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Preliminary Review of the Marine Segment of the Ornamental Fish Industry in Sri Lanka

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Table 1: Marine fishes reported by exporters as exported from Sri Lanka

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EXECUTIVE SUMMARY

This report is a review of information available on the marine fish component of the ornamental fish trade in Sri Lanka and preliminary survey results. Ornamental fish exports have increased from Sri Lanka during recent years due primarily to expansion of freshwater aquaculture facilities and increased importation of wild captured marine fishes from the Maldives. Lack of specific statistical records on ornamental fish collection and exportation and lack of environmental monitoring data on fish populations do not allow for a comprehensive assessment. Political unrest in Sri Lanka presently functions as a limit to the range of fish collection along the coastal areas and provides for effective reserves to overharvesting along much of the coast.

The major problem affecting inshore fish populations is uncontrolled habitat destruction. This is attributed to several causes with every area along the coast experiencing specific problems. Intensive coastal development along the southwestern coast has led to increased habitat destruction from sedimentation, coral "mining", harbor development, boat/anchor damage, pollution (as separate from sedimentation), and destructive fishing practises for both food fishes and ornamental fishes. Other coastal areas experience these problems to varying degrees. The degree to which these factors affect habitat degradation and fish populations has been qualitatively assessed, but it is extremely difficult to quantify the damage due to each factor. Clearly, several activities are destructive and can be regulated. Activities, such as coral 'mining', are illegal but are not enforced. Other activities, such as destructive fishing methods, should be regulated and enforced to diminish habitat destruction. The greatest destruction to habitat in many areas is caused from the use of bottom-set nylon nets for food fishes by commercial/ artisanal fishermen. This method is not used for the collection of ornamental fish due to damage caused to valuable specimens. Two ornamental fish collection methods were identified as destructive and are in need of regulation. The use of 'moxie' nets and fish collection by untrained collectors (primarily children) contributes to habitat destruction, primarily of inshore, shallow-water coral habitats, and should be regulated.

This report provides a brief overview of the status of marine ornamental fish collection in Sri Lanka. The information provided should be considered preliminary. Additional information must be collected and summarized in order to provide a more complete evaluation of the impact of ornamental fish collection on natural population abundance. The management considerations provided herein should be carefully and immediately evaluated for implementation. Delay will postpone the critical need for deterrence of habitat destruction. Arbitrary regulation and lack of enforcement will increase the difficulty of later efforts for critically needed coastal conservation.

Clearly, US AID should carefully review environmental concerns of all related projects and fund only projects that promote environmentally-conscious approaches and management considerations. The present project working with the ornamental trade industry is apparently very concerned with the environmental issues and has provided information to exporters to improve aquaculture, decrease mortality, and increase environmental awareness. Such environmental concerns should be regularly reviewed, evaluated and promoted in this and other sectors.

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I do not consider this to be but a preliminary review of the topic and hope to discuss aspects with numerous other informed and concerned individuals who can enhance the growing perspective of the ornamental export industry and related conservation issues.

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GOALS AND OBJECTIVES

The objective of the present survey was to provide a preliminary view of the status of marine fish species exported from Sri Lanka in the ornamental trade and to provide a plan for the investigation of the impact of collection on local populations of ornamental trade species.

BACKGROUND

The aquarium trade industry in Sri Lanka has grown into a relatively large and profitable economic sector. Although government statistics demonstrated a large increase in exports of ornamental fish during the 1980s (over 150% in value), the reporting system does not provide information on numbers of fish exported nor any records by species, which makes evaluation extremely difficult. Historical descriptions and export information has been published in several articles and reports (Jonklass 1991; Wood 1985; Mee 1993). Wood (1985) provided a thorough review of the ornamental trade in Sri Lanka and listed numerous conservation and management considerations. Wood (1985) estimated that approximately 200,000 marine fishes were exported per year in the mid-1980s and provided estimated export numbers by family. Approximately 150 species of marine fishes are exported from Sri Lanka. Except for periods of political unrest, the trends show increased exports of ornamental fish especially during the last decade (Mee 1993). It has been estimated that 50-60% of ornamental fish exports are wild-captured marine fishes. Wood (1985) estimated that about 20% of the marine fish exported from Sri Lanka are imported from the Maldives. Excellent export records are maintained by the Government of the Maldives and demonstrate over 300% increase in ornamental marine fish exports since 1980 (Mee 1993). The Government of the Maldives have cautiously raised its export quota ornamental trade species in recent years with most fishes exported to Sri Lanka. Concern over the impact of ornamental fish collection in Sri Lanka has increased during recent years (Wood 1985, De Silva 1985, Rajasuriya 1993).

