PN-ABZ-793
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THE CURRENT STATUS

OF

THE EXPORT OF FRESH WATER FISH

FROM SRI LANKA

by

Dr S U K Ekaratne,
Department of Zoology,
University of Colombo,
Colombo 3,
Sri Lanka.

May 1996

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INTRODUCTION

The recent past has witnessed much debate and controversy with regard to the aquarium fish trade. Many sectors that make up the functioning framework of our society, including conservationists, exporters, fish collectors, biologists, administrators, journalists, law makers, financiers and politicians have all become involved to various extents in contributing to this debate. Discussions, at times impassioned, have taken place in various fora which have served to highlight the significance that this aquarium fish export trade has on the economy, social structure and the natural heritage of this biodiverse and resplendent island that all of us love and cherish.

The aquarium fish export trade is concerned with the export of both live marine and fresh-water species. Whereas all exported marine fish and marine invertebrates are collected from their natural habitats (often referred to as "wild-caught" stock), some of the fresh-water fish are derived from hatchery reared stock while the rest are caught from the wild. It is in relation to the wild-caught stocks that controversy is yet on-going, because some claim that sufficient numbers are present in the natural habitats for sustainable harvesting from the wild, when counter-claims assert that natural stocks are scarce and that collections from the wild are irreparably damaging the sustainability of our natural resources. Obviously, then, there is an urgent need to examine the issues as an objective exercise.

It is under such a climate of feelings that I have to thank the National Experts Committee on Biological Diversity of the Ministry dealing with the Environment for having invited me to throw some light on these controversies through the preparation of this **Position paper on The Current Status of the Export of Fresh Water Fish from Sri Lanka, particularly in relation to Endemic Species**. The recognition of species has been based on Pethiyagoda, 1991, but it must be mentioned that taxonomic revisions have recently changed

status of some of the fish species (Pethiyagoda, pers. comm.). I wish also to thank Mr Gamini Gamage of the said Ministry for his characteristic patience and to many others for making possible the production of this Position Paper, from among whom Mr Rohan Pethiyagoda and Mr Samantha Gunasekera merit special mention. The book authored by Mr Rohan Pethiyagoda has provided a wealth of information that has no parallel for fresh-water fish of Sri Lanka. It is my privilege to express my sense of gratitude to the many Sri Lankan and overseas institutions that have given me financial and other facilties over about the last twenty five years to conduct research in the aquatic environment, without which I could not have developed the love and dedication towards my work. Many in the aquarium trade provided me with information, in confidence, and I thank them for their trust. I thank the Export Development Board (Dr Elmo Weerakoon) and the Customs Department for allowing me to access their data.

SUMMARY

From among the 80 species of indigenous fresh-water fish in Sri Lanka, 27 are endemic. 60 species are presently recorded as being collected from wild populations and exported in the aquarium trade. From among the 27 endemic fresh-water fish species, upto 20 species are presently being used regularly in the aquarium export trade. Among the most sought after species for exports are the endemic *Puntius nigrofasciatus* and *Puntius titteya* with *Rasbora vaterifloris, Puntius cumingii* and *Belontia signata* being among the other popular exported endemics. *Monodactylus argenteus* is the single-most heavily fished non-endemic species.

Some of the endemic species require urgent management and conservatioin measures for their protection and sustainable management. This is because, their collection imposes further stresses, often severe, on their already strained populations due to their small population size, heavy collection pressure, the intense targeted collection of their attractively coloured varieties or/and specific size groups, population declines due to unknown reasons that could embrace coplex reasons including environmental degradation.The species meriting such concern are *Puntius cumingii, Puntius nigrofasciatus, Puntius titteya, Puntius bimaculatus, Danio pathirana, Rasbora vaterifloris, Aplocheilus werneri, Sicyopus jonklaasi, Malpulutta kretseri, Belontia signata, Aplocheilus werneri and Channa orientalis.*

The fish are exported to about 25 countries, mostly "developed" countries, that include USA, Japan, United Kingdom, Holland, Germany, Singapore, Hong Kong with the USA, Hong Kong, Japan and Germany being the leading countries that receive our exported fish. The consignments that reach Singapore, Hong Kong and Holland are mostly re-exported to other "western" countries.Exports have increased very rapidly over the last 2 to 3 years, particularly since prices have bcome more competitive, and to offset lowered incomes due to the price reduction, exporters have increased exported output. There are over 25 major exporters, with most being registered at Export Development Board and one exporter being registered also under the Board of Investment.

Most endemic species are restricted to very narrow specific habitats and many are shade-loving species, so that apart from physical over exploitation for the aquarium trade, habitat alteration will have added adverse impacts on their survival. There are no comprehensive scienific studies that have been carried out on the requirements of the endemic exported species. In the absence of suitable impact studies, it is not possible to predict what impact habitat alteration will have on these species. Exporters target the more colourful varieties and since their ecological significance has not been studied, what long-term effect such selective exploitation will have cannot yet be forecast in detail. Some species are more susceptible to poor handling and transport conditions. Exporters simply harvest larger numbers to offset

attendant mortalities of such species. Inadequate space, water volume and poor oxygenation during export and excessive pre-export starvation exacts a telling toll on exported numbers of some species.

Apart from legislation that can be effectively monitored, eco-physiological and population studies of a quantitative nature are urgently needed to advise on collection, maintenance and transport conditions that need to be followed by exporters to safeguard collected stocks from unnecessry mortalities. Exporters are eager to learn and would be receptive to receiving appropriate, scientifically formulated, well-meaning practical advice. Studies should be targeted towards this end also, since it seems unlikely that the export trade can yet be modulated based on conservation requirements. Such a strategy could only become feasible after an adequately robust ecological data base has been compiled, which would invariably require time.

Section 1

BRIEF HISTORICAL PERSPECTIVE

1.1. A HOBBY DEVELOPS

Man has always liked to associate himself closely with nature. From the era of his cave-dwelling existence, he has considered animals as somewhat "magical" elements (Bronowski, 1977). Animals were first utilised for purposes of appeasing his hunger and for ensuring his nutritional well-being. As man became more and more domiciled and then increasingly urbanised, his longing to be associated with animals and nature was evinced in various ways, one of which being the rearing of animals in captive form.

The recorded history with regard to the keeping of aquarium fish as pets by man dates back to the days of the ancient chinese civilisations (Kvalvag, 1984). The goldfish, *Carassius auratus*, appears to have been popular even that far back in time since it was the goldfish that the chinese kept in a diversity of aquaria ranging from bowls to ponds (Kvalvag, 1982). The wider availability of a domestic supply of electricity, the lowering of air transport costs in the post-war period and the later development of cost-effective aquarium accessories such as aerators and heating elements facilitated the popularisation of the aquarium fish-keeping hobby. These developments made it easier for people in the colder temperate countries to procure and to maintain the more coulourful warm-water aquarium fish species that originated in tropical countries.

Thus, the keeping of fish as pets in aquaria, which began as a hobby that was limited to the more affluent sectors of society became broader based. After becoming recognised as a hobby from about the 1930s, fish keeping steadily became more affordable and popular so that it is rated as being among the most popular hobbies of the present day consumer-oriented society. Its popularity in the developed world can best be gauged by its recognition as the second most popular hobby in the USA (Alava and Gomes, 1989). With the growth in its popularity and the concurrent expansion of the market for warm water colourful fish

in the developed temperate countries, the stage was soon set for meeting an insatiable demand for more fanciful and impressively coloured fish species and varieties that could command higher market prices. The response from the industry was the continual introduction of newer fish species to the aquarium export market. Such introductions required the intensification of the search for more attractive species and varieties and soon led to the exploitation of hitherto unutilised habitats and the use of wild caught vibrantly coloured fish from tropical biodiverse habitats. Such was the trend that became established for satisfying the demands of the more fastidious hobbyists of developed countries.

1.2. AN EXPORT INDUSTRY FOR SRI LANKA

Sri Lanka is said to have become recruited to this competitive and profitable aquarium fish export trade as early as in the 1920s to 1930s period. Though it is difficult to pin down an exact starting date, there is no doubt that each passing year witnessed the expansion of the aquarium fish export trade in Sri Lanka. Such expansion of an export trade, at the rate of about 10% annually over the last 5 years, served to bring in increasing amounts of much needed foreign exchange and employment opportunities to a country that was valiantly battling to overcome its widening budget deficit and increasing unemployment problem, the dual challenges that continue to bedevil the development processes of our Developing Countries.

