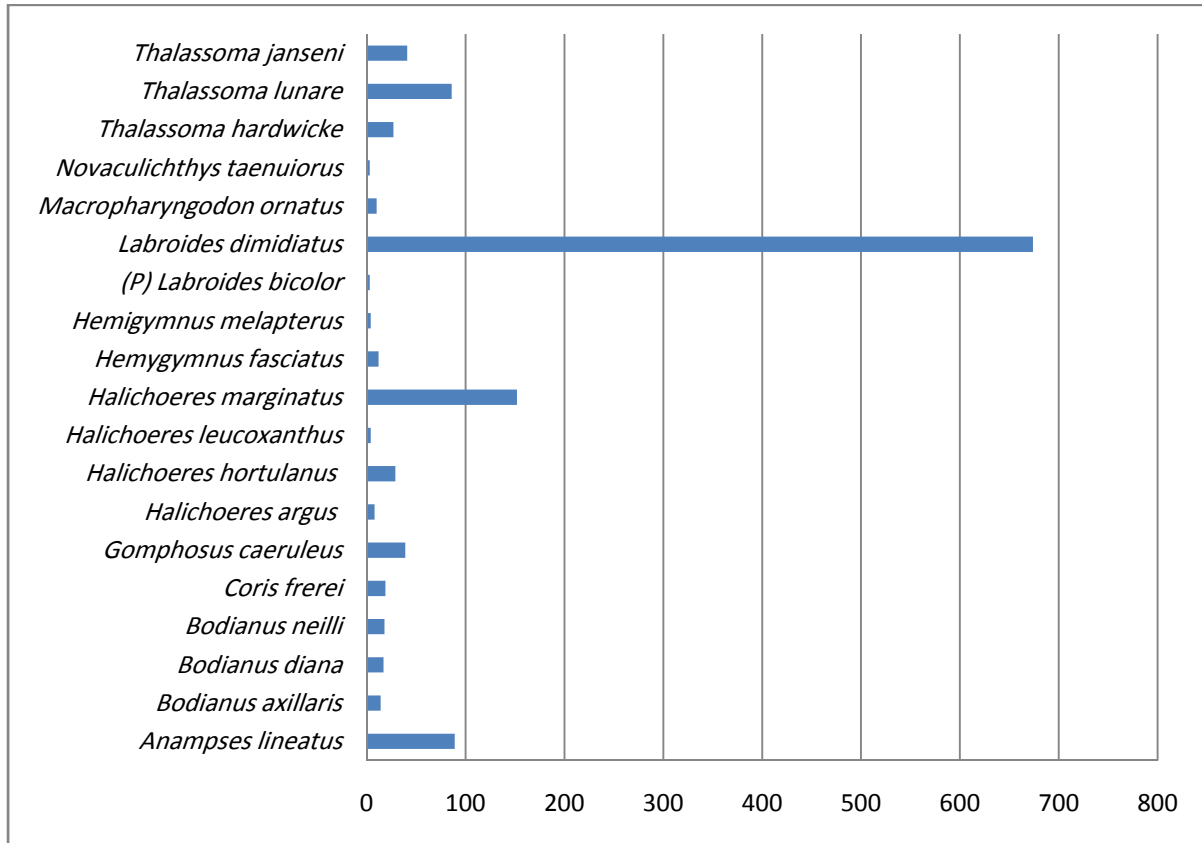


Figure 5. Number of individuals of each species of Labridae recorded in Batticoloa and Ampara Districts. (P) Protected species.

Nineteen species of wrasses used in the aquarium trade were recorded of which one species (*Labroides bicolor*) belonged to the Protected Category. *Labroides dimidiatus* had the highest abundance.

