Status of the Marine Aquarium Fishery in the Bar Reef Marine Sanctuary, Puttalam District CENARA Reports: Marine Aquarium Fishery, Northwestern coast, 2008

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Executive Summary

The marine aquarium fishery in Sri Lanka has been in existence for more than 70 years (Wabnitz *et al*., 2003). Presently this fishery is carried out in all coastal areas of the country except in northern coastal waters. All indigenous species are wild caught from reef areas. The current value of the marine aquarium sector of the ornamental fish industry is estimated to be about US $ 4 to 5 million annually. Wood (1996) reported that about 250 species of fish and about 50 species of invertebrates are utilized by this industry. These numbers have increased in the recent past and at present about 330 species of fish and about 50 species of invertebrates are exported from Sri Lanka (De Alwis, 2007). Marine aquarium species are exported mainly to western countries. Three main operational components constitute the industry, namely fish collectors, suppliers and exporters. It is believed that about 100o fish collectors, both scuba divers and snorkelers are engaged in this fishery island-wide. About half of them live in the southern coast within Galle and Matara Districts. The number of individuals that are engaged as aquarium keepers, packers, boat operators, compressor operators etc. is yet to be determined. Habitat damage to coral reefs due to fish collecting and over collection of aquarium species have been attributed to this industry (Wood, 1985; 1996; Mee, 1993; Beets, 1994). Some of these studies created the misconception that the collection of aquarium fish is the main cause of coral reef damage in the country, while the habitat quality was affected by a combination of natural and many human impacts extraneous to the activities of the marine aquarium fishery. The government of Sri Lanka introduced regulations to protect several species under the Fauna and Flora Protection Ordinance (GOSL, 1993) and the Fisheries and Aquatic Resources Act (GOSL, 1996). Because of the large number of species used by the industry it requires to be managed on the basis of individual species or species groups taking into consideration their ecological requirements, abundance and the rate of harvesting. However, the management authorities lacked information on the above aspects. The primary goal of the studies on the marine aquarium fishery of the CENARA project is to obtain the necessary data for adaptive management of the fishery.

The survey was conducted in November 2008 in the Bar Reef Marine Sanctuary, located west of the Kalpitiya Peninsula in the Puttalam District. Information derived from studies conducted by NARA (Rajasuriya and De Silva, 1988; Rajasuriya, De Silva and Ohman, 1995; Ohman, Rajasuriya and Olafsson,1997. Dayaratne et al. 1997; Ohman, Rajasuriya and Svensson, 1998; ; Rajasuriya, 2005, CCD, 2005; CCD, 2007) were used to select the study area. The survey was designed using GIS and 100 sites were randomly selected within the Bar Reef Marine Sanctuary covering an area of about 50 square Kilometers. Sampling was carried out by snorkeling and scuba

diving. Data was collected using the Fish Belt Transect method to record the abundance of selected aquarium fish species and the Point Intercept Transect method to collect data on benthic cover and a two meter belt transect to record the abundance of large invertebrates. In addition, focused interviews were carried out with the primary stakeholders to obtain data on catch and effort and information about the fishery. A major difficulty was encountered in the collection of catch data as the collectors and suppliers were concerned about providing this information as they believed that the data will be used to ban the fishery or bring in various regulations and taxation.

The CENARA Data Systems Standard operating procedures were used to enter and analyse data. Abundance and the maximum sustainable yield for a total of 127 species were calculated and the total allowable catch (TAC) was estimated with 90% upper and lower confidence intervals.

Results showed that sections of patch reefs among the shallow coral reef habitats had recovered well after the 1998 bleaching event. Overall live hard coral cover in the study area was 16.97% whilst some patches of coral had live coral cover of about 90%. The percentage of coral rubble was relatively high at 30.37% within the study area. The main causes of reef degradation were identified as the 1998 coral bleaching event coupled with various other human activities including intensive fishing for edible species of fish with the use of different types of fishing gear and the collection of marine aquarium fish. Use of the seine net (Laila net) has a major impact on all species of fish as it is a surrounding net designed to catch all species except the small fish like the damselfish. Moreover the continued use of bottom-set nets to catch spiny lobsters also causes habitat damage to the reef. The abundance of some of the highly sought after species by the aquarium trade are relatively low, particularly the Powder blue surgeonfish (*Acanthurus leucosternon*), Orangespine unicorn surgeonfish (*Naso lituratus*) and some butterflyfish species (Chaetodontidae). Importantly, none of the presently protected species of aquarium fish were recorded and only 5 species listed under the restricted export category were recorded.

Holding facilities of some suppliers were not properly maintained with several species of fish kept together in relatively small containers and tanks. Stress and mortality can be avoided by improving these facilities with adequate space and by appropriate handling of the specimens. There were 16 scuba divers in three groups were engaged in the collection of aquarium fish; two were based at Kandakuliya while the other was at Kalpitiya. It was noted that the number of divers change occasionally by three to four individuals. All the divers operating within the Bar Reef Marine Sanctuary use scuba to collect fish. The depth of the collecting sites varied between 15m - 30m. Aquarium fish collectors may snorkel occasionally to catch butterfly fish within the shallow coral areas of the reef. It was also observed that the collectors used the banned 'moxy' net even with the use of scuba. According to the Fauna and Flora Protection Ordinance it is illegal to fish within a marine sanctuary. However, all forms of fisheries activities continue within the marine protected area. The boundaries of the sanctuary is unmarked, however, there is no enforcement mechanisms established for the marine protected area. All the collectors possessed permits issued by the Department of Fisheries and Aquatic Resources. Permits varied from a license to collect aquarium fish to some that did not specify a type of fishery. In addition the Sri Lanka Navy at Kalpitiya issues a separate pass for divers in order to maintain security in the area. The main issues raised by the stakeholders were the increasing number of collectors leading to over-harvesting and the commercial fisheries for edible purposes that causes habitat damage and the by-catch of fishing nets that include large specimens of aquarium species. Concerns were expressed regarding the possibility of sea cucumber and chank divers that may begin aquarium fish collecting after over exploiting the stocks of sea cucumber and chanks. Problems related to the use of scuba in deep water were also recorded among the aquarium fish collectors but was a more serious problem among the sea cucumber and chank divers. Nevertheless it is important to educate divers on this aspect.