Section 2

EXPORTED FRESH-WATER FISH AND THEIR STATUS IN THE EXPORT TRADE

2.1. EXPORTED FRESH-WATER FISH

The total number of exported wild-caught fresh water fish from Sri Lanka is presently 61 species. This number, however is variable because depending on the quantities that are economically harvestable, some species will not be collected for export since an export order has to contain a certain number of individuals and the exporter should be able to supply his overseas client on a regular basis for which reliability of supplies in required numbers has to be ensured.

The case of *Puntius bandula* illustrates how the long-term sustainability of the trade is dependent on a healthy and regenerating population. It is presently reported that *P. Bandula* is not exported because of low numbers present in the wild.

The number of species that are presently exported is therefore 60, as listed in Table 2.1, below.The commonly used english and sinhala names of these fish are given in Annex 1.

Table 2.1. List of Sri Lankan fresh-water wild-caught fish species that are exported from Sri Lanka.

1. *Anguilla bicolor*
2. *Chela laubuca*
3. *Danio malabaricus*
4. *Danio pathirana*
5. *Esomus thermoicos*
6. *Garra ceylonensis*
7. *Puntius amphibius*
8. *Puntius asoka*
9. *Puntius bimaculatus*
10. *Puntius chola*

11. *Puntius cumingii*
12. *Puntius dorsalis*
13. *Puntius filamentosus*
14. *Puntius nigrofasciatus*
15 *Puntius pleurotaenia*
16. *Puntius ticto*
17. *Puntius titteya*
18. *Puntius vittatus*
19. *Rasbora daniconius*
20. *Rasbora vaterifloris*
21. *Lepidocephalichthys thermalis*
22. *Acanthobitis urophthalmus*
23. *Schistura notostigma*
24. *Mystus gulio*
25. *Mystus keletius*
26. *Mystus vittatus*
27. *Ompok bimaculatus*
28. *Heteropneustes fossilis*
29. *Oryzias melastigma*
30. *Aplocheilus dayi*
31. *Aplocheilus parvus*
32. *Aplocheilus werneri*
33. *Microphis brachyurus*
34. *Monodactylus argenteus*
35. *Toxotes chatareus*
36. *Scatophagus argus*
37. *Etroplus maculatus*
38. *Etroplus suratensis*
39. *Butis butis*
40. *Eleotris fusca*
41. *Glossogobius giuris*
42. *Redigobius balteatops*
43. *Schismatogobius deraniyagalai*
44. *Sicyopterus griseus*
45. *Sicyopus jonklaasi*
46. *Anabas testudineus*
47. *Belontia signata*
48. *Malpulutta kretseri*
49. *Pseudosphromenus cupanus*
50. *Channa orientalis*
51. *Channa striata*

52. *Macrognathus aral*
53. *Mastacembelus armatus*
54. *Tetratodon fluviatilis*

Fish species in limited demand in aquarium trade (Pethiyagoda. 1991)
55. *Puntius sarana*
56. *Rasbora caverii*
57. *Clarias brachysoma* - **endemic**
58. *Zenarchopterus dispar*
59. *Sicyopus jonklaasi* - **endemic**, rare

Fish species that are used rarely because of low numbers

60. *Xenetodon cancila*

Although this report has only 60 species as being exported, various lists and statistics in different institutes may give other species also. After studying these many lists and after comparing with other data and literature, I have felt it to be more accurate to exclude some of those other species from the definitive list given in Table 2.1. Some of those excluded species, alongside the reasons for such exclusion, are shown in Table 2.2.

Table 2.2. Fresh-water fish species that appear in some lists as being exported from Sri Lanka but are not included as exported species in this report due to reasons indicated.

Species earlier exported in aquarium trade but now apparently not used
Puntius bandula - **endemic**, highly threatened

Fish whose taxonomic statuts unclear, but used in aquarium trade
Danio aequipinnatus - this species is commonly confused with *Danio malabaricus*

Fish species that have entered export statistics but are probably cases of mistaken identity
Anguilla nebulosa - probably misidentified for *Anguilla bicolor*
Gymnothorax polyuranodon- probably mislabelled intentionally for marine maray eel species, since this species is very rare in fresh waters
Garra phillipsi - probably misidentified for *Garra ceylonensis*
Microphis ocellatus- this is not well known since its habitat is among marginal

vegetation, probably misidentified for *Microphis brachyurus*

Some Introduced species that are sometimes caught from the wild for use in the export trade
Xiphophorus helleri
Trichogaster pectoralis
Osphronemus goramy

2.2. STATUS OF EXPORTED SPECIES IN THE TRADE

From among the 60 species that are exported and shown in Table 2.1, one species (*Xenetodon cancila)* is not exported on a regular basis and another five species (*viz., Puntius sarana, Rasbora caverii, Clarias brachysoma, Zenarchopterus dispar* and *Sicyopus jonklaasi*) are not in high demand (Pethiyagoda, 1991) so that it is 54 species that are regularly exported and presently form the mainstay of this industry.

From among the regularly exported 54 species, 22 species have a heavy demand and are therefore exported in large numbers (Table 2.3) while 17 species and 15 species are exported in moderate (Table 2.4) and low numbers (Table 2.5), respectively.

The fish species that are exported most are *Puntius titteya* (162,965 specimens, numbers are annual figures for 1994, from Gunasekera, 1995), *P. nigrofasciatus* (177,314 specimens) and *Rasbora vaterifloris* (190,054 specimens) .The other heavily exported species are *P. cumingii* (80,320 specimens) and *Belontia signata* (75,321). *Monodactylus argenteus* is the single non-endemic species that is exported in largest quantities with almost 150,000 fish having been exported over a 6-month period in 1994.

Table 2.3 shows, in summary form, the status of the heavily utilised fish. It shows that, in addtion to the 5 species that are among the most heavily collected species, *Lepidocephalichthys thermalis* is also collected in large numbers but its populations seem yet to be in satisfactory condition though *P. asoka* population sizes have suffered severe reduction. Of the two *Aplocheilus* species, *A. dayi* is collected in larger numbers but seems to be maintaining a satisfactory population whereas *Aplocheilus werneri* seems to have suffered in terms of population structure with larger individuals becoming less abundant.

Similar effects on population structure were discernible in *Monodactylus argenteus*, *Toxotes chatareus* and *Scatophagus argus*. The reduction in the more colourful varieties in *Belontia signata, Puntius bimaculatus, P. cumingi, P. nigrofasciatus* and *P. titteya* seems to indicate that an alteration in population characteristics has been brought about by the selective fish collections carried out for the export trade.

Table 2.3. Heavily utilised Sri Lankan wild-caught fresh-water fish species, showing their status and with notes of interest, such as distribution and indicative population condition.

1. *Chela laubuca* - a common fish that is easily bred
2. *Danio malabaricus* - a fish of very common occurrence and is very widely distributed
3. *Garra ceylonensis* - common and quite widely distributed
4. *Puntius asoka* - An endemic species that is becoming scarce and **very restricted** in distribution.
5. *Puntius bimaculatus* - An endemic species that is common, although the more colourful specimens that are selecitvely collected for export may be under intense threat.
6. *Puntius cumingii* - An endemic species that is not uncommon, but the more colourful specimens that are selecitvely collected for export may be under intense threat.
7. *Puntius dorsalis* - not always caught in large numbers. Only the more colourful varieties are selected for export.
8. *Puntius filamentosus* - smaller individuals are used, but is a common widely distributed species.
9. *Puntius nigrofasciatus* - an endemic species which is very **heavily exploited** in the aquarium trade, particularly its colourful varieties. Since it is easily bred in captivity, popularisation of **breeding methods** for this species would lead eventually to cessation of wild collection of this species in large numbers.
10. *Puntius titteya* - an endemic whose colour varieties are much in demand. Although the species is yet somewhat common, sought after colour varieties are rapidly declining. Since **breeding** is not difficult, suitable breeding programmes must be established and popularised without undue delay.
11. *Rasbora daniconius* - is an extremely common widely distributed indigenous species
12. *Rasbora vaterifloris* - is **heavily threatened** by overfishing and by bad handling after capture. Ecological studies, population estimates, conservation measures including better handling and tranport techniques and breeding methods need to be **speedily adopted** for this species.