Coastal zone management plans have been completed which provide summary data and trends for various segments affecting nearshore habitats (Coast Conservation Dept. 1990, Olsen et al. 1992). These management plans provide valuable strategies for management of important coastal areas. Recommendations have been made for protection of inshore habitats critical to ornamental fish life history and for the need to manage the ornamental trade to ensure sustained yields.

There are over 600 species of reef fishes around Sri Lanka. Although aquarium trade collection has been conducted for several decades, no complete systematic list of reef fishes has been produced for Sri Lanka. Lists have been derived for use in the ornamental fish trade, but these lists include several species imported from the Maldives and other areas (Table 1). Many collectors and exporters are exceptional observers and use scientific names for fishes, but names are rarely confirmed by scientists or by using scientific literature. Most exporters and collectors refer to Burgess et al. (1990) for identification and occasional errors are apparent (Table 1). Species imported from the Maldives and other locations are consolidated in holding aquaria prior to export so that export lists are of only relative use in deriving species lists for Sri Lanka.

Distribution and abundance information on the coastal marine species of Sri Lanka is sparse. Systematic surveys of inshore marine fishes have not been conducted. Most of the available

information relates to the identification and collection of fishes (Burgess and Axelrod 1973, Jonklass 1975). Jonklass (1975) provided anecdotal information on the distributions and habitats of a few marine species. A few studies have presented information on species richness and abundance at selected sites in Sri Lanka (Ohman et al. 1993 a&b).

Many of the species collected around Sri Lanka are obligate reef-dwellers or attain their greatest abundance on coral reefs or other inshore habitats. The extent of coral reef development around Sri Lanka is small, as it has been over recent geological time. The status of reefs has been investigated and charted by the National Aquatics Resources Agency (NARA; Baldwin 1991). Coral reef conditions and increasing degradation around Sri Lanka has been addressed in a few publications (De Silva 1985, Rajasuriya 1993, Rajasuriya and White 1994). Coral reef degradation has a profound negative effect on the abundance and diversity of coral reef fishes.

Several publications discuss the increasing problem of habitat destruction in the marine environment around Sri Lanka (De Silva 1985, Olsen et al. 1992, Ohman et al. 1993 a&b, Rajasuriya 1993, Rajasuriya and White 1994). Ohman et al. (1993 a&b) conducted studies on reefs of the western coast of Sri Lanka and provided excellent information on the impact of habitat destruction on living coral abundance, structure, and associated fishes. They concluded that commercial/artisanal fishing for food fishes using bottom-set nylon nets was primarily responsible for habitat destruction in this area. Several other causes of habitat destuction have been identified, such as coral 'mining', blast (dynamite) fishing , pollution, and boat damage (De Silva 1985, Olsen et al. 1992, Rajasuriya 1993, Rajasuriya and White 1994). Premaratne (1984, cited in Olsen et al. 1992) estimated coral 'mining' (collection) at over 18,000 metric tons in 1984, with 2282 metric tons from reef and 5377 metric tons from beach.

Although much information about the ornamental fish industry has been presented, there has been little information collected on the impact of fish collection on local fish populations. Several publications have made reference to the harmful aspects of marine fish collection in Sri Lanka to fish populations due to overfishing (Lubbock and Polunin 1975, Wood 1985) and to habitat destruction (De Silva 1985, Rajasuriya 1993, Rajasuriya and White 1994). Lubbock and Polunin (1975) reported that butterflyfishes had declined in abundance in Trincomalee Bay. In an article on fish conservation, Andrews (1990) cited Wood (1985) and Banister (1989) as examples of the over-exploitation of ornamental fishes in Sri Lanka. Unfortunately, no data are presented to support these statements. Indeed, the lack of data available for analysis does not allow for comprehensive scientific assessments.