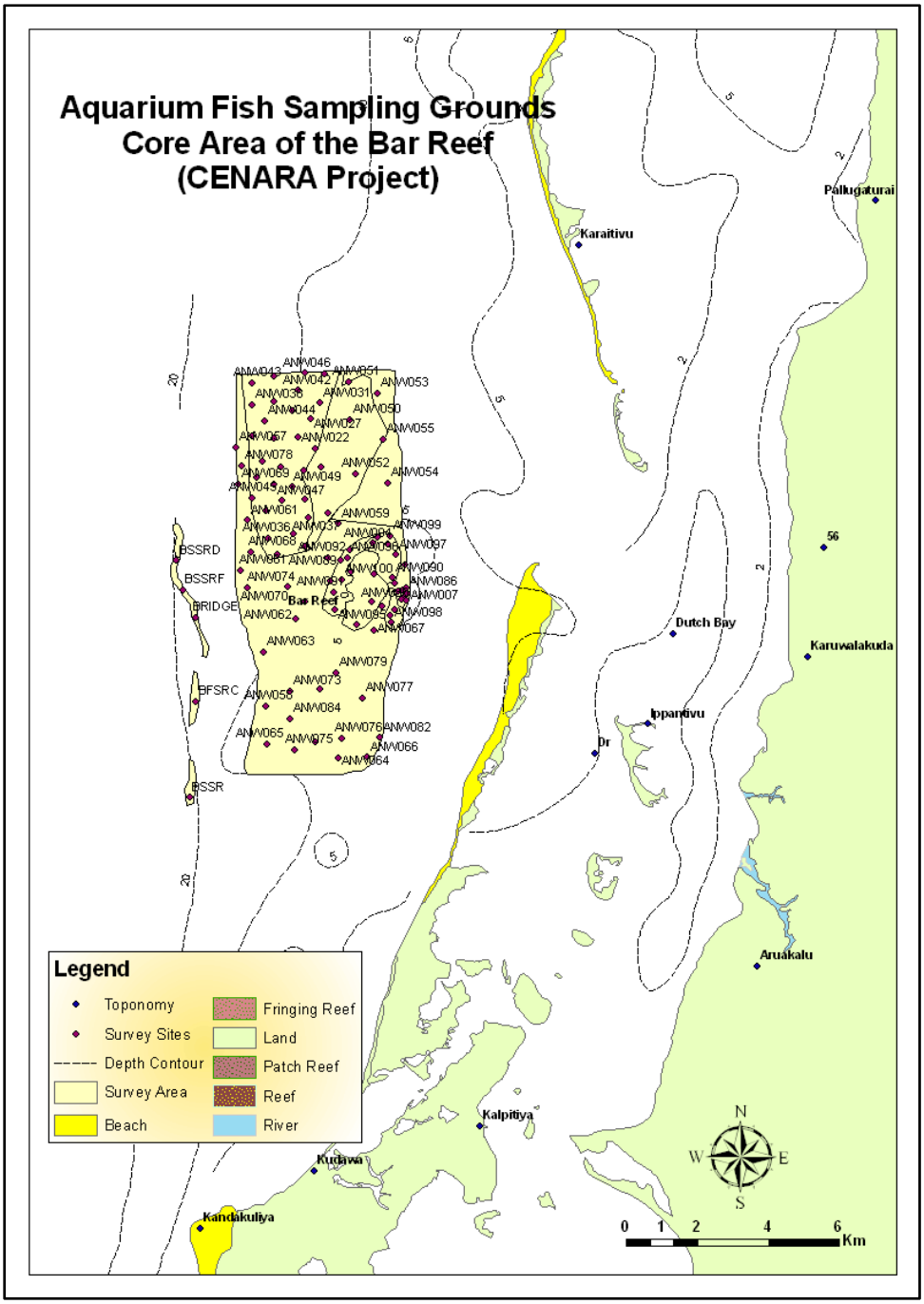
As the marine aquarium fishery is directly affected by the quality of the reef environment, the fishery has to be managed taking into consideration all other impacts on the marine habitats, particularly the impact of commercial fisheries for edible species and the use of destructive fishing methods including blastfishing which is practiced by the 'Laila- net' fishers. Therefore management has to be addressed not only with the stakeholders of the aquarium

industry but with fishers engaged in other forms of fishing as well as the Department of Wildlife Conservation which is responsible for the management of the marine sanctuary. Tour operators engaged in showing dolphins to visitors have begun to use the shallow coral areas of the Bar Reef as a site to show corals to visitors. This activity has already caused damage to the corals by visitors walking on the corals and boats ramming the reef. Planned development activities related to tourism in the Kalpitiya area will undoubtedly increase the impacts on the coral reefs due to visitor pressure and coastal development may cause negative impacts on the marine environment in general. The main issues and management opportunities are listed below.