Family: Balistidae

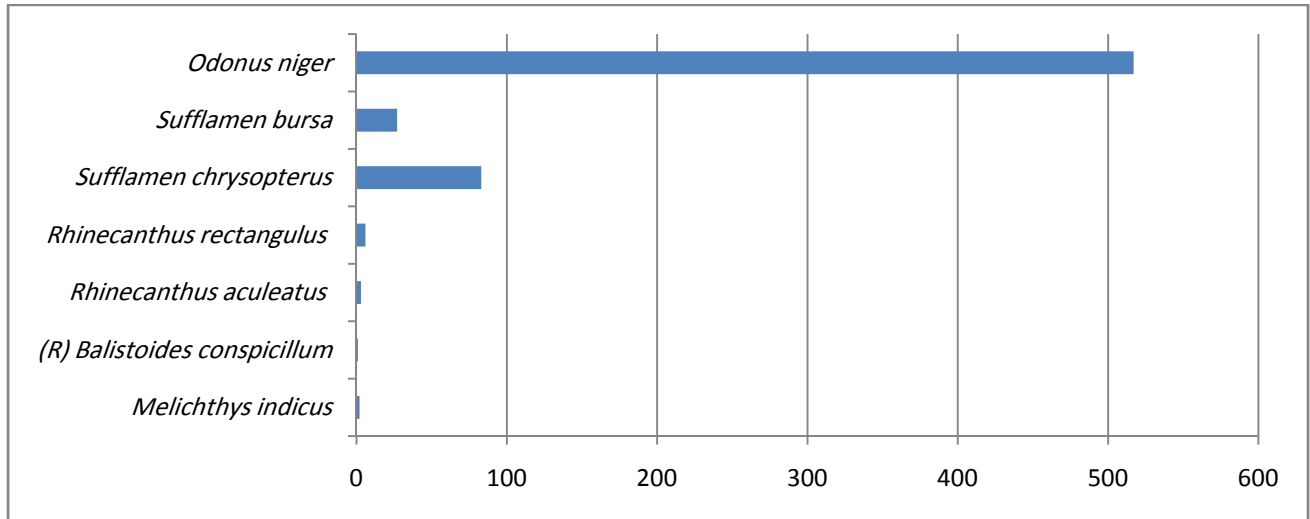


Figure 6. Number of individuals of each species of Balistidae recorded in Batticaloa and Ampara Districts.

Odonus niger is widespread in Sri Lanka especially on offshore reefs around 20 to 30 meters. Only a single specimen of *Balistoides conspicillum* was recorded. The ornamental fish collectors raised concern about the use of Barrier nets to catch large adults of *Balistoides conspicillum* and according to them this practice has caused a decline in the availability of breeders of these species.

Family: Scorpaenidae

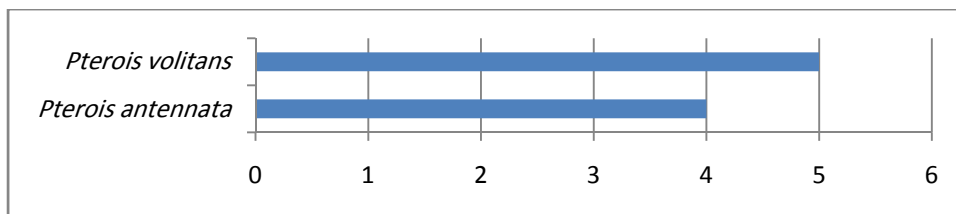


Figure 7. Number of individuals of each species of Scorpaenidae recorded in Batticaloa and Ampara Districts.

Table 2. Number of individuals of each species recorded within fish belt transects in Batticaloa and Ampara Districts.

Family	Species	Nos	
Acanthuridae	<i>Acanthurus leucosternon</i>	401	
	<i>Acanthurus lineatus</i>	104	
	<i>Acanthurus triostegus</i>	11	
	<i>Acanthurus tennetti</i>	19	
	<i>Acanthurus eiblii</i>	5	
	<i>Acanthurus</i> spp	69	
	<i>Ctenochaetus strigosus</i>	19	
	<i>Naso lituratus</i>	66	
	<i>Zebrasoma scopas</i>	41	
	<i>Zebrasoma desjardeini</i>	3	
	Balistidae	<i>Balistoides conspicillum (R)</i>	1
		<i>Balistapus undulatus</i>	1
		<i>Melichthys indicus</i>	2
<i>Rhinecanthus aculeatus</i>		3	
<i>Rhinecanthus rectangulus</i>		6	
<i>Sufflamen chrysopterus</i>		83	
<i>Sufflamen bursa</i>		27	
<i>Odonus niger</i>		517	
Blennidae		<i>Ecsenius bicolor</i>	15
	<i>Meiacanthus smithi</i>	4	
	<i>Plagiotremus sphenax</i>	1	
Callionymidae	<i>Synchiropus stellatus</i>	11	
Chaetodontidae	<i>Chaetodon auriga</i>	10	
	<i>Chaetodon citrinellus</i>	12	
	<i>Chaetodon collare</i>	13	
	<i>Chaetodon decussates</i>	275	
	<i>Chaetodon falcula (R)</i>	2	
	<i>Chaetodon guttatissimus</i>	179	
	<i>Chaetodon interruptus (R)</i>	4	
	<i>Chaetodon kleinii</i>	126	
	<i>Chaetodon melannotus</i>	6	
	<i>Chaetodon mertensii (R)</i>	58	
	<i>Chaetodon meyeri (R)</i>	77	
	<i>Chaetodon plebeius</i>	20	
	<i>Chaetodon triangulum</i>	2	
	<i>Chaetodon trifascialis</i>	26	
	<i>Chaetodon trifasciatus</i>	368	
	<i>Chaetodon vagabundus</i>	20	