SURVEY FINDINGS

Discussions with collectors have provided some very valuable information on the distribution and abundance of fishes around Sri Lanka. Much of the information obtained was similar to that presented by Wood (1985), which is detailed in that report.

Exporters primarily purchase and export small juvenile fishes. Larger fishes are not preferred. Although several exporters employ their own collectors, most exporters purchase fishes from collectors or agents. Collectors rarely form cooperatives, so agents purchase fishes from full-time and part-time collectors. Most part-time collectors are apparently untrained non-professionals, usually children. Several areas, especially along the

southwestern coast, do not allow fish collection except by members of the local community. This greatly varies around the coast of Sri Lanka.

Wood (1985) estimated fewer than 500 full- and part-time collectors in Sri Lanka. This is difficult to document since no licensing system exists and records are not maintained on this activity, but apparently the number of collectors has increased during the past decade (especially non-professional, part-time collectors). There are apparently more children presently involved in part-time collecting than a decade ago. Most professional collectors are full-time and collect fishes using nets and scuba. Fortunately, collecting does not involve the use of chemicals which is a great marketing benefit to Sri Lankan exporters. Jonklass (1975) lists numerous collecting methods, but hand nets apparently dominate. Some fishes are collected around 'brush-piles', which are bundles of brush tied together and placed in brackish-water to collect ornamental and food fishes. Full-time collectors and exporters are apparently very concerned about habitat destruction.

Most of the marine fishes exported are collected from the western and southwestern coasts of Sri Lanka and the areas around Trincomalee and Batticaloa on the eastern coast. Terrorist activities limit collection to these areas. This present situation effectively provides reserves to intensive collection although several areas are intensively fished using destructive gear for food fishes, such as bottom-set nylon nets (see below).

Climatic conditions greatly limit reef fish collection around Sri Lanka. The southwestern monsoon normally lasts from May to November and the northeastern monsoon normally exists during the remaining months. This constrains collecting on both coasts for approximately half the year. Monsoon activity thus provides a closed season for collecting which allows fishes to recolonize areas which are heavily collected and may correlate with recruitment periods for many species.

Although over 150 marine species are exported from Sri Lanka, a few species dominate the export numbers. Based on exporter discussions, the species exported in greatest numbers are *Dascyllus trimaculatus* and *Pomacentrus similis? (=melanochir?)*. These species have low wholesale price but are abundant and have low shipping mortality. Other species of damselfishes (including anemone(clown)fishes), butterflyfishes, surgeonfishes, lionfishes, wrasses, triggerfishes, and angelfishes comprise the bulk of exports. Wood (1985) estimated that approximately 200,000 fishes were exported per year in the mid-1980s and provided estimated export numbers by family. Based on estimated value of exports, the estimated number of fishes exported has more than doubled during the last decade although most of the increase is from cultured freshwater fishes and imported fishes from the Maldives. Updated trends and estimates will be available with the publication of Joseph (in press), which was not available at the time of this report.

Presently, no government agency maintains specific records of reef fish collection or export from which numbers of fish per species per month can be calculated. Records are not available on origin (location) of fishes exported and, as stated, fishes imported from the Maldives are combined in export shipment from Sri Lanka. Government statistics are maintained by export of metric tons and value. Since live fishes are shipped in water with great variation in number of fishes per shipment by (water) weight, numerical estimates are vitually useless. Effort was made to review available government records which yielded little useful information for this assessment.