Issues	Recommendations & Management opportunities
• The study revealed that some species that are important for the industry are in low abundance as their TAC is very low. (Intense harvesting of these species may result in their populations falling below a recovery stage).	• Discuss with all stakeholders and inform them of the current status of these species, especially in the light of serious habitat degradation. • Harvesting should be carried out cautiously adhering to the 'precautionary principal' when harvesting species with low stock sizes.
• None of the 'Protected species' were recorded	• Retain the currently protected species in Part 1 of the schedule under the Fisheries and Aquatic Resources Act of 1996.
• Only 5 species listed in the 'Restricted Export' category was recorded indicating that many other species are also uncommon.	• Re-evaluate the status of these species with surveys conducted in the Eastern and Southern coastal waters. • Consider the possibility of shifting very rare species listed in the 'Restricted Export' category to the 'Protected species' list whilst species that are not under threat of over-exploitation should be considered for de-listing. (This should be carried out with caution and by comparing the results of the studies in the east and northwestern waters).
• Collection of very small size classes of fish. (This is harmful as small juveniles of many species do not survive in captivity).	• Discuss with the exporters and agree on minimum size classes.
• Collection of very large size classes of fish. (These size classes are classified as 'extra-large' and are collected to cater to special orders for public aquaria. This is harmful as breeders are caught and exported. They are difficult to pack and travel poorly. Some tend to die during transit from collecting sites).	• Discuss with the exporters. Discourage the export of breeders.
• Use of moxy nets and other fishing methods that cause habitat degradation. • Over-exploitation of fish stocks • Spear fishing, especially groupers that maintain the habitats of the scarlet shrimps (*Lysmata debelius)* and painted shrimps (*L. amboinensis*)	• Implement the existing regulations. Strengthen the monitoring systems for illegal and destructive fishing. • Discuss with exporters and collectors and establish a 'code of conduct' using best practices to prevent habitat damage due to collecting. • The fish collectors should be educated on the role of the groupers in maintaining the habitats of the reef shrimps (*Lysmata* spp.) and also of the fact that spear fishing is banned in Sri Lanka under the Fauna and Flora Protection Ordinance.
• Inability to obtain catch data from the collectors and suppliers. (It is important to obtain catch data from different areas because species and abundance can vary depending on locations).	• Catch data can be obtained from the record books maintained by every supplier. To obtain this data it is necessary to establish a system through the network of fisheries inspectors. A logbook can be supplied by the DFAR to each Assistant Director in

	charge of the different districts where the catch can be entered.
• Lack of a standardized operational license for the fish collectors in the Kalpitiya area. • Lack of registration of suppliers.	• A standard license should be issued to all the collectors with type of fishing, gear and area specified in the license. • All the suppliers should also be registered although most are not actively engaged in collecting specimens. • The registration of the suppliers should be linked to the data collection system.
• Lack of suitable holding facilities and improper handling of specimens.	• Conduct awareness programmes for suppliers on the proper maintenance of holding facilities. • Conduct awareness programmes for collectors and suppliers on the proper handling of specimens. • Develop a set of guidelines and best practices for holding facilities, handling and packing of specimens.
• Habitat degradation due to natural causes such as coral bleaching, storms etc.	• Improve the protection of coral reefs to enhance their resilience to perturbations.
• Habitat damage and alteration due to human activities such as destructive fishing, pollution etc. (Ecosystems recover from serious damage if they are resilient to perturbations and if chronic negative impacts are absent).	• Implement the existing regulations through the relevant government organizations to prevent the use of destructive fishing methods and illegal activities such as coral mining and illegal construction. • Seek the assistance of the Coast Guard Department to eliminate destructive fishing such as blast fishing. • Conduct awareness programmes for all stakeholders including the local government authorities to impress that the health of the costal waters and reef habitats is critically important and that pollution from the towns and cities as well as other industries need to be managed.
• Increase in the number of fish collectors	• Limiting the number of collectors is a key factor in controlling over harvesting. Therefore the number of collectors should be limited to those who are presently engaged in this fishery. New entrants to the trade should be discouraged. Limit the number to a maximum of 20 individuals.
• Lack of demarcation of the boundaries of the Bar Reef Marine Sanctuary and capacity to enforce sanctuary regulations.	• Although a Special Area Management Planning process was carried out in Kalpitiya and environments with the aim of protecting the Bar Reef very little action has been initiated to actually provide protection to the coral reefs. There is an immediate need to demarcate the sanctuary and establish a system to patrol and enforce the marine sanctuary regulations. • It is important to prevent fishing in the 'Core Area' of the sanctuary that contains the shallow coral reef areas.

Sampling area of the northwestern coastal area



Management issues

During the study and subsequent meetings held with the primary stakeholders of the industry, several issues came to light with regard to management, species and habitat conservation.

- Collection of aquarium species within the Bar Reef Marine Sanctuary.
- Lack of demarcation of the marine sanctuary.
- Lack of capacity and infrastructure to enforce sanctuary and fishery regulations.
- Continued use of destructive fishing methods including blast fishing.
- Increasing number of collectors.
- Lack of standardized licensing of all collectors.
- Collection of small (small juveniles) of some species.
- Habitat damage caused by fishing activities (Laila nets and Bottom set nets).
- Slow recovery of reefs after the 1998 coral bleaching event and impacts on aquaiurm species depend on live corals for feeding and habitat.
- Continued habitat and species changes due to environmental shifts due to climate change.
- Collection of large individuals of species (breeders).
- Improper handling of specimens leading to mortality of collected specimens.
- Increasing expenses for collecting trips, maintenance of aquariums/holding facilities.
- The need to use several scuba cylinders and venture into deeper water resulting in decompression problems.
- Lack of knowledge on problems related to scuba diving.
- Low prices for many species. Prices have not been revised in the recent past.
- Increasing visitor pressure among the shallow coral areas due to promotion of tourism without adequate planning and safeguards to protect the reef.