	<i>Forcipiger flavissimus</i>	106
	<i>Hemitaurichthys zoster</i>	7
	<i>Heniochus acuminatus</i>	4
	<i>Heniochus pleurotaenia (R)</i>	2
	<i>Heniochus singularius</i>	10
Cirrhitidae	<i>Cirrhitichthys oxycephalus</i>	33
	<i>Paracirrhites forsteri</i>	71
Haemulidae	<i>Plectorhinchus vittatus</i>	3
Gobiidae	<i>Valenciennea puellaris</i>	3
	<i>Valenciennea strigata</i>	11
	<i>Plectorhinchus vittatus</i>	46
Holocentridae	<i>Sargocentron diadema</i>	60
Labridae	<i>Anampses lineatus</i>	89
	<i>Bodianus axillaris</i>	14
	<i>Bodianus Diana</i>	17
	<i>Bodianus neilli</i>	18
	<i>Oxychelinus bimaculatus</i>	2
	<i>Coris frerei</i>	19
	<i>Gomphosus caeruleus</i>	39
	<i>Halichoeres argus</i>	8
	<i>Halichoeres hortulanus</i>	29
	<i>Halichoeres leucoxanthus</i>	4
	<i>Halichoeres marginatus</i>	152
	<i>Hemigymnus fasciatus</i>	12
	<i>Hemigymnus melapterus</i>	4
	<i>Labroides bicolor (P)</i>	3
	<i>Labroides dimidiatus</i>	674
	<i>Macropharyngodon ornatus</i>	10
	<i>Novaculichthys taeniurus</i>	3
	<i>Thalassoma Hardwicke</i>	27
	<i>Thalassoma lunare</i>	86
	<i>Thalassoma janseni</i>	41
Microdesmidae	<i>Ptereleotris evides</i>	4
	<i>Ptereleotris heteroptera</i>	2
Monacanthidae	<i>Pervagor janthinisoma</i>	10
Mullidae	<i>Parupeneus macronema</i>	96
	<i>Parupeneus sp</i>	89
Ostraciidae	<i>Ostracion cubicus</i>	1
	<i>Ostracion meleagris</i>	9
Pomacanthidae	<i>Apolemichthys xanthurus</i>	287
	<i>Centropyge eibli</i>	98

	<i>Centropyge flavipectoralis</i> (R)	345
	<i>Centropyge multispinis</i>	307
	<i>Pomacanthus annularis</i>	6
	<i>Pomacanthus imperator</i>	37
	<i>Pomacanthus semicirculatus</i>	36
Pomacentridae	<i>Amphiprion clarki</i>	53
	<i>Amphiprion nigripes</i>	100
	<i>Abudefduf vaigiensis</i>	2
	<i>Chromis dimidiatus</i>	19
	<i>Dascyllus carneus</i>	447
	<i>Dascyllus trimaculatus</i>	61
	<i>Neopomacentrus azysron</i>	2045
	<i>Neopomacentrus cyanomos</i>	105
	<i>Pomacentrus similis</i>	2448
Pseudochromidae	<i>Pseudochromis fuscus</i>	3
Serranidae	<i>Epinephelus caeruleopunctatus</i>	1
	<i>Epinephelus quoyanus</i>	7
	<i>Cephalopholis argus</i>	41
	<i>Cephalopholis formosa</i>	21
	<i>Cephalopholis miniata</i>	79
	<i>Pseudanthias squamipinnis</i>	292
	<i>Pseudanthias dispar</i>	100
	<i>Plectropomus aereolatus</i>	3
Scorpaenidae	<i>Pterois antennata</i>	4
	<i>Pterois volitans</i>	5
Tetraodontidae	<i>Canthigaster solandri</i>	41
	<i>Canthigaster valentine</i>	59
	<i>Arothron hispidus</i>	3
	<i>Arothron</i> sp	4
Zanclidae	<i>Zanclus cornutus</i>	219

(P) = Protected category, (R) = Restricted Export category

5. Fishing effort in the Batticaloa and Ampara Districts

There were four main centers of operation for the ornamental aquarium fishery; Kayankeni, Batticaloa, Kattankudi and Kalmunai. The highest number of fish collectors were at Kalmunai while the least number was at Kayankeni (table 3). The majority were migrant collectors from the southern and western coastal areas as well as from Trincomalee. Although most fish collectors tend to operate in the general area of their base camps they may occasionally go far and fish in other areas. For example collectors from Kattankudi may go up to Kalmunai or to Kayankeni. This type of movement also depends on the species that is required to fulfill a particular order. All the fish collectors in the Batticaloa and Ampara Districts were professional divers. There were no amateur divers learning to collect fish during the period of the

survey. This is due to the fact that almost all the fish collectors are migrants and amateur fish collectors are not brought from other areas due to the relatively high cost of living.

In all locations the number of collectors varies during each season as well as at different times during a given season. Whenever sea conditions are not favourable many collectors go back to their home towns to reduce the expenses that they incur by staying on site. Individual collectors sometimes shift their operational areas when they transfer from one group to another. This type of movement occurs when collectors form new alliances with suppliers or due to other personal reasons. Some collectors were unlicensed and none had licenses for collecting gear.

Table 3. Main collecting centers, numbers of aquarium fish collectors and their origins within the study area.