A recurring statement in discussions was that extreme habitat destruction is caused by 'bottom set nets'. This is a commercial/artisanal fishing method used for food fishes in nearshore habitats. Commericial nylon gill nets are used by deploying nets from a boat onto the substrate weighted by large rocks, limestone, coral, cement or bricks. Frequently this gear is set on living coral habitat where the greatest abundance of fishes may be caught. The weights and nets break the living coral reducing the area to rubble. Coral has a slow regeneration and recovery time, especially when large sections are destroyed. This eliminates fish habitat for years, possibly decades. Frequently, nets are left for days or lost and continue to kill fish and destroy habitat for weeks or years. The damage caused by this very destructive method has been documented by Ohman et al. (1993 a&b). This was identified as the most damaging activity in need of immediate attention.

Blast fishing for food fishes using dynamite has also been identified as a contribution to habitat destruction (De Silva 1985, Rajasuriya 1993, Rajasuriya and White 1994). This is a common problem, but easily observed. Usually the total area of reef destroyed per blast is not large but repetitive blasts can damage large reef areas.

Another method causing habitat destruction is the increasing use of 'moxie' nets by ornamental trade collectors. The method is well described by Jonklass (1975). Collectors use this large circular, weighted net to trap fish within an area for capture. Professional collectors are said to cause little damage using this method. However, this method has been increasingly used by young, unskilled, non-professional collectors. Although this activity does not destroy as much area as 'bottom set nets' used by food fishermen, the method is very destructive to coral habitat and should be banned.

The National Aquatics Resources Agency (NARA) is actively involved in marine assessments. Studies in progress related marine habitat and fish resources include coral and habitat assessments and dermersal fish surveys. NARA is conducting surveys on selected reef areas around Sri Lanka which include fish surveys (A. Rajasuriya, pers. comm.). Results of some investigations have been published (De Silva 1985, Ohman et al. 1993 a&b, Rajasuriya 1993, Rajasuriya and White 1994), and a report on the fish surveys should be available within a few months. A survey of landings of food fishes caught by commercial/artisanal fishermen has been conducted during the last year (R. Maldeniya). The report should be available within a few months and will provide valuation information on species which may also be used in the ornamental trade.

Distribution of fishes

Information on the distribution of marine fishes around Sri Lanka is sparse. Jonklass (1975) provided anecdotal information on distribution of some species commonly collected for the ornamental fish trade.

Several species have their greatest abundance in estuaries and harbors with significant freshwater inflow. Species commonly collected in these habitats include *Pterois miles, Cephalopholis argus, C. boenacki, Chaetodon auriga, C. collare, C. (=pictus) decussatus, C. xanthocephalus, Heniochus acuminatus, Zanclus cornutus, Pomacanthus annularis, P. semicirculatus,* and *Pomacentrus melanochir* (Jonklass 1975).

A few species appear in greatest abundance only in certain localities. *Pomacanthus annularis* and *Acanthurus leucosternon* are primarily western and southern coast species. The emperor snapper, *Lutjanus sebae*, primarily occurs in Trincomalee Bay on the eastern coast. This species is usually seen associated with sea urchins which move into the bay. Adults are not observed in the fishery. *Pomacanthus imperator* is also commonly collected in Trincomalee Bay, and *P. annularis* is occasionally found in abundance in this location.

Recruitment patterns

The level of larval supply and variability of recruitment (juvenile abundance following settlement from the plankton) of reef fishes are major factors influencing local abundances. In order to understand the local abundance of different marine fish species and to assess the impact of ornamental trade collecting, some knowledge of local recruitment is necessary (see section on Species of concern below). Since most marine fishes have pelagic larvae, local juvenile fish abundances are not necessarily linked to adult abundances. Fishing intensity may have little to no affect on local juvenile abundance.

The area with the greatest recruitment of most reef fish species is apparently the southwestern coast of Sri Lanka. Collectors state that the greatest abundances of small juveniles along the western and southwestern coasts are present in December following the decline in wave activity driven by the southwestern monsoon. Wind and wave activity is from the southwest from April to November during the southwestern monsoon. Large abundances of *Pomacanthus annularis, P. semicirculatus, Pomacentrus similis?? (=melanochir?)* and *Acanthurus leucosternon* are most noted in this area in November and December.