Management recommendations

Considering the degraded of the coral reef habitats in the northwestern coastal waters during the 1998 coral bleaching event it is important to adhere to the 'precautionary principal' in harvesting aquarium species as well as other living marine resources. Recovery of the populations of aquarium species depends much on the improvement of the habitat and the survival of viable breeding populations. At present there is relatively good recovery of some coral patches in the Bar Reef Marine Sanctuary but lacks full recovery compared to the pre-bleaching status of the reef. Destructive fishing and over harvesting are major issues in the Northwestern coastal waters and aquarium fish collecting is only one aspect of the threats to the populations of reef fish and many species of invertebrates. The following recommendations are made in view of the above.

Aquarium fish collectors catch the required species in all size classes due to the demand and management measures designed to control fish collecting through the divers is unlikely to succeed if the exporters purchase the catch. The most effective approach to control harvesting and to adopt responsible collecting methods is to implement management actions through the exporters. The results of this survey can be used as a guide to control harvesting of species. However, for the recommendation of species based quotas it is necessary to obtain the number of each species harvested. At present the collectors refuse to part with this information because they fear that the authorities would take management actions that are detrimental to their earning capability. Due to the patchy distribution of species it is necessary to obtain catch data by area or reef section or at larger spatial scales by district.

Although the marine aquarium trade utilizes a large number of species, it relies on several high value species to retain a hold in the highly competitive world market. Today the foreign buyers have the opportunity to browse the World Wide Web and select the required species from a vast array of suppliers. Many species with a high value have low abundances naturally. Others such as the powder blue surgeonfish (*Acanthurus leucosternon*) is a highly sought after species and is required for almost every consignment. Management recommendations for such species should take into consideration the possible impacts on the industry as well as the effect on the populations of these fishes.

Species

The results indicate that some of the most sought after species *Acanthurus leucosternon* and *Naso lituratus* have a very low abundance. Both species are highly important for the aquarium trade and exporters need these two species among several other species to maintain their orders in the international market. Although the TAC can be based on the standing stock or the upper or lower 90% CIs, in order to protect species with a low abundance the TAC should ideally be based on the number given under the TAC and not the upper 90% CI indicated for such species. However, due to prevailing market preferences species with very low abundance need to be harvested in order to maintain the trade. Therefore it is recommended that the 'precautionary principal' is applied in such situations and that these species are harvested at the level estimated by the TAC.

None of the species listed under 'Protected species' list of the Fisheries and Aquatic Resources Act and the Fauna and Flora Protection Ordinance were recorded during this study. Therefore these species should be retained in the list of protected species.

Only 5 species out of 17 species listed in the 'Restricted Export' category of the Fisheries and Aquatic Resources Act 1996 were recorded during the study. Therefore the status of the species in the Restricted Category requires re-evaluation. The status of these species can be assessed further by examining results of the surveys conducted in the eastern and southern coastal waters under this project and recommendations can be made accordingly.

The export of small juveniles and large breeding stage adult fishes are harmful to the wild stocks and the exporters should be educated on the detrimental aspects of harvesting unsuitable size classes. However it is difficult to enforce restrictions on size classes as it is impractical to measure fish sizes at the time of exporting. Therefore it is suggested to establish a mechanism such as a monitoring team from the relevant management organizations to visit aquaria periodically to ensure that unsuitable size classes are not stocked. Furthermore, it is highly desirable for the exporters to voluntarily stop the export of unsuitable size classes.

Collecting methods

The use of the illegal moxy net should not be allowed. However, policing the coastal waters to prevent the use of moxy nets is extremely difficult if not impossible because of the small size of the moxy net and its use has to be checked underwater.

Although the barrier net does not cause habitat damage its use is harmful for some species as large breeding sized fishes can be caught with it. Therefore catching the breeders should be prevented. This is a matter that should be discussed with exporters as they can stop the export of large specimens.

Conduct awareness programmes and develop publications such as leaflets to educate the divers on the negative impacts of spear fishing, and the role of the groupers in maintaining the habitats of the scarlet shrimps (*Lysmata debelius*) and painted shrimps (*L. amboinensis*) and in proper collecting methods and post harvest care.

Catch data

It is recommended that a mechanism to obtain catch data be established through the network of fisheries inspectors and the Assistant Director of Fisheries for each District. Every fish collector and supplier maintains catch data in a personal record book. The exporter pays the collectors based on these lists. However, collecting the list from individual fish collectors is not practical and therefore it is recommended that the DFAR make it mandatory for the supplier to provide this list to the Assistant Director of Fisheries of the District. A logbook supplied by the DFAR to each Assistant Director of Fisheries would support this process.

Licensing

Collectors operating in the Kalpitiya area do not have a standard form of license. Some possess an operational license with types of fisheries allowed specified in the license form while others operate on a license issued to a supplier. Still others use a license to engage in fishery activities by diving. Therefore it is essential to issue a standard license to all aquarium fish collectors and list the types of gear that can be used by the collectors. These should be listed in the permit itself.

Limit the number of fish collectors to the present number engaged in this fishery. During the study period there were 16 scuba divers fishing along the western boundary of the Bar Reef Marine Sanctuary. Two groups were based at Kandakuliya while the third was based at Kalpitiya. However, this number varied slightly by about 3 to 4 divers during the study period. Therefore it is important to limit the number of collectors as there is the threat of more divers obtaining licenses especially when the sea cucumber and chank resources become scarce due to over harvesting.

There are only three to four suppliers in the Kalpitiya area. They are not registered at present. Registration of suppliers is important and a license issued, because they can control the size classes of fish when purchasing and they should be the primary source of catch data collection.

Holding facilities

The temporary holding facilities maintained by the suppliers should be improved as many have inadequate facilities with poorly maintained water quality. The suppliers are not concerned about the quality of these facilities because the fish are sent to the exporters daily or every few days. Therefore they do not think that it is necessary to improve the quality of the holding facilities. The DFAR should visit the holding facilities regularly and supervise these facilities.