Locations	No of migrant collectors & their home town	No of local collectors	Total no at location
Kayankeni	03 (Kurunegala & Matara)	01	04
Kattankudi	05 (Matara)	0	05
Batticaloa	17 (Trincomalee)	0	17
Kalmunai	35 (Colombo, Matara & Marawila)	01	36

Boats and outboard motors (OBM) are either brought to location by the migrant collectors and suppliers or they may be hired from the location. Hiring of boats may vary during and between seasons. All boats were of similar size (18 to 19 ft in length) and with 15 hp outboard motors. Presently the security forces had banned the use of OBM above 15 hp.

Some boats did not have registration numbers. The only form of identification available on unregistered crafts was the manufacturers' number for each craft. Furthermore, a large number of boats were obtained through donations given to fisher communities after the 2004 tsunami and most of these were unregistered. Aquarium fish collectors hire some of these boats for their fishing operations. In Batticaloa all fishing boats have to enter the sea through the Batticaloa Lagoon outfall and thus the security forces is able to keep a record of all the crafts operating in that area. As a result, boats in Batticaloa had registration numbers issued by the Department of Fisheries and Aquatic Resources. However in Kayankeni and Kalmunai the registration numbers of boats are not checked by the security forces because there is no central location for the boats to set out to sea. Therefore some crafts are not registered by the Department of Fisheries and Aquatic Resources. As with the variation in the number of collectors at a given time the number of crafts also varies depending on the need. For example if there are many collectors at a location for a few days they may hire boats that are available locally.

Table 4. Locations of main collecting centers and the types of crafts used and their areas of registration.

Locations	Type of crafts	No of crafts	Registered area
Kayankeni	All location had the same type of craft which was 18ft or 19ft FRP boats with 15 hp OBMs. (Occasionally may use a 25 hp OBM). Presently the use of 25hp OBM is banned due to security reasons	02	Kayankeni
Kattankudi		01	Matara
Batticaloa		12	Trincomalee
Kalmunai		13	Kalmunai, Marawila/Negombo

5.1 Fish collecting

Most aquarium fish collectors operate from temporary abodes. These may be small houses or camp style structures. The scuba compressors and diving gear will be housed in the same facility. Usually there is an area kept aside for holding the fish, either in polythene bags or in plastic containers with aeration. Fish collectors target only those species that are required to fulfill an order placed by an exporter. The day's catch is placed in these temporary holding tanks. Many species are highly territorial and aggressive towards conspecifics as well as heterospecifics and they have to be kept separately. Aggressive species are kept individually in polythene bags with oxygen and the water is changed twice a day to remove polluted water and to replenish the oxygen in the bag. Generally fish are taken to Colombo daily by lorry. Sometimes organisms are held for a couple of days. There are many species of invertebrates such as starfish and reef shrimps that are collected for export; these species are also treated in the same manner as the fish.

Fish collectors work singly or in pairs. Usually collectors operate in pairs if both are equally skilled and the ability to contribute to the catch is balanced. Most snorkelers work alone, often off the beach. Occasionally, a few snorkelers would get together and use a boat to get to a site that is too far to swim out from the shore. Snorkelers target juvenile and sub-adult butterflyfish, surgeonfish, wrasses and damselfish in shallow coral reef habitats. Most scuba divers operate in pairs with a single boat operator. Scuba is carried out from about 8m to about 30m depth. An operational area and depth depend on the species to be collected. The main target species of the scuba divers are Scarlet shrimps (*Lysmata debelius*), Painted shrimps (*L. amboinensis*), emperor angelfish (*Pomacanthus imperator*), cream angelfish (*Apolectichthys xanthurus*), pygmy angelfish (*Centropyge* spp), gobies (Gobiidae), scorpionfish (Scorpaenidae), omnivorous butterflyfish (Chaetodontidae), clown fish (*Amphirion* spp), and wrasses (Labridae) as well as some invertebrates such as red starfish and poisonous sea urchins.

5.2 Fish collecting gear

Several types of collecting gear are used in the eastern coastal waters. These include the hand net, chaser net (also called the night net), moxy net and the barrier net. Although the use of the moxy net is banned under the Fisheries Act, it is used freely by almost all the fish collectors.

6. Problems experienced in data collection

6.1 Fishery independent data

There were several locations where data could not be collected due to the prevailing security situation. Nearshore reef areas from Punnakuda in the Batticaloa District to Kalmunai in the Ampara District could not be accessed as there were many guard posts along the coast and diving in the nearshore area was prohibited. As a result, species such as *Abudefduf vaigiensis* that are found in large numbers in very shallow reef habitats is not well represented in the data. This is evident when comparing the abundance of the species in the Batticaloa and Ampara Districts (table 1.). Several shallow fringing coral reefs were accessible north of Batticaloa while none of the shallow nearshore reefs were accessible in the Ampara District. Low visibility during the survey due to high turbidity in shallow fringing reefs was also a problem, especially in Challitivu Island and at Kathiraveli.