As stated previously, the red emperor snapper, *Lutjanus sebae*, primarily recruits into Trincomalee Bay on the eastern coast in May or June as urchins, with which they associate, move into the bay. The emperor angelfish, *Pomacanthus imperator*, is collected in abundance in Trincomalee Bay, especially during years of large recruitment.

Results of visual surveys

Several sites were reviewed along the southwestern coast of Sri Lanka. Coral and limestone collection was observed at several sites along the coast. Although illegal, this activity can be commonly observed due to lax enforcement. Coral and limestone are piled beside shoreline areas and transported to kilns for processing into construction lime.

Collection of shallow water fishes by small children carrying small nets and plastic bags was observed at several sites. At two sites, children were working the reef flats by moving small coral colonies. (I could not determine if these colonies were alive.) Several contacts informed me that living coral is frequently broken or moved by non-professional collectors in order to collect fishes.

The inshore area around the old Dutch Fort in Galle is a site of obvious coral destruction. In previous years, the reef flats were covered with living coral colonies (C. Martenstyn, pers. comm.). Presently, the area is littered with broken, dead coral rubble with few living colonies. Coral collection for sale to tourists as curios (and possible for construction

material) and collection of fishes apparently were the primary causes of habitat destruction on this reef. Bleached coral colonies were observed for sale on the fort and children were observed collecting fishes on the reef flats.

The reef at Weligama obviously had a high percentage of living coral in previous years. Unfortunately, the reef is presently very degraded with many dead coral colonies. Although it is difficult to determine the degree of degradation caused by different factors, sedimentation from coastal development, boat use resuspending sediment and anchor damage, and pollution are apparent. Destructive fishing methods were also stated as common and significant problems.

The most impressive reef observed during this survey was located in the southern portion of the bay at Galle, known as Buena Vista. This is an beautiful, shallow-water reef consisting of several spurs with high percentage of living coral cover. The fish fauna had high diversity and abundance. Portions of reef had been damaged from blast (dynamite) fishing, harbor construction, and possibly other harmful fishing methods. Harbor construction has been inactive for several years but is still planned. This activity will certainly cause severe habitat destruction and probably result in total loss of this reef.

Hikkaduwa Marine Sancturary has good coral cover and large numbers of reef fishes is the outer, protected portion. The remaining inshore reef areas in Hikkaduwa have incurred severe degradation from sedimentation from coastal development, harbor construction, boat/anchor damage, destructive fishing methods, and other forms of pollution. Although activities are regulated in the sanctuary, enforcement is minimal. Private interests have maintained a level of protection. Anchoring of glass bottom boats is a significant problem within the sanctuary.

The quantitative transects conducted on two reefs (Buena Vista and Hikkaduwa) during this survey showed that ornamental fishes are a relatively small percentage of the total number of fishes observed on protected, shallow-water reef habitat. Total number of species and fishes are high on these reefs which are in relatively healthy condition. Fish assemblage structure (species composition and abundance) varies greatly with habitat condition (health). Ohman et al. (1993 a&b) demonstrated differences in species richness of fishes among reefs in various states of degradation in Sri Lanka. If ornamental collecting is significant in areas, those species should be in lower abundance in heavily collected areas when compared to similar areas with lower collecting pressure. This has yet to be investigated.

Due to limited time and sea conditions, additional surveys could not be accomplished during this visit. Obviously, many other reefs and marine habitats in Sri Lanka require investigation during an intensive evaluation. Several sites are under study by NARA to enhance the existing knowledge of marine habitat conditions (Baldwin 1991).