Fish collectors should be educated in techniques of responsible harvesting, handling and care of the specimens. A series of regular lectures on a set of Best Practices together with diving safety should be conducted to educate them.

Protection of habitats

The marine aquarium fishery cannot be managed in isolation because the habitats of reef fish are being affected by various other human activities as well as natural impacts such as coral bleaching. The main causes of reef degradation due to human activities are; indiscriminate netting to catch spiny lobsters, pollution form land-based sources, blast fishing and coral mining. These should be controlled or eliminated by implementing the existing regulations. Assistance should be sought from the newly established Coast Guard Department to implement some of these regulations.

Crown of Thorns Starfish infestations

Coral reefs in the northwestern coastal waters were severely affected by perioding infestations of the coral predator the ‘Crown of Thorns starfish’ since the 1970’s. Although this starfish was present in fairly high numbers they disappeared immediately after the 1998 coral bleaching event due to lack of live hard corals. During the present survey a few starfish have been observed although they are not present at epidemic levels. However, another population explosion of the starfish could occur that may cause serious damage to the recovering reefs. Therefore it is necessary to monitor the abundance of this starfish periodically in order to take appropriate action should their population indicate an increase.

Managing the Bar Reef Marine Sanctuary

The Bar Reef Marine Sanctuary was declared in 1992 for the protection of species and to serve as a refuge for fish and other organisms. Although it is illegal to harvest within the sanctuary, due to lack of enforcement many forms of fishing activities prevail within the sanctuary. At present it will not be possible to eliminate all forms of fishing within the sanctuary because it will adversely affect the livelihoods of the people. Therefore it is important to demarcate the most sensitive shallow coral reefs and exclude all forms of fishing from the core area of the sanctuary.

The Department of Wildlife Conservation should be involved in the management of the marine protected area and their assistance should be obtained to control the activities within the marine sanctuary.

The abundance, maximum sustainable yield and the Total Allowable Catch for the recorded fish species in the Galle District.

Species		Abudance	MSY	TAC
Abudefduf vaigiensis	Total	23,635	2,363	1,182
	Upper 90%CI	38,656	3,866	1,933
	Lower 90%CI	8,613	861	431
Acanthurus leucosternon	Total	8,755	876	438
	Upper 90%CI	20,297	2,030	1,015
	Lower 90%CI	-2,786	-279	-139
Acanthurus lineatus	Total	60,884	6,088	3,044
	Upper 90%CI	107,613	10,761	5,381
	Lower 90%CI	14,154	1,415	708
Acanthurus mata	Total	4,935	494	247
	Upper 90%CI	9,819	982	491
	Lower 90%CI	51	5	3
Acanthurus spp.	Total	73,134	7,313	3,657
	Upper 90%CI	123,173	12,317	6,159
	Lower 90%CI	23,094	2,309	1,155
Aethaloperca rogaa	Total	4,756	476	238
	Upper 90%CI	9,321	932	466
	Lower 90%CI	191	19	10
Amphiprion clarkii	Total	52,206	5,221	2,610
	Upper 90%CI	91,316	9,132	4,566
	Lower 90%CI	13,096	1,310	655
Amphiprion nigripes	Total	10,483	1,048	524
	Upper 90%CI	17,988	1,799	899
	Lower 90%CI	2,979	298	149
Amphiprion sebae	Total	8,235	823	412
	Upper 90%CI	20,232	2,023	1,012
	Lower 90%CI	-3,762	-376	-188
Anampses lineatus	Total	30,951	3,095	1,548
	Upper 90%CI	53,495	5,350	2,675
	Lower 90%CI	8,408	841	420
Apogon spp	Total	44,521	4,452	2,226
	Upper 90%CI	80,525	8,053	4,026

	Lower 90%CI	8,516	852	426
Apolemichthys xanthurus	Total	698,367	69,837	34,918
	Upper 90%CI	986,664	98,666	49,333
	Lower 90%CI	410,070	41,007	20,503
Balistapus undulatus	Total	28,823	2,882	1,441
	Upper 90%CI	48,108	4,811	2,405
	Lower 90%CI	9,537	954	477
Balistoides conspicillum	Total	2,299	230	115
	Upper 90%CI	6,108	611	305
	Lower 90%CI	-1,510	-151	-75
Bodianus diana	Total	55,100	5,510	2,755
	Upper 90%CI	106,217	10,622	5,311
	Lower 90%CI	3,982	398	199
Bodianus neilli	Total	67,743	6,774	3,387
	Upper 90%CI	121,026	12,103	6,051
	Lower 90%CI	14,461	1,446	723
Caesio xanthonota	Total	4,756	476	238
	Upper 90%CI	9,321	932	466
	Lower 90%CI	191	19	10
Cantherhines pardalis	Total	10,371	1,037	519
	Upper 90%CI	24,667	2,467	1,233
	Lower 90%CI	-3,925	-392	-196
Caranx spp	Total	198,170	19,817	9,908
	Upper 90%CI	410,091	41,009	20,505
	Lower 90%CI	-13,752	-1,375	-688
Centropyge eibli	Total	14,268	1,427	713
	Upper 90%CI	32,956	3,296	1,648
	Lower 90%CI	-4,419	-442	-221
Centropyge flavipectoralis	Total	120,335	12,033	6,017
	Upper 90%CI	198,046	19,805	9,902
	Lower 90%CI	42,624	4,262	2,131
Centropyge multispinis	Total	307,839	30,784	15,392
	Upper 90%CI	528,845	52,885	26,442
	Lower 90%CI	86,834	8,683	4,342
Cephalopholis argus	Total	15,052	1,505	753
	Upper 90%CI	25,847	2,585	1,292
	Lower 90%CI	4,257	426	213