There are a large number of species collected for export in the marine aquarium fishery. The sampling method used in this study cannot capture the cryptic species such as gobies (Gobiidae), dragonets

(Callionymidae) and dartfishes (Microdesmidae) used in the industry. Similarly reef shrimps cannot be sampled well using these methods as they live within the reef structure and are rarely in the open to be seen by observers. Many species spawn at different times of year and the juveniles appear on the reefs at varying times of the year. Therefore data collection at a given time may not capture all of the species that occur in a given reef area.

6.2 Fishery dependent data

In order to record the catch data accurately it has to be collected at least once a week. Fish collectors keep a record of their catch and it is also recorded by the suppliers. However, fish collectors and suppliers are reluctant to provide this data. The industry stakeholders expressed concern that data collected by NARA will be used to control or stop the marine aquarium fish industry and therefore they fear that providing data to the government could lead to restrictions in collecting and exports. Hence collectors do not provide catch data readily, although all fish collectors maintain a log book in which each collector records his catch. As the number of collectors vary during seasons and also within a given season it is difficult to obtain catch and effort data unless it is collected frequently at least once a week. However, this is not practical for NARA to collect it as sites cannot be visited frequently. Therefore it is important to develop an alternative mechanism to obtain this data.

7. Management Issues

For a healthy marine aquarium fish industry it is important to take into consideration a number of factors; the key issues can be grouped into matters related to: habitat quality, habitat damage due to other human related activities, post harvest care, increasing number of fish collectors, methods used in collecting, harvesting unsuitable size classes of fish and other species, high cost of operations, diving related problems lack of implementation of regulations.

- The overall quality of the coral reef habitats was low except in small patches in Kayankeni. There is little recovery after the 1998 coral bleaching event and the 2004 tsunami. Butterfly fish (Chaetodontidae) is one of the indicators of the quality of a coral reef. During this survey many sites had relatively low abundance of butterfly fish as indicated by the total number sighted for all the transects (Figure 4) indicating the low hard coral cover in many sites.
- High levels of sedimentation was observed on the fringing reefs, reducing their potential to recover from previous negative impacts. Furthermore, due to overall poor recovery of the coral habitats after the bleaching in 1998 and the tsunami in 2004 the long-term effects on the populations of marine aquarium species cannot be predicted as many species are dependent on good habitat quality for recruitment, survival and reproductive fitness. The unpredictable nature of the habitat quality and the subsequent impacts on populations results in difficulties in the planning of future harvestable limits.
- Ornamental fish collectors continue to use the 'moxy net' which is illegal under the Fisheries and Aquatic Resources Act. However this is difficult to implement as the moxy net is small and can be taken by a diver without being detected. In addition the use of 'Barrier Nets' could result in over harvesting, particularly the adults of selected species such as the Blue Surgeon fish (*Acanthurus leucosternon*).
- The habitat quality is seriously compromised by other human activities, particularly the use of nets on reef habitats. These bottom-set nets are used to catch spiny lobsters and reef fish. Entanglement causes loss of reef building organisms such as hard corals, soft corals, sponges

etc. Nets laid even close to reefs can get entangled on reefs as the nets move during strong currents and they eventually get hooked onto reef structures. Furthermore a large number of invertebrates; various species of Echinoderms, and mollusks are also brought up as a result of netting. This by-catch is unutilized and discarded.

- Blast fishing is still present in the area although there is a reduction compared to previous years.
- Coral mining for the production of lime used in the construction industry is still prevalent in Kayankeni and adjacent areas. A tractor load of the mined coral was observed on route to a lime kiln during this survey.
- Ornamental fish collectors raised the concerns of the increase in the number of collectors in the area. This was particularly due to the restrictions placed on diving in the Trincomalee Districts due to security reasons. This can have adverse impacts on the available stocks of aquarium fish in the area.
- Collecting large adult specimens, particularly the large individual breeders of *Pomacanthus imperator*, *Pomacanthus semicirculatus*, *Balistoides conspicillum*, *Acanthurus leucosternon* and some butterfly fish is a major threat to the populations of these species. They are collected to fulfill special orders that require large specimens for zoos and other exhibits. Fish collectors were also of the opinion that collecting these large individuals is a harmful practice.
- Clown fishes (*Amphiprion species*) are negatively affected by the collection of sea anemones as these fish are unable to survive without sea anemones.
- A rapid increase in the cost of operations due to high prices of fuel, living expenses and the other expenses such as boat hire, salaries of boat operators and packers etc. compel collectors to catch anything that can be sold. Fish collectors try to compensate the excess expenses by spear-fishing and by catching spiny lobsters, chanks and sea cucumber. Spear-fishing leads to systematic elimination of large groupers (Serranidae), snappers (Lutjanidae) and emperors (Lethrinidae). Habitats of cleaner shrimps such as Scarlet shrimps (*Lysmata debelius*) and Painted shrimps (*L. amboinensis*) are maintained by these large fish because they also live within the same reef crevices. The large fishes maintain these crevices and holes by fanning out the sand and silt that would otherwise accumulate due to sand and sediment transport on the seabed. Therefore eliminating these large fish results in the reef structure being covered by sand and sediment that eventually cause negative impacts on the populations of the reef shrimps because the shrimps feed on the parasites and dead skin of larger fish. Spearfishing is also illegal in Sri Lanka according to regulations of the Fauna and Flora Protection Ordinance of the Department of Wildlife Conservation.
- There are no proper holding facilities owned by the collectors. Although mortality of collected specimens is generally low during collecting it may be significant when they are held in polythene bags before sending to the exporter. A few damaged and dead specimens were observed twice at Kathankudi and at Kalmunai. However, the level of mortality while in captivity has not been studied. Several species of fish suffer from swim bladder expansion when they are brought up from relatively deep water. Angelfish in particular are prone to this problem. Fish collectors use a hypodermic syringe to puncture the swimbladder of the affected fish while ascending.
- At the current level of aquarium fish collecting, each scuba diver uses 5 cylinders a day. Many collect fish at a depth of 20 to 30m with a 10 minute surface interval between dives. Therefore fish collectors run the risk of suffering from decompression sickness every day. Most divers experience mild forms of bends frequently and carryout in-water recompression and save themselves from a 18more serious attack of the bends. The recompression chamber at the Navy Base in Trincomalee has also been used to treat divers suffering from serious effects of the bends. This problem leads to loss of income as well as social problems when divers get totally incapacitated due to decompression sickness.