13. *Lepidocephalichthys thermalis* - is a very common indigenous species that appears to be under no apparent threat. It is, however, very heavily collected and its breeding biology completely unknown that it merits some ecological study.
14. *Acanthobitis urophthalmus* - an endemic species that is not widely distributed, not very common and for which ecological, biological, population data are seriously lacking. It does not appear to be under immediate threat, but **compilation of a data base** for this sepcies is highly desirable, because its characteristics, so far as is known together with heavy fishing pressure, does not bode well for the species..
15. *Aplocheilus dayi* - an endemic species that is collected in large numbers, without seeming to suffer any large population decrease.
16. *Aplocheilus werneri* - an endemic fish whose **population structure** appears to be affected by collections for the aquarium trade. Since it is not very widely distributed, it would seem appropriate to conduct population studies to assess its population status before too great an impact takes place.
17. *Monodactylus argenteus* - an indigenous fish collected from estuarine habitats where the **size** of the exported stock has recorded a decline in recent years (to a 2 to 5cm size), probably as a direct result of over-collection.
18. *Toxotes chatareus* - an indigenous species under heavy collection pressure, with difficulty now being experienced to find specimens larger than 15cm in **size**.
19. *Scatophagus argus* - a heavily fished estuarine indigenous species, whose export **size** seems to have decreased over the years.
20. *Etroplus maculatus* - an indigenous species that is common, though perhaps in reduced quantities. No reliable population estimates are present.
21. *Etroplus suratensis* - an indigenous common species whose smaller sizes are exported
22. *Belontia signata* - an endemic species whose bright colour varieties have decreased greatly due to over collection and requires **restriction of collection**, as well as popularisation of breeding methods.

Table 2.4. Moderately utilised Sri Lankan wild-caught fresh-water fish species.

1. *Danio pathirana*
2. *Esomus thermoicos*
3. *Puntius pleurotaenia*
4. *Puntius ticto*
5. *Puntius vittatus*
6. *Schistura notostigma*
7. *Mystus vittatus*
8. *Heteropneustes fossilis*

9. *Aplocheilus parvus*
10. *Microphis brachyurus*
11. *Redigobius balteatops*
12. *Schismatogobius deraniyagalai*
13. *Malpulutta kretseri*
14. *Pseudosphromenus cupanus*
15. *Channa orientalis*
16. *Mastacembelus armatus*
17. *Tetratodon fluviatilis*

Table 2.5. Sri Lankan wild-caught fresh-water fish species that are exported in low numbers.

1. Anguilla bicolor
2. *Puntius amphibius*
3. *Puntius chola*
4. *Mystus gulio*
5. *Mystus keletius*
6. *Ompok bimaculatus*
7. *Oryzias melastigma*
8. *Butis butis*
9. *Eleotris fusca*
10. *Glossogobius giuris*
11. *Sicyopterus grisseus*
12. *Sicyopus jonklaasi*
13. *Anabas testudineus*
14. *Channa striata*
15. *Macrognathus aral*

From among the 27 species of endemic fresh-water fish species, 20 are used in the aquarium export trade (Table 4.1)

Section 3

BIOLOGY, ECOLOGY, DISTRIBUTION AND POPULATIONS OF EXPORTED FRESH-WATER FISH

The status of the biological and ecological knowledge of the species that are affected by the aquarium trade was considered important. This has been attempted in the next sub-section and it would be seen that very little quantitative knowledge has been gathered for our fish fauna. Although we possess a good knowledge base on the species of fish that are present and some qualitative aspects of their biology and ecology, it would be essential to gather data on **quantitative aspects** for us to entertain any hope at an efficient and sustainable management of our fish stocks that are being harvested. For example, the data base which is summarised below would contain very subjective words with respect population numbers, such as "common", "very common", "uncommon", etc.,. which are not of much use for population management.

Such is the state of our knowledge base and it thus becomes quite clear that it is incorrect for us to state that we possess a good knowledge of our fish fauna, although the situation is undoubtedly much better than for other groups such as most invertebrates.

3.1. FIFTY FOUR EXPORTED SPECIES: THE EXISTING DATA BASE

1. *Anguilla bicolor*

This is one of two indigenous species belonging to the order Anguilliformes (true eels). This species grows in fresh-water and when it is ready to breed, it will undergo metamorphosis involving the build up of adipose tissue, enlargement of eyes and loss of its dark colour (thereafter called "silver eels'). Following metamorphosis, it will migrate into the sea where it will breed, producing glassy leaf-shaped leptocephali larvae. Leptocephali

will then grow and, in coastal waters, metamorphose into transparent, large-headed eel-like forms called elvers. The elvers enter estuaries and travel upriver into fresh waters.

The detailed biology of Sri Lankan eels is as yet unreported, other than for elvers having been reported in the sea off Manaar (Deraniyagala, 1952) and observed in the estuaries at Panadura, Kalutara and Rekawa (personal observations). The Ruhunu University is conducting studies into the biology of Sri Lankan eels (Dr R. Kumaranatunga, pers. comm.) and the Colombo University is studying the reproductive and feeding biology of this species.

The eel is nocturnal and has a carnivorous feeding habit, feeding on fish, crustaceans and molluscs. It is a pest in lagoon prawn fisheries where eels will prey heavily on prawns caught in gill nets (personal observations, Rekawa lagoon). It prefers marshy habitats. It is very common and widely distributed specially in the coastal areas.

The species and larvae are discussed by Deraniyagala (1929, 1931) and various aspects are summarised by Pethiyagoda (1991).

Only small numbers of smaller-sized specimens are used in the aquarium trade and in view of its availability, this species is not presently under threat through practices of the aquarium trade.

2. *Chela laubuca*

C. laubuca is an indigenous, common, widely distributed species. It is distributed almost throughout the dry zone, except perhaps the Walawe basin (Pethiyagoda, 1991). It also extends into the lowland parts of the wet zone. It occupies a mid-depth position of both shallow and deeper slow to fast-flowing streams as well as occurring in ponds and tanks. Commonly shoals in schools of 15 to 30 individuals.

It is a hardy species that feeds mainly on insects (Costa and Fernando, 1967) while taking also stems and leaves (Pethiyagoda, 1991). They spawn easily and mating takes place at dusk or dawn in shallow waters. The 30 or so eggs that are spawned hatch in about 24 hours.

Although wet zone specimens of this species are heavily utilised in the aquarium trade

(Pethiyagoda, 1991), populations of this species are not presently under threat.

3. *Danio malabaricus*

Danio malabaricus is a very common, indigenous species that enjoys a very wide distribution from the dry and wet zone lowlands upto the central highlands. It is commoner in flowing waters but is found in various habitats from tanks, reservoirs, small pools in streams to torrential mountain streams. It is a fast swimmer preferring mid-waters.

It is a hardy fish, feeding on terrestrial insects and detritus (Moyle and Senanayake, 1984). Over 200 light orange-coloured slightly sticky eggs are spawned among marginal weeds and roots, usually after heavy rains. They hatch in one to two days and become free-swimming in about five days (Pethiyagoda, 1991).

Although this species is heavily utilised in the aquarium trade, populations of this species are not presently under threat.

4. *Danio pathirana*

Danio pathirana is a recently described (in 1990) endemic species that has a very restricted distribution in the Nilwala River basin which is not sympatric with the very widely distributed *Danio malabaricus*.It occurs in pools to swift-flowing areas of streams with a pebble or boulder substrate frequenting near-surface waters and swimming slowly in groups of between three to five individuals (Pethiyagoda, 1991; Kottelat and Pethiyagoda, 1990).

Its food habits are not known and Pethiyagoda (1991) has expressed the opinion that it is probably an insectivore. Its breeding biology, ecology are also not well known. It could be adversely impacted by high loads of silt.

It is said (Pethiyagoda, 1991) that aquarium fish exporters voluntarily refarained from collecting this species earlier but that it is now collected in "moderate numbers".

Since it is found in very restricted locations, it is necessary to breed it in captivity for the aquarium trade as well as to adopt conservation measures for its protection (Pethiyagoda,

1991). Ecological studies on this species need to be carried out.

5. *Esomus thermoicos*

This is a widely distributed fish preferring to inhabit muddy pools of the low country dry and wet zones, though it is said to be more abundant in the north eastern dry zone waters (Pethiyagoda, 1991). It is a fast swimmer and has a tendency to leap out of aquaria.

Esomus thermoicos feed son insect larvae, small worms and crustaceans. It is bred easily and spawns about 150 light grey-coloured semi-adhesive eggs in several batches onto floating or marginal vegetation within a period of about one hour (Pethiyagoda, 1991).

It is moderately utilised in the aquarium trade but appears to be in no danger as large populations are reported to be widely distributed.

6. *Garra ceylonensis*

It is an endemic species that frequents the bottoms of rocky or pebble-laden pools or streams. It is widely distributed in both dry and wet zones but is commoner in the wet zone. It is the only species recorded from many high-elevation hill streams (Pethiyagoda, 1991).