Cephalopholis miniata	Total	143,079	14,308	7,154
	Upper 90%CI	310,180	31,018	15,509
	Lower 90%CI	-24,023	-2,402	-1,201
Cephalopholis sonnerati	Total	22,932	2,293	1,147
	Upper 90%CI	42,987	4,299	2,149
	Lower 90%CI	2,877	288	144
Chaetodon auriga	Total	26,275	2,627	1,314
	Upper 90%CI	49,539	4,954	2,477
	Lower 90%CI	3,011	301	151
Chaetodon collare	Total	268,478	26,848	13,424
	Upper 90%CI	422,281	42,228	21,114
	Lower 90%CI	114,674	11,467	5,734
Chaetodon decussatus	Total	229,688	22,969	11,484
	Upper 90%CI	316,779	31,678	15,839
	Lower 90%CI	142,598	14,260	7,130
Chaetodon gardineri	Total	12,683	1,268	634
	Upper 90%CI	20,452	2,045	1,023
	Lower 90%CI	4,914	491	246
Chaetodon guttatissimus	Total	10,371	1,037	519
	Upper 90%CI	24,667	2,467	1,233
	Lower 90%CI	-3,925	-392	-196
Chaetodon kleinii	Total	56,510	5,651	2,825
	Upper 90%CI	99,179	9,918	4,959
	Lower 90%CI	13,841	1,384	692
Chaetodon lineolatus	Total	4,836	484	242
	Upper 90%CI	9,373	937	469
	Lower 90%CI	299	30	15
Chaetodon lunula	Total	2,690	269	135
	Upper 90%CI	6,530	653	326
	Lower 90%CI	-1,149	-115	-57
Chaetodon melannotus	Total	5,344	534	267
	Upper 90%CI	11,632	1,163	582
	Lower 90%CI	-944	-94	-47
Chaetodon meyeri	Total	82,971	8,297	4,149
	Upper 90%CI	175,768	17,577	8,788
	Lower 90%CI	-9,826	-983	-491
Chaetodon octofasciatus	Total	48,423	4,842	2,421

	Upper 90%CI	110,037	11,004	5,502
	Lower 90%CI	-13,191	-1,319	-660
Chaetodon plebeius	Total	258,372	25,837	12,919
	Upper 90%CI	530,640	53,064	26,532
	Lower 90%CI	-13,896	-1,390	-695
Chaetodon triangulum	Total	20,938	2,094	1,047
	Upper 90%CI	41,945	4,195	2,097
	Lower 90%CI	-69	-7	-3
Chaetodon trifascialis	Total	202,792	20,279	10,140
	Upper 90%CI	335,337	33,534	16,767
	Lower 90%CI	70,248	7,025	3,512
Chaetodon trifasciatus	Total	164,065	16,406	8,203
	Upper 90%CI	244,120	24,412	12,206
	Lower 90%CI	84,010	8,401	4,200
Chaetodon vagabundus	Total	18,012	1,801	901
	Upper 90%CI	33,766	3,377	1,688
	Lower 90%CI	2,257	226	113
Chaetodon xanthocephalus	Total	2,152	215	108
	Upper 90%CI	4,570	457	229
	Lower 90%CI	-266	-27	-13
Cheilinus undulatus	Total	10,739	1,074	537
	Upper 90%CI	23,766	2,377	1,188
	Lower 90%CI	-2,288	-229	-114
Chlorurus rhakoura	Total	3,171	317	159
	Upper 90%CI	7,324	732	366
	Lower 90%CI	-982	-98	-49
Chromis dimidiata	Total	145,304	14,530	7,265
	Upper 90%CI	307,590	30,759	15,379
	Lower 90%CI	-16,981	-1,698	-849
Chrysiptera leucopoma	Total	196	20	10
	Upper 90%CI	513	51	26
	Lower 90%CI	-122	-12	-6
Cirrhilabrus rubrisquamis	Total	4,706	471	235
	Upper 90%CI	11,561	1,156	578
	Lower 90%CI	-2,150	-215	-107
Cirrhitichthys oxycephalus	Total	91,993	9,199	4,600
	Upper 90%CI	159,967	15,997	7,998

	Lower 90%CI	24,019	2,402	1,201
Coris frerei	Total	593,239	59,324	29,662
	Upper 90%CI	877,684	87,768	43,884
	Lower 90%CI	308,793	30,879	15,440
Ctenochaetus striatus	Total	5,636	564	282
	Upper 90%CI	12,027	1,203	601
	Lower 90%CI	-755	-75	-38
Dascyllus aruanus	Total	75,554	7,555	3,778
	Upper 90%CI	182,691	18,269	9,135
	Lower 90%CI	-31,584	-3,158	-1,579
Dascyllus carneus	Total	442,148	44,215	22,107
	Upper 90%CI	658,450	65,845	32,923
	Lower 90%CI	225,845	22,585	11,292
Dascyllus trimaculatus	Total	610,335	61,034	30,517
	Upper 90%CI	836,770	83,677	41,838
	Lower 90%CI	383,901	38,390	19,195
Ecsenius bicolor	Total	20,170	2,017	1,008
	Upper 90%CI	37,235	3,723	1,862
	Lower 90%CI	3,105	311	155
Epinephelus fasciatus	Total	11,098	1,110	555
	Upper 90%CI	22,117	2,212	1,106
	Lower 90%CI	78	8	4
Epinephelus faveatus	Total	21,145	2,115	1,057
	Upper 90%CI	41,472	4,147	2,074
	Lower 90%CI	819	82	41
Epinephelus fuscoguttatus	Total	782	78	39
	Upper 90%CI	2,053	205	103
	Lower 90%CI	-488	-49	-24
Epinephelus malabaricus	Total	13,829	1,383	691
	Upper 90%CI	32,890	3,289	1,644
	Lower 90%CI	-5,233	-523	-262
Epinephelus merra	Total	1,765	176	88
	Upper 90%CI	3,629	363	181
	Lower 90%CI	-100	-10	-5
Epinephelus quoyanus	Total	23,780	2,378	1,189
	Upper 90%CI	54,926	5,493	2,746
	Lower 90%CI	-7,366	-737	-368