Species of concern

Species of concern have been listed in reports which address the ornamental trade. The status of these species is important in order to provide a comprehensive understanding of species which may be considered rare in Sri Lankan waters. First, it is important to understand something of the biology of rare species (and marine organism, in general). Since most marine species have pelagic (free, ocean-living) larvae, which are normally

planktonic for over a month before settling to available substrate, it is unusual to find a species which occurs in abundance with a small, restricted range. This is a much different situation than for freshwater species, such as the bandula barb, *Puntius bandula*, a Sri Lankan cyprinid which has a range of a few hundred meters of a single stream to which its entire natural life history is restricted (Kottelat and Pethiyagoda 1991). Rare reef species are usually found in low abundance on scattered habitat over a large area (tens to hundreds of kilometers). This may be the result from scattered recruitment over a large area of few surviving larvae from spawning events of local individuals. Alternatively, the rare recruits may be the result of spawning events which took place hundreds of kilometers away (such as the Maldives) and transported by currents until suitable settling substrate was encountered. Regardless, the sources of such rare fishes are extremely difficult (or impossible) to determine using existing techniques, making assessment and management difficult. The process of conducting assessments of such stocks is a challenge to marine scientists. It is quite possible that the maintenence, or even existence, of some rare reef fishes in Sri Lanka is dependent on healthy populations in surrounding areas. Therefore, it is advantageous to promote environmental management to adjacent nations, especially nations active in the ornamental trade, such as the Maldives.

Due to the biology of rare marine reef fishes, few species have been listed as threatened or endangered in nations throughout the world. Indeed, reef fish species are rarely listed in the IUCN Red List of Endangered Animals (Anonymous 1988). Most reef fish species have relatively large ranges and become increasing rare at the boundaries of their natural distribution. Many rare and uncommon reef species in Sri Lanka are near the boundaries of their distribution. In Sri Lanka, the Fauna and Flora Protection (Amendment) Act, No. 49 of 1993, lists seven reef fish species. Athough quantitative information is not available, each species will be addressed based on information from collectors, exporters, and other sources (Smith and Heemstra 1986, Myers 1991, Randall 1992).

Pterois radiata - (clearfin) lionfish. This species is naturally rare in Sri Lanka. Normally inhabits bays, lagoons and seaward reefs from reef flat to depth over 15 m. Range: Red Sea to the Society Islands, north to the Ryukyus, south to New Calidonia. Least common of *Pterois* species throughout most of its range.

Platax pinnatus - pinnate batfish. This species is uncommon to rare in Sri Lanka. Normally inhabits sheltered reefs, in caves or under ledges, inshore to mangroves. Range: Red Sea to New Caledonia, north to the Ryukyus.

Chaetodon semeion - semion butterflyfish. This is an extremely rare species in Sri Lanka. Normally inhabits clear water and rich coral growth of outer bay, lagoon and seaward reefs. Range: Maldives to the Tuamotus, north to the Ryukyus, southe to the Great Barrier Reef. Uncommon to rare throughout its range.

Centropyge bispinosus - two-spined angelfish. This species is naturally rare in Sri Lanka, but has been observed to be periodically abundant in Trincomalee Bay (C. Martenstyn, pers. comm.). Normally inhabits bay, lagoon and seaward slopes with rich coral growth. Range: East Africa to the Tuamotus, north to the Izus, south to Lord Howe Island. Relatively common in portions of Micronesia, but rare in the Indian Ocean.

Pygoplites diacanthus - regal angelfish (royal angelfish). This species is extremely rare in Sri Lanka. Normally inhabits clear lagoons and seaward reefs with rich coral growth. Range: Red Sea to the Tuamotus, north to the Ryukyus, south to New Caledonia. Moderately common throughout Micronesia.

Coris aygula - clown wrasse. This species is rare to uncommon in Sri Lanka. Normally inhabits sand or rubble patches of exposed reef flats, lagoon reefs, and seaward reefs to 30 m depth. Range: Red Sea to Line and Ducie Islands, north to southern Japan, south to Lord Howe and Rapa Islands. Uncommon thoughout range.

Labroides bicolor - bicolor (cleaner) wrasse. This species is uncommon to common in Sri Lanka. It has been captured using a small-mesh hand net ('diesel' net) where it is relatively common. This species is a 'cleaner' wrasse which removes parasites from fishes, commonly at established 'cleaning stations' although adults may range over a larger area. Range: East Africa to the Line, Marquesas, and Society Islands, north to southern Japan, south to Lord Howe Island.

Jonklass (1975) listed five species which he stated 'face grave danger of extermination' in Sri Lanka.