The diet of *Garra ceylonensis* consists mainly of diatoms and detritus (Costa and Fernando, 1967) that it probably scrapes off rocks. Breeding biology of the species is not well known, other than that it ascends small rocky streams to breed and that young fish are free-swimming until they reach about a 5cm length at which stage they become benthic (Pethiyagoda, 1991).

It is used in moderate to heavy numbers in the aquarium trade, but it is common and thus does not appear to be under immediate threat.

7. *Puntius amphibius*

This indigenous species is distributed mainly in the wet zone and extends into the coastal dry zone also where it is not uncommon, though not found in large-sized populations

(Pethiyagoda, 1991). It is said to tolerate salinity, occurring in coastal marshes. It occurs in streams and tanks in the dry zone and in gravel or pebble lined streams in the wet zone.

Puntius amphibius feeds on detritus, algae (Prem Kumar *et al*, 1987) and other vegetation. It breeds after the rains, spawning among vegetation in shallow water.

It is sparingly used in the aquarium trade and its populations are not under threat.

8. *Puntius asoka*

Puntius asoka is an endemic species whose numbers have declined in the recent past. It is highly restricted in distribution and occurs only in a few locations in and around the Sitawaka River and in a restricted part of the Kelani River. It is a fast swimmer that does not seem to require shaded habitats. Adults prefer 1 to 2m depths having sandy or gravelly substrates whereas schools of juveniles comprising 30 to 100 individuals frequent very shallow water.

Its diet and breeding biology are not known.

Puntius asoka is popular with the aquarium fish exporters and, in view of their dwindling population numbers, require conservation measures and studies into its biology and ecology.

9. *Puntius bimaculatus*

Puntius bimaculatus is an endemic, common, widely distributed throughout the island but is commoner in the wet zone, being recorded as one of the few fish that ascends montane streams above 1,500m elevation (Pethiyagoda, 1991). It frequents all types of habitats from tanks, rivers to hill streams.

In food habits, it is a substrate feeder, feeding on diatoms, filamentous algae, green algae and detritus (Geisler, 1967; De Silva, Kortmulder and Wijeratne, 1977; Moyle and Senanayake, 1984). It spawns several batches of about 100 egss amongst weeds in shallow water after the onset of rains which hatch after about 48 hours and fry are free-swimming after 1 to 2 days (De Silva, Schut and Kortmulder, 1985).

The more colourful varieties are heavily used in the aquarium and, evn though the species as such is not under threat, some have expressed concern that such varieties would be lost from the gene pool if remedial measures are not speedily adopted.

10. *Puntius chola*

This indigenous species is found in streams, rivers and tanks in both dry and wet zone lowlands, though it is now commoner in the dry zone. It is a shallow water dweller preferring a silty substrate and is abundantly found at dry zone tank sluices.

It is omnivorous browser in feeding habits, preferring zoobenthos (Schiemer and Hofer, 1983). It breeds following the rains and spawns among the vegetation.

It is a hardy fish thaty is utilised in small numbers in the aquarium trade.

11. *Puntius cumingii*

Puntius cumingii is an endemic species found in the south western wet zone, preferring flowing waters, with the red finned variety occurring in slow flowing water in mud or silt substrates of marshy areas adjacent to the Kelani Valley foothills. The yellow finned variety prefers flowing waters with sand to boulder substrates and are to be found in the Kalu River and more southerly areas. *Puntius cumingii* inhabits the water layer near to the bottom where it is present in medium-sized shoals.

It is a hardy species, feeding on green algae, plankton and detritus (Giesler, 1967), but could probably be an omnivore. *Puntius cumingii* matures at about a 3cm length (De Silva and Kortmulder, 1977), spawning after the rains where the spawn of about a 100 eggs hatch in about one day and develop into free swimming fry after another day (De Silva, Schut and Kortmulder, 1985).

The introduction of this fish, along with 3 other species, to the Mahaweli at Ginigathhena by Moyle and Senanayake (on 4th February 1981: Evans, 1981) is highly questionable and can now be used as an example to illustrate how translocation experiments should NOT be

carried out, if the long-term conservation interests of a species assemblage is to be addressed.

It is heavily caught for the aquarium trade. Though the species is not uncommon, the selective harvesting of the more colourful varieties, such as the red-finned varieties, imposes a threat on their gene pool.

12. *Puntius dorsalis*

This an indigenous, common species which is widely distributed in the island, except in the montane area. It prefers flowing waters having pebbles where it stays close to the bottom layers. Its diet consists of algae, diatoms, detritus, higher plants, insects and zoobenthos (Fernando, 1965; Costa and Fernando, 1967; Giesler, 1967; Schiemer and Hofer, 1983; Mayle and Senanayake, 1984). Spawning occurs after the rains when upto 700 small egss are spawned among vegetation.

Smaller-sized more colourful varieties are collected for the aquarium trade in moderate, and sometimes high, numbers.

13. *Puntius filamentosus*

This indigenous *Puntius* species is widely distributed upto about 600m elevation, occurring mainly in flowing water but extending into still and brackish waters (Pethiyagoda, 1991). Its diet consist of crustaceans, diatomsand filamentous algae (Moyle and Senanayake, 1984). In breeding, 500 to 1,000 are spawned around shallow water vegetation which hatch out in about 48 hours and develop into free swimming fry after two days.

Smaller specimens are heavily utilised for the export trade, but it is a common widely distributed species not requiring stringent protective measures at present.

14. *Puntius nigrofasciatus*

Puntius nigrofasciatus is an endemic species that is not widely distributed since it is restricted to forest streams from Kelani to Nilwala basins, with a preference to hilly areas

upto about 300m elevation (Pethiyagoda, 1991). It requires clear, cool shaded sttream waters with sandy or gravelly bottoms and may sometimes be found in quiet pools of streams and rivers.

It feeds on filamentous algae and detritus (De Silva and Kortmulder, 1977; Moyle and Senanayake, 1984). Eggs, numbering about a hundred, are spawned onto marginal plants which hatch in one to two days, developing into free swimming fry a day later (Pethiyagoda, 1991). It is easily bred in captivity (Axelrod, 1967).

This species is very heavily used in the export fresh water fish trade. Although its populations are still abundant in some locations, it should be considered as an endemic species facing risk, particularly with regard to the colour varieties, such as deep red and black varieties, that are selectively collected from some locations. Since *Puntius nigrofasciatus* can be bred easily, popularisation of breeding techniques should take pride of place in evolving conservation measures for this species so that the market for collection of large numbers from the wild would gradually dry up.

15. *Puntius pleurotaenia*

This also is possibly an endemic species, which is not uncommon and being confined to the lower south western hills, within the Kelani and Nilwala catchment areas (Pethiyagoda, 1991). It prefers middle layers of the water column and requires clear, heavily shaded streams exceeding 1m in depth where it tends to form small shoals.

The diet of *Puntius pleurotaenia* consists of filamentous algae, terrestrial insects and detritus (Moyle and Senanayake, 1977). Its breeding habits are unknown, except that maturity is reached at about 64cm (De Silva and Kortmulder, 1977).

It is caught in moderate numbers for the aquarium trade.

16. *Puntius ticto*

Puntius ticto is indigenous and is distributed widely in tanks and smaller rivers of the

northern and eastern dry zone where it frequents the still and shallow marginal areas (Pethiyagoda, 1991). It feeds on crustaceans, insects and plankton and has been bred in captivity where about 150 eggs are laid in batches of about 20. The eggs hatch in a day and develop to free swimming fry in another day (Axelrod, 1980).

This commonly found species is exploited by the aquarium trade in moderate numbers.

17. *Puntius titteya*

This endemic species is not widely distributed and is confined to heavily shaded, shallow, slow-flowing waters with silty and leaf-debris substrates in the low country wet zone, upto about 300m in elevation (Pethiyagoda, 1991). It has an omnivorous diet consisting of detritus, algae, diatoms, diptetans and animal matter. It has been easily bred in captivity for many years (Axelrod, 1967). It is not a hardy fish. Eggs, numbering about 200, are scattered among marginal vegetation. Hatching occur in one to two days and free-swimming fry develop two days after hatching.. Fry rearing requires careful feeding.

Puntius titteya is very popular among exporters, specially the more colourful varieties, such as the males of the red variety from Nilwala basin. Although the species itself is still quite common, certain colour varieties, such as the red-finned varieties, are extremely difficult to find and is rapidly being overfished. Therefore, exports should ideally be confined to hatchery-rearedd individuals and breeding programmes should be tested with fry food available in Sri Lanka and popularised.