8. Recommendations to mitigate impacts and protect species and their habitats

- Although a species based quota cannot be determined with a single survey it is desirable to establish a quota for several species to prevent their over exploitation. Therefore adopt and use the precautionary principle in harvesting resources and establishing species based quotas for selected species based on further studies.
- Implement the existing regulations under the Fisheries Act, Coast Conservation Act, Environmental Act and the Fauna and Flora Protection Ordinance to stop all forms of illegal resource extraction and the use of fishing gear and the conduct of activities that cause habitat degradation, over-exploitation and destruction of species that is part of the by-catch in other commercial fisheries.
- Issue licenses to all ornamental fish collectors and determine the types of gear that can be used by the collectors. These should be identified in the permits issued for ornamental fish collection.
- Restrict or ban the collection and export of large adults of species of angelfish, triggerfish, surgeonfish, moray eels and sea anemones.
- Conduct awareness programmes and develop publications such as leaflets to educate the divers on the negative impacts of spearfishing, proper collecting methods, post harvest care, acceptable holding facilities and safety aspects in diving and emergency procedures.
- As most species listed in the 'Restricted Export Category' were in low numbers and several have not been sighted at all it is necessary to upgrade some of the species such as *Chaetodon ornatissimus* and *Chaetodon bennetti* into the protected category.
- Retain the species listed under the present 'Protected Species Category'.
- Develop a list of species that could be included in a 'Vulnerable Species Category' to indicate that these species should be exploited with caution as their populations are quite low and could be affected by other perturbations such as coral bleaching and infestations of predators that feed on corals.
- Determine through further studies whether the *Centropyge flavipectoralis* should be retained in the 'Restricted Export Category'.

9. Conclusions

The results of the survey indicated that many species used in the marine aquarium fishery is not under immediate threat of over exploitation. However, conclusions could not be drawn with a single survey of the marine aquarium fish because some of the shallow reefs were not sampled due to inaccessibility, thus some species are under-represented in the samples (e.g. *Abudefduf vaigiensis*, *Acanthurus triostegus*). Both these species are abundant in nearshore reefs in Sri Lanka. Furthermore, the number of sampling sites may not adequately represent all of the available reef area within the total extent of the survey area. Smaller cryptic species such as the *Pseudochromis fuscus* hide within the reef structure and they are easily missed by observers; thus these species may be under-represented as well. However it is necessary to adopt a precautionary approach is harvesting.

Among the species currently listed in the 'Restricted Export Category' of the Fisheries and Aquatic Resources Act (FARA) ; *Balistoides conspicillum*, *Chaetodon falcula*, *C. interruptus*, *C. triangulum*, *H. pleurotaenia*, *Plectropomus aereolatus*, *P. laevis*, were in relatively low numbers, as a result the total

allowable catch for these species is very low. Most species within this category were rare or not seen at all. Except the bicolor wrasse (*Labroides bicolor*) none of the other protected species were recorded from the list of 'Protected Species Category' indicating the currently protected species require continued protection. Therefore it is necessary to retain the currently protected species in that category.

Centropyge flavipectoralis is presently listed under the 'Restricted Export Category' of the FARA. However, this species was relatively abundant in the survey area. Therefore further studies in other locations have to be conducted to consider whether it is necessary to retain this species in the above category.

Habitat destruction by various human activities is a serious threat not only to the marine aquarium fishery but also to other economic activities such as tourism and the fishing industry. Human activities combined with climate related habitat degradation and alteration and uncontrolled resource exploitation will further reduce the ability of the reef ecosystems to recover from perturbations. Therefore it is critically important to educate the resource users and implement laws and regulations to sustain the marine aquarium fishery in the Eastern Coastal waters.

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Annex 1.