Chaetodon ephippium - saddleback butterflyfish. This species is naturally rare in Sri Lanka. Normally inhabits lagoon and seaward slopes with clear water and rich coral growth. Range: Maldives(?) to the Hawaiian, Marquesan, and Tuamotus Islands, north to southern Japan, south to Rowley Shoals, New South Wales and Rapa Island. Common in portions of Micronesia.

Forcipiger flavissimus - longnose butterflyfish. This species is naturally rare in Sri Lanka although periodically more common, possibly due to recruitment pulses. Normally inhabits caves and ledges on exposed seaward reefs and lagoon reefs to lesser degree. Range: Red Sea to Mexico, north to southern Japan and the Hawaiian Islands, south to Lord Howe and Easter Islands. Common in portions of its range.

Pomacanthus imperator - emperor angelfish. This species is uncommon in Sri Lanka although localized recruitment events occur. Periodically, this species experiences abundant recruitment into Trincomalee Bay on the eastern coast. During the 1994 season, juveniles of this species are so abundant that exporters selectively purchase from collectors and occasionally purchase a portion of those available. Juveniles normally inhabit ledges and holes in semi-protected areas in channels of bays, lagoon reefs and outer reef flats. As individuals grow, they move offshore to deeper, seaward reefs and ledges. Range: Red Sea to the Hawaiian, Line, and Tuamotu Islands, north to southern Japan, south to New Caledonia and the Australs. Never common throughout range.

Paracanthurus hepatus - regal (hepatus) tang; pallette surgeonfish. This species is rare in Sri Lanka. Normally inhabits clear, current-swept terraces on seaward reefs. Range: East Africa to the Line Islands, north to southern Japan, south to the southern Great Barrier Reef, New Caledonia, and Samoa. Uncommon and highly localized throughout its range.

Balistoides conspicillum - clown trigger. This is an uncommon species in Sri Lanka. Normally inhabits coral-rich outer reef terraces adjacent to steep dropoffs. Range: eastern Africa to Samoa, north to southern Hokkaido, south to Lord Howe Island. Uncommon to rare throughout its range.

Wood (1985; pages 100-102) listed 29 'vulnerable species' which were noted as uncommon or rare in Sri Lanka. Distribution and relative abundance information was presented based on information from interviews. Based on discussions, these species are still rare to uncommon. No species was stated to have been eliminated or greatly different in abundance over the entire coast. Some species have probably be been eliminated from localized areas due to habitat destruction.

CONCLUSIONS OF PRELIMINARY SURVEY

The major problem affecting inshore fish populations is uncontrolled habitat destruction. Intensive coastal development resulting in habitat destruction from sedimentation, coral "mining", harbor development, boat/anchor damage, pollution (as separate from sedimentation), and destructive fishing practises for both food fishes and ornamental fishes have been identified as major problems. Coastal areas experience these problems to varying degrees. The greatest destruction to habitat in many areas is caused from the use of bottom-set nylon nets for food fishes by commercial/ artisanal fishermen. Two ornamental fish collection methods were identified as destructive and are in need of regulation. The use of 'moxie' nets and fish collection by untrained collectors (primarily children) contributes to habitat destruction, primarily of inshore, shallow-water coral habitats, and should be regulated.

Due to the lack of existing data, it is not presently possible to determine if any marine species in the ornamental trade has declined in abundance, declined in frequency of occurrence, or become very rare (or disappeared). Additional efforts may provide some information available from exporters.

It is very difficult to evaluate the information provided from discussions with collectors and exporters on species abundance trends. The difficulty of objectiveness is confounded by bias from constant work with the resource, desire to supply the present demand, desire to maintain their profession, and such factors as expansion into unexploited (or less exploited) areas. Clearly, some species have locally declined in abundance. Species, such as *Dascyllus aruanus* and *Pomacentrus amboiensis*, were previously abundant in shallow water among inshore coral colonies and declines are due to habitat destruction from several sources, as discussed.