18. *Puntius vittatus*

Puntius vittatus is a very common indigenous species, occurring in water bodies, including brackish waters, in the wet and dry zones upto about 300m in elevation. It is algal feeding herbivore, feeding on filamentous and blue-green algae. This fish species breeds easily and prolifically, spawning about a 1,000 eggs that hatch on the next day and develop into free swimming fry after a further day.

Some colour varieties of this common fish are used in the aquarium trade.

19. *Rasbora daniconius*

Rasbora daniconius is very common, widely distributed and one of the most abundant indigenous fishes, occurring mainly in sandy streams and rivers and extending to almost saline waters. In distribution it occurs throughout the island at elevations below 500m. It feeds mainly on aquatic insects and detritus and small quantities of macrophytes (Fernando, 1956; Costa and Fernando, 1967; Moyle and Senanayake, 1984). This species lays about 500 non-adhesive eggs which sink to the bottom to hatch in 36 to 48 hours, the fry becoming free swimming about two days later (Pethiyagoda, 1991).

Rasbora daniconius is a popularly exported fish species for the aquarium trade, but it is so abundant that no threat can be conceived to occur on this species through the aquarium exports.

20. *Rasbora vaterifloris*

Rasbora vaterifloris is an endemic, attractive species that has a restricted distribution in streams of the Kalu River to Nilwala River basins. It requires heavy shade and shallow, cool, clear streams with leaf debris on a silty substrate, as are to be found in forested areas (Pethiyagoda, 1991). It is a quiet, retiring fish tending to avoid light and frequenting mid-regios of the water column.

R. vaterifloris feeds on dipterans, coleopterans, other insects and detritus (Giesler, 1967; Moyle and senanayake, 1984). It is a prolific breeder laying several batches of about 20 eggs among submerged marginal vegetation within about a 30 minute period. The eggs sink and hatch in about 36 hours, developing into free swimming fry on the following day. The young, as are the adults, are very sensitive to water conditions.

This species has several colour varieties and the red, orange, yellow-finned colour varieties are very heavily sought after fish for the export aquarium trade. It is under heavy

threat through over-exploitation by the export trade and requires immediate study and the adoption ofconservation measures. Animals that are caught are very sensitive to stress, handling and water conditions so much so that it is said (Pethiyagoda, 1991) that only about 10% of captured fish survive to the retailing point.

21. ***Lepidocephalichthys thermalis***

This indigenous hardy loach is widely distributed in quiet, flowing, unshaded waters with sandy to muddy substrates ranging from coastal areas to elevations of around 600m. It feeds on algae, leaf debris and detritus while its breeding biology is completely unknown.

It is heavily collected for the aquarium industry but its populations have been sufficiently large and widely dispersed so as to withstand this pressure without any apparent signs of population stress.

22. ***Acanthobitis urophthalmus***

Acanthobitis urophthalmus is an endemic loach that is not very common. Its distribution is restricted to shallow, flowing pebble-bottomed waters of the south western lowlands, upto an elevation of about 300m.Its diet and breeding biology are not known, but it probably feeds on detritus and invertebrates (Pethiyagoda, 1991).

Its body colouration of tiger-like stripes has made it a sought after species for the aquarium trade and is heavily fished. The population status of *Acanthobitis urophthalmus*is not known, though existing populations seem to support thge view that it is not under immediate heavy threaty at present.

23. ***Schistura notostigma***

This endemic banded loach is not uncommon in its shallow flowing water habitat which is mainly in the central hills, going upto 1,500m in elevation. It ascends steep inclines and

is found in high mountain streams. It is a benthic feeder, taking also trichopterans, ephemeropterans algae, vegetable matter and detritus (Costa and Fernando, 1967; Moyle and Senanayake, 1984; Pethiyagoda, 1991). Its breeding habits are not known.

It is moderately fished for the aquarium trade, but does not seem to be in urgent danger.

24. *Mystus gulio*

Mystus gulio is an indigenous catfish that is primarily a brackish-water species extending its range successsfully into fresh water. It is found mainly on the coastal plains upto about a 30km distance inland. It feeds probably on an invertebrate diet and spawns eggs that are attached to vegetation, beyond which its biology is unknown.

It is only collected for the aquarium trade in small numbers.

25. *Mystus keletius*

This indigenous catfish species is widely distributed in muddy substrates of pools and tanks in the Anuradhapura-Polonnaruwa area (Pethiyagoda, 1991). It also occurs near coastal areas but does not extend into the hills. It is noctural and feeds on plants, insects, detritus and benthic animals (Fernando, 1965). Its breeding biology is unknown.

Mystus keletius is regukarly collected for the aquarium trade, though in samll numbers.

26. *Mystus vittatus*

This is an indigenous nocturnal catfish having a wide distribution throughout the low country and is commonly found among marginal vegetation in lakes and swamps having a muddy substrate (Pethiyagoda, 1991). It feeds on plants, insects, detritus and benthic animals (Fernando, 1965). Its breeding biology is unknown.

It is collected for the aquarium trade in moderate to heavy numbers.

27. *Ompok bimaculatus*

Ompok bimaculatus is a common, indigenous catfish having a wide distribution in tanks and small streams of the low country having shallow, quiet muddy to sandy bottoms. It is noctunal and feeds on vegetable matter and fish (Fernando, 1965). Its reproductive biology is hardly known.

Limited numbers are caught for export.

28. *Heteropneustes fossilis*

This stinging catfish is widely distributed and indigenous. It is found throughout the low country inhabiting swampy, turbid waters forming schools of about 10 similar-sized individuals. It extends into brackish waters. It is omnivorous. It lays light green eggs in a muddy depression in shallow water excavated by both parents. Eggs hatch in about two days and the young are cared for by the parents until they are about a month old. *Heteropneustes fossilis* can tolerate tempeatures upto almost 40°C (Vasal and Sudara Raj, 1978) and can stay out of water for extended periods since it is able to breathe air.

There is a moderate to heavy collection of this species for the aquarium trade but it appears to be able to withstand it, at present.

29. *Oryzias melastigma*

This is a common, quite widely distributed small-sized fish inhabiting swampy brackish waters of the coastal wet zone. They are found in shallow waters among roots and mangroves. *Oryzias melastigma* feeds on small animals such as insects, larval forms and fry. It is easily spawned in captivitty where eggs of upto a dozen per batch are attached to the underside of surface vegetation by adhesive filaments. Eggs take about 10 days to hatch (Pethiyagoda, 1991).

A few of these fish are collected for export.

30. ***Aplocheilus dayi***

Aplocheilus dayi is a common endemic species having a distribution that is confined to the Kelani River basin and its adjacent coastal areas. They occur in shallow, heavily shaded shallow forest streams with a silt substrate, extending into less saline parts of mangrove swamps.It feeds on small such as insects, larval forms and fry. Spawned eggs hatch in about 2 weeks and the species is easily bred in captivity.

Large numbers of *Aplocheilus dayi* are collected for export, but its population does not seem to have suffered any large-scale decline.

31. ***Aplocheilus parvus***

This is an indigenous fish that is common in coastal fresh and brackish water habitats of the low-country, including paddy fields. It is a slow swimmer, preferring to stay just under the cover of surface vegetation. It is a shoaling species inhabiting shallow to deep waters. Like the previous species, it feeds on small animals such as insects, larval forms and fry. About a hundred adhesive eggs that are deposited on submerged vegetation hatch in about 10 to 14 days.

Aplocheilus parvus is collected for the aquarium trade in moderate to heavy numbers, *but* continues to be a coomonly available fish species.

32. ***Aplocheilus werneri***

This endemic killifish is still quite abundant within the restricted areas in which it is found. It is distributed from the Kalu River to Nilwala basins, upto about 200m in elevation where it frequents shallow, slow-flowing heavily shaded streams having a silt or to clay substrate. It feeds on small insects, larvae and fry. Its breeding biology is not clearly known but would probably be similar to the previous species.

Aplocheilus werneri is intensively collected for the aquarium trade and it is reported that large-sized individuals are now hard to find (Pethiyagoda, 1991), so that collections would

seem to have some impact on its population structure.

33. *Microphis brachyurus*

This is an indigenous pipefish that has a wide regional distribution, though not very common. It occurs in margins of estuaries of wet zone rivers among vegetation in shallow still to slow-flowing waters (Pethiyagoda, 1991). It is thought that it lays about 250 minute eggs that are carried on the ventral side of the male.