Epinephelus spp.	Total	1,765	176	88
	Upper 90%CI	4,335	434	217
	Lower 90%CI	-806	-81	-40
Forcipiger flavissimus	Total	17,277	1,728	864
	Upper 90%CI	37,176	3,718	1,859
	Lower 90%CI	-2,622	-262	-131
Gnathanodon speciosus	Total	20,130	2,013	1,006
	Upper 90%CI	52,516	5,252	2,626
	Lower 90%CI	-12,256	-1,226	-613
Gomphosus caeruleus	Total	374,322	37,432	18,716
	Upper 90%CI	622,889	62,289	31,144
	Lower 90%CI	125,756	12,576	6,288
Halichoeres hortulanus	Total	464,706	46,471	23,235
	Upper 90%CI	667,600	66,760	33,380
	Lower 90%CI	261,811	26,181	13,091
Halichoeres leucoxanthus	Total	137,635	13,764	6,882
	Upper 90%CI	210,331	21,033	10,517
	Lower 90%CI	64,939	6,494	3,247
Halichoeres marginatus	Total	161,375	16,137	8,069
	Upper 90%CI	254,215	25,422	12,711
	Lower 90%CI	68,534	6,853	3,427
Halichoeres spp	Total	154,540	15,454	7,727
	Upper 90%CI	255,954	25,595	12,798
	Lower 90%CI	53,126	5,313	2,656
Hemigymnus fasciatus	Total	42,555	4,255	2,128
	Upper 90%CI	95,189	9,519	4,759
	Lower 90%CI	-10,080	-1,008	-504
Hemigymnus melapterus	Total	3,526	353	176
	Upper 90%CI	7,448	745	372
	Lower 90%CI	-395	-40	-20
Heniochus acuminatus	Total	19,122	1,912	956
	Upper 90%CI	39,685	3,968	1,984
	Lower 90%CI	-1,440	-144	-72
Heniochus pleurotaenia	Total	1,468	147	73
	Upper 90%CI	2,750	275	137
	Lower 90%CI	187	19	9
Heniochus singularius	Total	30,926	3,093	1,546

	Upper 90%CI	69,274	6,927	3,464
	Lower 90%CI	-7,423	-742	-371
Kyphosus cinerascens	Total	1,176	118	59
	Upper 90%CI	2,890	289	145
	Lower 90%CI	-537	-54	-27
Labroides dimidiatus	Total	674,183	67,418	33,709
	Upper 90%CI	822,900	82,290	41,145
	Lower 90%CI	525,465	52,547	26,273
Lethrinus nebulosus	Total	23,780	2,378	1,189
	Upper 90%CI	54,926	5,493	2,746
	Lower 90%CI	-7,366	-737	-368
Lutjanus argentimaculatus	Total	391	39	20
	Upper 90%CI	1,026	103	51
	Lower 90%CI	-244	-24	-12
Lutjanus decussatus	Total	106,119	10,612	5,306
	Upper 90%CI	169,384	16,938	8,469
	Lower 90%CI	42,854	4,285	2,143
Lutjanus fulviflamma	Total	10,085	1,008	504
	Upper 90%CI	20,481	2,048	1,024
	Lower 90%CI	-311	-31	-16
Lutjanus lunulatus	Total	588	59	29
	Upper 90%CI	1,445	145	72
	Lower 90%CI	-269	-27	-13
Lutjanus malabaricus	Total	4,706	471	235
	Upper 90%CI	11,561	1,156	578
	Lower 90%CI	-2,150	-215	-107
Lutjanus quinquelineatus	Total	45,263	4,526	2,263
	Upper 90%CI	92,019	9,202	4,601
	Lower 90%CI	-1,493	-149	-75
Lutjanus rivulatus	Total	31,114	3,111	1,556
	Upper 90%CI	74,002	7,400	3,700
	Lower 90%CI	-11,774	-1,177	-589
Macropharyngodon ornatus	Total	405,213	40,521	20,261
	Upper 90%CI	835,995	83,599	41,800
	Lower 90%CI	-25,570	-2,557	-1,278
Naso hexacanthus	Total	38,908	3,891	1,945
	Upper 90%CI	69,804	6,980	3,490

	Lower 90%CI	8,012	801	401
Neopomacentrus azysron	Total	11,222	1,122	561
	Upper 90%CI	20,921	2,092	1,046
	Lower 90%CI	1,523	152	76
Odonus niger	Total	2,299	230	115
	Upper 90%CI	6,108	611	305
	Lower 90%CI	-1,510	-151	-75
Ostracion cubicus	Total	3,457	346	173
	Upper 90%CI	8,222	822	411
	Lower 90%CI	-1,308	-131	-65
Paracirrhites forsteri	Total	30,695	3,069	1,535
	Upper 90%CI	63,266	6,327	3,163
	Lower 90%CI	-1,877	-188	-94
Parapercis clathrata	Total	4,652	465	233
	Upper 90%CI	9,776	978	489
	Lower 90%CI	-472	-47	-24
Parupeneus indicus	Total	172,856	17,286	8,643
	Upper 90%CI	411,123	41,112	20,556
	Lower 90%CI	-65,410	-6,541	-3,270
Parupeneus macronema	Total	178,207	17,821	8,910
	Upper 90%CI	315,896	31,590	15,795
	Lower 90%CI	40,519	4,052	2,026
Parupeneus spp.	Total	3,529	353	176
	Upper 90%CI	8,671	867	434
	Lower 90%CI	-1,612	-161	-81
Plectorhinchus ceylonensis	Total	83,841	8,384	4,192
	Upper 90%CI	161,448	16,145	8,072
	Lower 90%CI	6,234	623	312
Plectorhinchus schotaf	Total	450,573	45,057	22,529
	Upper 90%CI	842,123	84,212	42,106
	Lower 90%CI	59,022	5,902	2,951
Plectorhinchus vittatus	Total	262,613	26,261	13,131
	Upper 90%CI	620,024	62,002	31,001
	Lower 90%CI	-94,799	-9,480	-4,740
Pomacanthus annularis	Total	47,453	4,745	2,373
	Upper 90%CI	91,695	9,170	4,585
	Lower 90%CI	3,211	321	161