At present, I could recommend few species for additional protection based on scientific information. The legally protected species should be enforced to promote the conservation ethic, but the status of these species should be scientifically evaluated. Some of these species may not face greater danger of extripation than other species. I support the protection of the 'cut flower' species (Mee 1993). These species feed on living coral polyps in their natural habitat and eventually starve to death in aquaria. These species may not be in danger of over-harvesting, but should not be exported in order to promote the conservation ethic and improve the image of the industry. Indeed, one can argue that most collected fish eventually die in export or aquaria within a few months (Wood 1985). However, through technological

improvements and education, the mortality of ornamental trade species can be diminished so that these organisms will hopefully be used for conservation education as well as for private pleasure.

The 'cut flower' marine species presently exported from Sri Lanka include:

Species	Common Names
Chaetodon bennetti	Bennett's butterflyfish
Chaetodon citrinellus	lemon butterflyfish
	citrine butterflyfish
Chaetodon meyeri	Meyer's butterflyfish
Chaetodon octofasciatus	eight-stripe butterflyfish
Chaetodon ornatissimus	ornate butterflyfish
Chaetodon plebius	bluespot butterflyfish
	plebius butterflyfish
Chaetodon triangulum	triangle butterflyfish
Chaetodon trifascialis	chevron butterflyfish
Chaetodon trifasciatus	melon butterflyfish
	sunset butterflyfish

The preliminary survey did allow identification of activities which require immediate management consideration and action. The following management considerations should be viewed as the first level of action which is necessary to provide conservation of these important marine resources.

MANAGEMENT CONSIDERATIONS

1) **Ban use of destructive gear**
In both the commercial food fishery and ornamental trade fishery, destructive gear is presently used. Minimally, the use of chemicals, 'bottom set nets' and 'moxey' nets should be illegal. Blast (dynamite) fishing is illegal but should be strictly enforced. Consideration should be given to the ban of gill nets, especially in certain habitats (coral reefs) and for certain species.

2) **Destruction of coral habitat for any purpose should be illegal and <u>enforced</u>**
The practices of coral 'mining' or collecting should be illegal and strictly enforced. Continued removal of coral, limestone, or any other marine substrate will only accelerate the loss of habitat and their associated fishes and related resources, as well accelerate beach erosion and related problems.

3) **License system for collectors**
A large number of collectors are untrained, non-professionals, especially children and young people. The amount of habitat damage, especially to inshore coral habitat, caused by these collectors appears to be very significant. A license system for collectors, which require mandatory collecting methods, would promote habitat preservation. A consideration could be to limit collection to scuba diving. Additionally, requirement of mandatory reporting of collected fishes by species and location would allow for maintenance of statistics for future assessments.

4) **Reporting systems**

A reporting system of statistical records on ornamental fish exportation should be immediately instituted so that future comprehensive assessments can be conducted. The present system of exporter reports provided to Sri Lanka Customs should be improved with detailed export information submitted to the Department of Fisheries and Aquatic Resources. These data should be maintained by the number of fish exported by species for each exporter by month. Data on number of each species collected per area by month should also be maintained. Ideally, statistical records should be maintained by licensed collectors (see management consideration 3) Presently, summary statistics are only available on weight of exports and value per year.

5) **Establishment and *enforcement* of marine reserves**

Marine reserves can provide an important refuge for spawning individuals and act as a source area of recruitment for other areas if the reserve areas are of sufficient size. The existing reserves are not adequately enforced and are too small to function as source areas for large-scale production. There is no need for the establishment of marine reserves unless strict enforcement can be ensured. Such measures could be viewed as counter-productive.

6) **Education activities**

Several education activities should be conducted to inform collectors, exporters, governmental employees, teachers, and the general public on various aspects of conservation. Workshops, brochures, and other activities should be provided to collectors, exporters, and interested persons on proper and improper collection methods and related information, such as illegal and recommended protected or avoided organisms. Similar activities could be provided for government employees, teachers, and the general public. Items, such as conservation coloring books, are quite effective tools for environmental education for children.

7) **Mariculture**

Mariculture of species in the ornamental trade should be promoted to alleviate the collection pressure.

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