It is caught in low to moderate numbers for export.

34. *Monodactylus argenteus*

Monodactylus argenteus is a common indigenous estuarine fish found in coastal water bodies including coastal reef areas. It is found specially in rivers with a low flow and prefers to frequent undersides of floating vegetation. Its natural diet is not known. Their eggs are demersal and are attached to stones, etc.

It is heavily fished for the export trade using a variety of methods, including brush piles. The size for export has decreased in recent years so that the intesive fishery seems to be impacting its population structure.

35. *Toxotes chatareus*

The archer fish is indigenous and is mainly recorded from estuaries of the smaller coastal basins (Pethiyagoda, 1991), particularly the Bentota River basin. It feeds predominantly on insects and it is said to lay from 20,000 to 150,000 eggs.

It is in heavy demand for export and may have led to the rarity of specimens larger than 15cm.

36. *Scatophagus argus*

Scatophagus argus is a moderately common indigenous species frequenting most coastal

lagoons and estuaries, but sometimes extending into fresh waters. It is an omnivore whose reproduction is not recorded and has not been bred in captivity.

It is heavily fished for the aqurium trade and its export size seems to have decreased over the years.

37. *Etroplus maculatus*

This is a common indigenous fish that is distributed throughout the low-country in estuaries, tanks and small streams, though not in large rivers. It is now rare in the dry zone tanks. It is a hardy fish that frequents marginal vegetation. *Etroplus maculatus* feeds on zooplankton, fish fry and algae. It spawns about 200 eggs either into a soft, shallow depression in shallow water or attaches them to a flat vertical surface. Though the eggs hatch in about five days under the guardianship of the parents, the fry remain attached to the eggs for about a further week and are thereafter tendded by the parents until almost fully mature.

It is collected in large numbers for the aquarium trade. Its rarity in the dry zone tanks is probably a result of competiton from introduced exotic species.

38. *Etroplus suratensis*

Etroplus suratensis is also a common indigenous cichlid that is abundant throughout the lowlands in large rivers, reservoirs, lagoons and estuaries. Adults are more herbivorous and will take some insects (Fernando, 1965; Pethiyagoda, 1991). The 500 or so attached eggs are guarded by the parents and hatch in about 4 days. Thereafter, the parents will tend the young until they are about 3 cm in body length, feeding them during the first week on a mucous secreted by the parents.

Small individuals are heavily utilised for the export trade.

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Small individuals are heavily utilised for the export trade.

39. *Butis butis*

This is an indigenous species that is not uncommon in the brackish waters of the south western coastal region. Called the "upside down sleeper", it is found in still water on or under submerged vegetation or a branch and would hardly move other than to catch its food. Although it had been common in the Dehiwela and Wellawatta canals earlier, pollution seems to have displaced them (Pethiyagoda, 1991). It feeds on small fish and crustaceans while its breeding biology is not recorded.

It is caught in small quantities for export.

40. *Eleotris fusca*

Eleotris fusca is indigenous and is not a common species. It is distributed throughout the coastal areas of the south west, from Lunawa to Matara, particularly among mangrove roots with smaller individuals often found perched on the mangrove roots. Adults are benthic on silt or muddy bottoms having marginal vegetation Like the earlier species, pollution has removed it from its earlier known locallities. It is a carnivorous fish. The eggs are spawned onto submerged, small leaves. Eggs and newly hatched frty receive parental care.

It is exported in small numbers. (Pethiyagoda, 1991)

41. *Glossogobius giuris*

This is a common, indigenous species that is primarily an estuarine species that has extended into fresh-water habitats. It is widely distributed throughout the lowland areas and is very common in the dry zone rivers and tanks, preferring sandy or muddy substrates where it leads a benthic existence (Pethiyagoda, 1991). It is a carnivore feeding on live food. Green eggs are laid that are firmly attached to a submerged substrate.

It is fished in low to moderate numbers for export.

42. ***Redigobius balteatops***

This indigenous goby is not common and its adult numbers in fresh waters show a seasonality, with a peak in October/November. It is found in sluggish, shallow, swampy, coastal fresh and brackish waters along the south western coastal belt (Pethiyagoda, 1991). It is said to feed on algae and small worms. Its breeding biology is not known, but probably breeds after heavy rains.

It is exported from wild collected stock in moderate to high numbers.

43. ***Schismatogobius deraniyagalai***

This is endemic and was described in 1989. It is recorded only from the type locality in the We River of the Kelani basin, where it is common. The habitat is shallow, coarse sand or gravel wherein the goby lies buried. Its natural food is not known. It has been bred in captivity. Several hundred adherent eggs are deposited in a small nest constructed by the male. The eggs hatch in four days.

It is exported in moderate numbers, being collected from the type locality.

44. ***Sicyopterus grisseus***

Sicyopterus grisseus is an indigenous goby that is known only from one locality in the Sitawaka River. It is commoner in marginal areas of deep, fast-flowing waters of this river. Its natural diet or breeding biology is unknown.

It is exported in very small quantities, but could also be a misidentification in exported lists.

45. ***Sicyopus jonklaasi***

This endemic goby is very rare and is found in rocky hill streams having fast-flowing water where they live attached by their suctorial discs. It is found only from 4 or 5 locations.

Its natural diet or natural breeding is unknown.

A few are exported during the dry season. (Pethiyagoda, 1991)

46. *Anabas testudineus*

Anabas testudineus is a very common, indigenous fish that is found widely distributed in Sri Lanka, except in the central hills. It is a very hardy spoecies found in turbid and stagnant waters. It is able to live out of water for considerable periods and able to travel overland using its pelvic fins and gill covers. It is a predatory carnivore and breeds prolifically. The yellow floating eggs that are spawned at he onset of rains hatch in about a day and develop into free swimming fry by about the third day following hatching.

Small numbers are collected for export.

47. *Belontia signata*

The endemic *Belontia signata* is common in the south west and mid-hill regions of the Mahaweli basin, upto about 800m. In the coastal belt is found the brown colour morph while the red-finned variety is from south west of Ratnapura.It inhabits shaded margins of shallow clear streams with pebble or sand substrates. It is acrnivorous on insects and also takes detritus (Costa and Fernando, 1967; Geisler, 1967; Moyle and Senanayake, 1984). In breeding, the male builds a bubble nest under a leaf or an overhang which holds the 500 or so light pink demersal eggs that are guarded by the male. Hatching takes place in about two to three days and fry are free swimming about two days thereafter. Both parents tend tyhe youg for a few weeks.

Belontia signata is heavily used for the export trade and though the species is still not a rarity, the brightly coloured varieties, such as rust coloured and neon blue-finned *B. signata*, have decreased greatly so that collection requires to be restricted. Since it breeds easily, captive breeding programmes should also be popularised. (Pethiyagoda, 1991)

48. *Malpulutta kretseri*

This endemic species is now not at all common and is considered a rarity by some. It is restricted to slow-flowing shallow forested streams and pools having rich marginal vegetation with silt and leaf-debris laden substrates of south western Sri Lanka within the Colombo-Galle-Ratnapura triangle. It feeds on plankton, insect larvae and fish fry. The male builds a bubble nest in which the 100 to 200 white eggs that are spawned in several batches hatch after about 2 days. The male parent gusrds the free swimming young until about a week old.

It is caught for the aquarium industry but not in large numbers due to its very low availability.

49. *Pseudosphromenus cupanus*

Pseudosphromenus cupanus is an indigenous species that is common in the shallow stagnant to slow-flowing streams, ditches and marshes having thick vegetation. It is restricted to the south western wet zone lowlands between Chilaw and Matara (Pethiyagoda, 1991). It feeds on zooplankton and insects. Breeding is as for the earlier species where the male builkds and guards a bubble nest in which eggs hatch in about one day and the fry become free swimming in about a week.

This species is collected in moderate to high numbers for export.

50. *Channa orientalis*

This endemic relatively small snakehead species frequents very shallow, quiet, clear, shaded, flowing streams in forested areas of the south western wet zone, extending upto the lower south westeern hills. It is declining in numbers due to habitat destruction than to over-collection. *Channa orientalis* feeds principally on insects and sometimes on fish (Senanayake and Moyle, 1984). The oily, floating eggs are mouth brooded by the male and after hatching, both male and female parents protect the fry in their oral chambers (Pethiyagoda, 1991).

This species is collected in small to moderate numbers for export.