List of reef fish species used for data collection

Family	Species	
Acanthuridae	<i>Acanthurus leucosternon</i>	
	<i>Acanthurus lineatus</i>	
	<i>Acanthurus triostegus</i>	
	<i>Acanthurus tennetti</i>	
	<i>Acanthurus eiblii</i>	
	<i>Acanthurus</i> spp	
	<i>Ctenochaetus strigosus</i>	
	<i>Naso lituratus</i>	
	<i>Paracanthurus hepatus</i>	
	<i>Zebrasoma scopas</i>	
	<i>Zebrasoma desjardeini</i>	
	Balistidae	<i>Balistoides conspicillum</i>
		<i>Balistapus undulatus</i>
<i>Melichthys indicus</i>		
<i>Pseudobalistes fuscus</i>		
<i>Rhinecanthus aculeatus</i>		
<i>Rhinecanthus rectangulus</i>		
<i>Sufflamen chrysopterus</i>		
<i>Sufflamen bursa</i>		
Blennidae	<i>Odonus niger</i>	
	<i>Ecsenius bicolor</i>	
	<i>Meiacanthus smithi</i>	
Callionymidae	<i>Plagiotremus sphenax</i>	
	<i>Synchiropus stellatus</i>	
Carangidae	<i>Caranx heberi</i>	
Chaetodontidae	<i>Chaetodon auriga</i>	
	<i>Chaetodon bennetti</i>	
	<i>Chaetodon citrinellus</i>	
	<i>Chaetodon collare</i>	
	<i>Chaetodon decussatus</i>	
	<i>Chaetodon ephippium</i>	
	<i>Chaetodon falcula</i>	
	<i>Chaetodon guttatissimus</i>	
	<i>Chaetodon unimaculatus</i>	
	<i>Chaetodon kleinii</i>	
	<i>Chaetodon lineolatus</i>	
	<i>Chaetodon lunula</i>	
	<i>Chaetodon melannotus</i>	
	<i>Chaetodon mertensii</i>	
	<i>Chaetodon meyeri</i>	
	<i>Chaetodon octofasciatus</i>	
	<i>Chaetodon ornatissimus</i>	
	<i>Chaetodon plebeius</i>	
	<i>Chaetodon rafflesi</i>	
	<i>Chaetodon semeion</i>	

Chaetodon triangulum
Chaetodon trifascialis
Chaetodon trifasciatus
Chaetodon vagabundus
Chaetodon xanthocephalus
Forcipiger flavissimus
Forcipiger longirostris
Hemitaurichthys zoster
Heniochus acuminatus
Heniochus diphreutes
Heniochus monoceros
Heniochus pleurotaenia
Heniochus singularis
Cirrhitidae *Cirrhitichthys oxycephalus*
Cirrhitichthys bleekeri
Cirrhitus pinnulatus
Paracirrhites forsteri
Paracirrhites arcatus
Haemulidae *Plectorhinchus vittatus*
Gobiidae *Gobiodon citrinus*
Istigobius decoratus
Valenciennea puellaris
Valenciennea strigata
Valenciennea sexguttata
Plectorhinchus vittatus
Holocentridae *Sargocentron diadema*
Labridae *Anampses lineatus*
Bodianus axillaris
Bodianus diana
Bodianus neilli
Cheilinus undulatus
Oxychelinus bimaculatus
Coris aygula
Coris frerei
Gomphosus caeruleus
Halichoeres argus
Halichoeres hortulanus
Halichoeres leucoxanthus
Halichoeres marginatus
Hemygymnus fasciatus
Hemigymnus melapterus
Labroides bicolor
Labroides dimidiatus
Macropharyngodon ornatus
Novaculichthys taeniurus
Thalassoma hardwicke
Thalassoma lunare
Thalassoma janseni
Microdesmidae *Nemateleotris magnifica*
Nemateleotris decora