Pomacanthus imperator	Total	225,948	22,595	11,297
	Upper 90%CI	360,698	36,070	18,035
	Lower 90%CI	91,199	9,120	4,560
Pomacanthus semicirculatus	Total	60,596	6,060	3,030
	Upper 90%CI	102,472	10,247	5,124
	Lower 90%CI	18,719	1,872	936
Pomacentrus similis	Total	981,801	98,180	49,090
	Upper 90%CI	1,419,518	141,952	70,976
	Lower 90%CI	544,083	54,408	27,204
Pseudanthias squamipinnis	Total	44,370	4,437	2,218
	Upper 90%CI	77,345	7,735	3,867
	Lower 90%CI	11,395	1,139	570
Pseudochromis fuscus	Total	69,143	6,914	3,457
	Upper 90%CI	164,449	16,445	8,222
	Lower 90%CI	-26,164	-2,616	-1,308
Ptereleotris evides	Total	52,317	5,232	2,616
	Upper 90%CI	114,661	11,466	5,733
	Lower 90%CI	-10,027	-1,003	-501
Ptereleotris heteroptera	Total	101,657	10,166	5,083
	Upper 90%CI	172,775	17,277	8,639
	Lower 90%CI	30,540	3,054	1,527
Ptereleotris spp	Total	6,914	691	346
	Upper 90%CI	16,445	1,644	822
	Lower 90%CI	-2,616	-262	-131
Pterocaesio chrysozona	Total	12,683	1,268	634
	Upper 90%CI	27,279	2,728	1,364
	Lower 90%CI	-1,914	-191	-96
Pterocaesio tile	Total	6,341	634	317
	Upper 90%CI	12,091	1,209	605
	Lower 90%CI	592	59	30
Pterois volitans	Total	4,706	471	235
	Upper 90%CI	11,561	1,156	578
	Lower 90%CI	-2,150	-215	-107
Sargocentron spp.	Total	14,268	1,427	713
	Upper 90%CI	29,217	2,922	1,461
	Lower 90%CI	-681	-68	-34
Scarus ghobban	Total	1,765	176	88

	Upper 90%CI	4,335	434	217
	Lower 90%CI	-806	-81	-40
Scarus spp	Total	157,535	15,753	7,877
	Upper 90%CI	264,234	26,423	13,212
	Lower 90%CI	50,836	5,084	2,542
Scomberomorus spp	Total	4,756	476	238
	Upper 90%CI	10,985	1,099	549
	Lower 90%CI	-1,473	-147	-74
Siganus javus	Total	2,353	235	118
	Upper 90%CI	5,780	578	289
	Lower 90%CI	-1,075	-107	-54
Siganus lineatus	Total	9,116	912	456
	Upper 90%CI	21,979	2,198	1,099
	Lower 90%CI	-3,746	-375	-187
Stethojulis spp	Total	16,769	1,677	838
	Upper 90%CI	36,306	3,631	1,815
	Lower 90%CI	-2,767	-277	-138
Sufflamen bursa	Total	6,341	634	317
	Upper 90%CI	14,647	1,465	732
	Lower 90%CI	-1,964	-196	-98
Sufflamen chrysopterus	Total	509,569	50,957	25,478
	Upper 90%CI	1,182,782	118,278	59,139
	Lower 90%CI	-163,644	-16,364	-8,182
Synchiropus stellatus	Total	31,886	3,189	1,594
	Upper 90%CI	71,422	7,142	3,571
	Lower 90%CI	-7,649	-765	-382
Thalassoma hardwicke	Total	50,152	5,015	2,508
	Upper 90%CI	97,375	9,737	4,869
	Lower 90%CI	2,930	293	146
Thalassoma jansenii	Total	62,842	6,284	3,142
	Upper 90%CI	102,014	10,201	5,101
	Lower 90%CI	23,671	2,367	1,184
Thalassoma lunare	Total	1,720,663	172,066	86,033
	Upper 90%CI	2,904,236	290,424	145,212
	Lower 90%CI	537,090	53,709	26,854
Valenciennea puellaris	Total	28,670	2,867	1,433
	Upper 90%CI	49,837	4,984	2,492

	Lower 90%CI	7,502	750	375
Valenciennea strigata	Total	25,366	2,537	1,268
	Upper 90%CI	56,494	5,649	2,825
	Lower 90%CI	-5,763	-576	-288
Variola louti	Total	726,824	72,682	36,341
	Upper 90%CI	1,680,418	168,042	84,021
	Lower 90%CI	-226,769	-22,677	-11,338
Zanclus cornutus	Total	104,873	10,487	5,244
	Upper 90%CI	161,981	16,198	8,099
	Lower 90%CI	47,765	4,777	2,388
Zebrasoma desjardinii	Total	69,298	6,930	3,465
	Upper 90%CI	113,649	11,365	5,682
	Lower 90%CI	24,947	2,495	1,247
Zebrasoma scopas	Total	51,682	5,168	2,584
	Upper 90%CI	109,598	10,960	5,480
	Lower 90%CI	-6,234	-623	-312

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