51. *Channa striata*

Channa striata is a common indigenous snakehead inhabiting swampy as well as relatively deep still water and river habitats of the lowlands of Sri Lanka. It also occurs in brckish water habitats so that it has a wide distribution. It is a carnivore, predating on fish and crustaceans. For breeding, it builds a nest of weeds in which the flowting eggs are laid. Hatching takes about three days and the fry soon turn into a bright orange colour, the young remainig with the mother for about a month and losing the orange colour from about the second month, but remaining under the mother's care until old enough to be able to hunt independently.

Small to moderate numbers are exported.

52. *Macrognathus aral*

This indigenous eel inhabits still waters having a silt or muddy substrtate of tanks, ponds and slow rivers of the lowlands. It had been very common but is now rare. It feeds on insects and worms and its breeding biology is not well known, except that the pale green demersal eggs that are laid on algal masses hatch in a day or two. (Pethiyagoda, 1991)

It is now not found in sufficient numbers to be exported.

53. *Mastacembelus armatus*

This is a common indigenous spiny eel occurring in streams and rives having a sandy to boulder substrate and distributed widely from the coastal area to about a 600m elevation. Its main diet is of insect matter and its breeding biology is unknown.

Smaller specimens are collected in low to moderate numbers for the export trade.

54. *Tetratodon fluviatilis*

Tetratodon fluviatilis is an indigenous puffer fish found in slow water bodies such as rivers, estuaries and backwaters and prefers shaded areas. It is recorded as being more abundant in the estuaries of the south west (Pethiyagoda, 1991). It appears predominantly to be carnivorous in food habits and may possibly take some plant matter. It is said to lay about 200 attached eggs in shallow water and guarding them until hatching or even thereafter.

It is used in moderate numbers in the export trade.

3.2. INCREMENTING THE DATA BASE

The above data base is not complete and the reader would have been made aware that it needs improvement both qualitatively and quantitatively. Research programmes should be started, commencing with species that are considered at greater risk.

Section 4.

ENDEMIC AND THREATENED EXPORTED SPECIES: THEIR STATUS

4.1. STATUS OF EXPORTED ENDEMIC SPECIES

Of the 80 species of indigenous fresh-water fish in Sri Lanka, 27 are endemic. From among the 27 endemic fresh-water fish species, 20 are presently being used in the aquarium export trade (Table 4.1).

Table 4.1 summarises the status of the exploited endemic species. It would be apparent that the lack of quantitative population data restricts any detailed analysis or recommendations that should be made. Even so, some the available data allows for a broad analysis whereby starting points for future work can be identified. Further details are given in the previous section (Section 3) to which cross reference should be made as and when required.

With regard to some species, only small populations are present and these species require that immediate measures are adopted for their conservation and management. These species are *Danio pathirana*, *Puntius asoka.* In *Aplocheilus werneri* only very small populations have so far been discovered, so that conservation measures are necessary here too. In other species, very low numbers are present in the wild (*Sicyopus jonklaasi, Malpulutta kretseri).* In *Puntius asoka, Puntius cumingii, Puntius nigrofasciatus, Puntius titteya* and *Rasbora vaterifloris* the populations present would require management/conservation measures due to the heavy collections that are ongoing. Colour varieties of *Puntius bimaculatus,Puntius cumingii, Puntius nigrofasciatus*, *Puntius titteya* and *Belontia signata* are being very heavily collected which would lead to deleterious effects on the gene pool. The effect of size targeted collections for export are in evidence for populations of species such as *Aplocheilus werneri* and *Malpulutta kretseri* and could eventually lead to population declines. Population declines are already recorded for *Channa orientalis.*

Table 4.1. Status of endemic Sri Lankan fresh-water fish species that are wild-caught for utilisation in the aquarium export industry, with notes of interest such as distribution, abundance, threatened status and measures that could be adopted for their sustainable management and conservation.

1. *Danio pathirana* - abundant where it occurs, but is extremely localised only to a single area in the Nilwala River basin Therefore conservation and captive breeding measures and ecological studies are **essential**.
2. *Esomus thermoicos* - possibly an endemic species, its status is still not fully resolved. This species does not seem to be under threat at present as it is common.
3. *Garra ceylonensis* - commonly found species, specially in the wet zone, not under immediate threat.
4. *Puntius asoka* - Very restricted, heavily fished and under threat. **Require** conservation measures and studies.
5. *Puntius bimaculatus* - Although this species is heavily utilised in the aquarium trade, populations of this species are not presently under threat, other than for the more attractive **colour varieties** that may require some protective measures..
6. *Puntius cumingii* - An endemic species that is not uncommon, but the more **colourful** specimens that are selecitvely collected for export may require proper management measures.
7. *Puntius nigrofasciatus* - An endemic species which is **very heavily collected** and exported, specially its colourful varieties.
8. *Puntius pleurotaenia* - A possible endemic that is caught in moderate numbers for export.
9. *Puntius titteya* - An endemic whose colourful varieties are in high demand and is **possibly overfished.**
10. *Rasbora vaterifloris* - A **much threatened** endemic species facing multiple threats from over-collection for the export trade, deforestation and declining water qulity arising from pollution.
11. *Acanthobitis urophthalmus* - a much sought after endemic loach that is not common, but seemingly able to stave off drastic population decline.
12. *Schistura notostigma* - a moderately sought after species which seems not to be in much danger.
13. *Aplocheilus dayi* - heavily fished, but appears to be able to sutain the fishing pressure at present.
14. *Aplocheilus werneri* - heavily fished, populations seem to be beginning to show the effects of size-specific collections for export.
15. *Schismatogobius deraniyagalai* - this endemic species is moderately fished fom its only known locality. Great care must be exercised and conservation measures adopted

until new populations are discovered.

16. *Sicyopus jonklaasi* - a rare gobid exported in very low numbers.
17. *Belontia signata* - heavily collected bright colour morphs have almost disappeared and require restriction of collection and the employment of captive breeding methods.
18. *Malpulutta kretseri* - collection for the aquarium trade is hampered by the low numbers of its population which requires protection. Also, smaller sizes are now present in the wild.
19. *Channa orientalis* - it is not collected in large numbers for export, but together with habitat destruction, its populations are on the decline.
20. *Clarias brachysoma* - this endemic catfish is exported in limited numbers.

4.2. STATUS OF THREATENED SPECIES

IUCN (1994) lists 19 species as threatened. Of these, 18 species are exported and only 1 of them (*Sicyopterus griseus*) is not an endemic species. The stauts of all the 18 exported threatened species is summarised in Table 4.2. The status of all, except *Sicyopterus griseus*, has been discussed further in the previous sub-section and shall therefore not be repeated here. *Sicyopterus griseus* is exported, if at all, in very low numbers since it is rare in the wild.

TABLE 4.2. Stauts of the 18 exported threatened fresh-water fish species.

1. . *Danio pathirana* - abundant where it occurs, but is extremely localised only to a single area in the Nilwala River basin Therefore conservation and captive breeding measures and ecological studies are **essential**. Is an endemic species.
2. *Garra ceylonensis* - commonly found endemic species, specially in the wet zone, not under immediate threat.
3. *Puntius asoka* - very restricted endemic, heavily fished and under threat. **Require** conservation measures and studies.
4. *Puntius bimaculatus* - although this species is heavily utilised in the aquarium trade, populations of this species are not presently under threat, other than for the more attractive **colour varieties** that may require some protective measures..
6. *Puntius cumingii* - an endemic species that is not uncommon, but the more **colourful** specimens that are selecitvely collected for export may require proper management measures.
7. *Puntius nigrofasciatus* - an endemic species which is **very heavily collected** and

exported, specially its colourful varieties.

8. *Puntius pleurotaenia* - a possible endemic that is caught in moderate numbers for export.
9. *Puntius titteya* - an endemic whose colourful varieties are in high demand and is **possibly overfished.**
10. *Rasbora vaterifloris* - a **much threatened** endemic species facing multiple threats from over-collection for the export trade, deforestation and declining water qulity arising from pollution.
11. *Acanthobitis urophthalmus* - a much sought after endemic loach that is not common, but seemingly able to stave off drastic population decline. *Rasbora vaterifloris*
12. *Schistura notostigma* - a moderately sought after endemic species which seems not to be in much danger.
13. *Aplocheilus dayi* - heavily fished endemic, but appears to be able to sutain the fishing pressure at present.
14. *Aplocheilus werneri* - heavily fished endemic, populations seem to be beginning to show the effects of size-specific collections for export.
15. *Schismatogobius deraniyagalai* - this endemic species is moderately fished fom its only known locality. Great care must be exercised and conservation measures adopted until new populations are discovered.
16. *Sicyopterus griseus* - is an indigenous fish that is caught in very low numbers or hardly at all as it very rare.
17. *Belontia signata* - heavily collected bright colour morphs have almost disappeared and require restriction of collection and the employment of captive breeding methods.
18. *Channa orientalis* -it is not collected in large numbers for export, but together with habitat destruction, its populations are on the decline.