	<i>Ptereleotris evides</i>
	<i>Ptereleotris heteroptera</i>
Monacanthidae	<i>Amanses scopas</i>
	<i>Oxymonacanthus longirostris</i>
	<i>Pervagor janthinisoma</i>
Muraenidae	<i>Echidna zebra</i>
	<i>Gymnothorax favagineus</i>
Mullidae	<i>Parupeneus forskali</i>
	<i>Parupeneus indicus</i>
	<i>Parupeneus macronema</i>
	<i>Parupeneus sp</i>
	<i>Upeneus tragula</i>
Ostraciidae	<i>Ostracion cubicus</i>
	<i>Ostracion meleagris</i>
Platiciidae	<i>Platax orbicularis</i>
	<i>Platax teira</i>
	<i>Platax pinnatus</i>
Pomacanthidae	<i>Apolemichthys xanthurus</i>
	<i>Centropyge bispinosus</i>
	<i>Centropyge eibli</i>
	<i>Centropyge flavipectoralis</i>
	<i>Centropyge flavicauda</i>
	<i>Centropyge multispinis</i>
	<i>Pygoplites diacanthus</i>
	<i>Pomacanthus annularis</i>
	<i>Pomacanthus imperator</i>
	<i>Pomacanthus semicirculatus</i>
Pomacentridae	<i>Amphiprion clarkii</i>
	<i>Amphiprion nigripes</i>
	<i>Amphiprion sebae</i>
	<i>Abudefduf vaigiensis</i>
	<i>Chromis dimidiatus</i>
	<i>Dascyllus carneus</i>
	<i>Dascyllus trimaculatus</i>
	<i>Neopomacentrus azysron</i>
	<i>Neopomacentrus cyanomos</i>
	<i>Pomacentrus similis</i>
	<i>Stegastes lividus</i>
Pseudochromidae	<i>Pseudochromis fuscus</i>
	<i>Pseudochromis sp</i>
Scaridae	<i>Clorurus rhakoura</i>
	<i>Scarus spp</i>
	<i>Epinephelus caeruleopunctatus</i>
Serranidae	<i>Epinephelus quoyanus</i>
	<i>Cephalopholis argus</i>
	<i>Cephalopholis formosa</i>
	<i>Cephalopholis miniata</i>
	<i>Pseudanthias squamipinnis</i>
	<i>Pseudanthias dispar</i>

Scorpaenidae	<i>Plectropomus aereolatus</i>
	<i>Plectropomus laevis</i>
	<i>Dendrochirus zebra</i>
	<i>Pterois antennata</i>
	<i>Pterois volitans</i>
Tetraodontidae	<i>Pterois radiata</i>
	<i>Canthigaster solandri</i>
	<i>Canthigaster valentini</i>
	<i>Arothron hispidus</i>
Zanclidae	<i>Arothron sp</i>
	<i>Zanclus cornutus</i>

Annex 2.

Marine aquarium species listed under Protected and Restricted Export categories in the Fisheries and Aquatic Resources Act 1996

Protected species include ten species of aquarium fish and another 16 species belong to the Restricted Export Category. In addition all species of groupers (Serranidae) are listed under the restricted export category.

<u>Family</u>	<u>Species</u>	<u>Categories</u>
Balistidae	<i>Balistoides conspicillum</i>	Restricted export
	<i>Pseudobalistes fuscus</i>	Restricted export
Chaetodontidae	<i>Chaetodon semeion</i>	Protected
	<i>Chaetodon octofasciatus</i>	Restricted export
	<i>Chaetodon ornatissimus</i>	Restricted export
	<i>Chaetodon falcula</i>	Restricted export
	<i>Chaetodon xanthocephalus</i>	Restricted export
	<i>Chaetodon ephippium</i>	Restricted export
	<i>Chaetodon interruptus</i>	Restricted export
	(previously recorded for the Indian Ocean as <i>C. unimaculatus</i>)	
	<i>Chaetodon madagascariensis</i>	Restricted export
	<i>Chaetodon rafflesii</i>	Restricted export
	<i>Chaetodon benetti</i>	Restricted export
	<i>Chaetodon meyeri</i>	Restricted export
	<i>Chaetodon triangulum</i>	Restricted export
	<i>Heniochus monoceros</i>	Restricted export
	<i>Heniochus pleurotaenia</i>	Restricted export
Haemulidae	<i>Plectorhinchus albovittatus</i>	Protected
Labridae	<i>Coris aygula</i>	Protected
	<i>Labroides bicolor</i>	Protected
Platyciidae	<i>Platax pinnatus</i>	Protected
Pomacanthidae	<i>Centropyge flavipectoralis</i>	Restricted export
	<i>Centropyge bispinosus</i>	Protected
	<i>Pygoplites diacanthus</i>	Protected
Scorpaenidae	<i>Pterois radiata</i>	Protected
Serranidae	<i>Epinephelus lanceolatus</i>	Protected
	<i>Epinephelus flavocoeruleus</i>	Protected
	All other groupers	Restricted export

Annex 3.

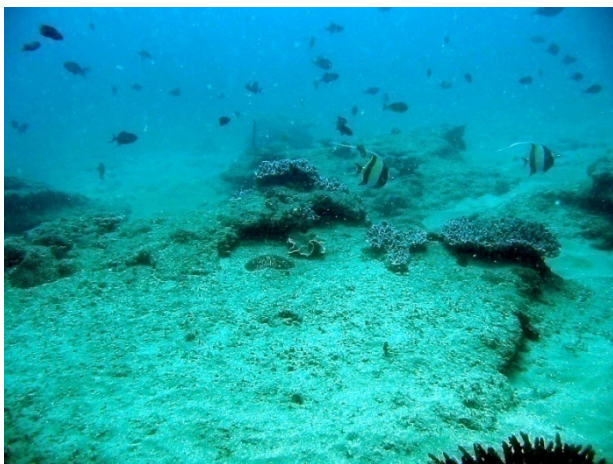
Types of reef habitats in the study area



Coral reef habitat



High relief sandstone/limestone reef habitat



Low relief sandstone/limestone reef habitat



Rock boulder reef habitat