Section 5

THE EXPORT TRADE

5.1. FROM THE WILD TO THE HOBBYIST

The fish that are collected by the fishermen from the tropical natural environment has eventually to find its way to the home tank of the hobbyist in his/her developed country. A long path has to be traversed during this circuit and the fish would travel from the wild → harvesting fisherman to the collector → exporter's holding tank → export package → airline → retailer → hobbyist.

At each stage, there are mortalities, the extent of mortalities varying with the degree of stress imposed on the animal and the ability of the fish pecies and the individual to withstand stress. Some species such as *Rasbora vaterifloris and Puntius titteya* are very sensitive species that suffer heavy mortalities with even minor stresses. For example, 10 to 20% of *R. vaterifloris* and *P. titteya* in the export packs were already dead at Customs examinations at the Katunayaka International Airport cargo terminal. In some cases, such mortality exceeded 30%. In a detection in March of 1995, fish were seen to be in a very weak condition due to starvation, which is sometimes employed by some exporters to reduce weight of the export pack and to achieve a reduction in the metabolic requirements of the fish that are being exported, in the belief that the reduced requirement for oxygen would enhance the duration of survival time of the fish that are being exported in the confines of the export pack. Space and water volume in the export pack are also sometimes reduced in order to decrease freight charges (Gunasekera, 1995). All of these stress the fish and lead to high mortalities. Even before fish are packed for export, improper catching, transport and holding methods take their toll on fish numbers causing heavy mortalities.Therefore, in order to cover up for these high mortalities, large quantities are collected from the wild, impacting wild stocks to an unnecessarily large extent.

The reduction of these mortalities through research, and making collectors and exporters aware of proper methods to be employed would reduce mortalities of wild stocks to a significant extent.

5.2. THE EXPORT MARKET

The international trade in ornamental fish dictates which species and in what quantities they are exported from supplying countries like Sri Lanka. 98% of the fish in this trade are tropical fish and 90% are of fresh-water origin, with many of the fresh-water fish being pond-raised. The market for ornamental fish is mainly among home hobbyists (99%) and is located in heavily populated industrial areas having cool climates (Bassleer, 1995).

Statistics that are gathered from official figures are only partly accurate due to inherent discrepancies in reporting systems. They can, however, be used as long as it is kept in mind that such figures are only estimates.

The total wholesale trade value of all types of live ornamental fish in 1992 was estimated at US$ 900,000,000 and its retail value was US$ 3,000,000,000. The largest markets are in the USA (worth an annual import value of US$ 100 million), Europe (US$ 93 million, with Germany being the leading country) and Japan (US$ 65 million).

Import values of tropical fish (fresh-water and marine; 1992 figures) from Sri Lanka into the USA, the EEC and Japan were US$ 1,200,000, 1,600,000 and 480,000, respectively. Figures available for imports into the EEC showed that US$ 400,000 was the fresh-water component (Bassleer, 1995).

The monetary value of aquarium fish exports from Sri Lanka was Rupees 248,000,000.00 in 1994 which is only a mere 0.5 to 1% slice of the global aquarium trade. The value of Sri Lankan aquarium fish exports has been increasing annually at a growth rate of 16.9%. Over the recent past (last 2-3 years), however, prices for individual fish have decreased so that the overall numbers that have been exported has increased to maintain the increased income from the trade as a whole.

The main competing countries against Sri Lanka vying for the lucrative aquarium market are Singapore, Indonesia, Thailand, Philippines and countries such as Kenya. Sri Lanka exports reach over 25 countries including USA, Japan, United Kingdom, Holland, Germany, Singapore, Malaysia, Bahrain, Canada, Belgium, Finland, Austria, Sweden, Finland, Portugal, Denmark, France, Italy, Spain, Israel, UAE, Maldives, India, South Africa and Argentina. The USA is our highest single-buying country while Hong Kong is the second-largest buying country, followed by Japan. Germany is also a leading buying country. Countries such as Singapore, Hong Kong, Malaysia, Bahrain and Holland purchase our aquarium fish mostly for re-export. The exports into Europe have been increasing at an annual rate of 10% over the last five years.

The exports from Sri Lanka are undertaken by about 25 exporting companies. 15 of these companies are registered with the Export Development Board and a single company is registered also with the Board of Investment. Exports are carried out under the HS Code that is given for this trade practice under the number 0-300-11010 for fresh water fish exports. Exported quantities reach a peak from around September to March of each year which corresponds with the colder season of the developed temperate countries implying that people purchase more aquarium fish over the colder, bleaker period when inclement weather make them more confined to their home interiors. The December to January period is a brisk sale period for aquarium fish in the Developed Countries because of the greater tendency for giving gifts over this Christmas and New Year period when aquarium fish invariably enter the gift commodity market.

It is the more attractive varieties, even within a species, that fetch a higher market price so that more colourful varieties are selectively targeted for wild collections. It is for these varieties that breeding techniques should be developed as a first priority if wild stocks are to be conserved.

Section 6

EMPLOYMENT AND THE FISH EXPORT TRADE

6.1. DIRECT EMPLOYMENT

The exporters employ various types of staff to man their offices and holding facilities. A leading exporter, who did not want himself named, said that he would routinely employ about 40 people to maintain his stock in the holding site near Colombo while during heavy export periods and days, this number would go upto around a 100 or more. During the packing day which is mostly done once a week unless there were urgent orders, he would employ another 10 to 12 people, depending on the size of the orders in hand. There is direct employment provided to transporting agencies and drivers, etc, as well as to some of the collectors that are directly employed or cotracted by exporters.

Exporters are quite wary of giving accurate figures and even collectors now tend to downplay the numbers that are involved so that it is not possible to get accurate estimates directly from individuals. On the other hand, as an organisation, a given group of exporters would tend to inflate the numbers that are involved in the trade in order to impress upon the employing capacity of the trade with which they are involved.

It is, therefore, not a productive exercise to assess the employing capacity of the trade other than to state that "quite a number" of people are dependent on the industry, which of course is not a helpful statement.

6.2. THE SERVICING SECTOR

Other than for direct employment, various other people and sectors are involved in the export trade. These groups involve those that bring in food, such as "worms" for maintaining the exporter's stocks, the people who manufacture tanks, those that import and sell aquarium accessories such as blowers, air stones, filters, polythene and polythene bags. A large number

of collectors also find employment, even though sometimes seasonal, from this export trade.

Institutions such as banks and advisory agencies such as the Export Development Board and monitoring agencies such as the Customs Department also are indirectly involved though most of them would not be dependent on the trade. Airline companies also generate indirect employment opportunities due to the aquarium export trade.

Section 7

INFRASTRUCTURE FOR DEVELOPMENT AND MANAGEMENT

It is the opinion of many exporters that there is little support given to them for the development or for the proper organisation or streamlining of the industry. They are of the opinion that streamlining will lead to decreasing unnecessary mortalities of wild stocks.

7.1. DEVELOPMENT ASSISTANCE

The only dedicated organisational set-up for advising the aquarium export industry is at the Export Development Board. It is advisable that any organisation or reorganisation of the industry makes use of this infrastructure which is already well developed at the Export Development Board. The EDB already has a good networking set up and this could easily be expanded with further facilities given to them.

The exporters say that, other than for the EDB, there is very little assistance given to them by way of advisory, financial, banking and export assistance and that if such assistance was available, they could then have more time freed to devote to developing the resource management aspects of the industry which can lead to the adoption of proper conservation measures.

The only training given in the aquarium-related industry is at the National Aquatic Resources Agency in some of their training courses. These courses are geared to the breeder and grow-out farmer, which could eventually be helpul in developing proper breeding and holding methods for the indigenous and endemic species. At present there is no focussed research targetting the problems related to the export of indigenous/endemic species. This capacity need to be developed urgently, as well as training capacities for training personnel employed in the trade in relation to indigenous species.

7.2. MANAGEMENT

There is almost a total lack of capacity or infrastructure for management of the export industry in relation to the indigenous species of fish. The Customs Department carries out some regulatory and monitoring activities, but the few officers there are greatly hampered due to the lack of a coherent policy framework. The lack of a policy is a very serious matter and this has led to some officers having even death threats delivered to them personally, simply because they are attempting to carry out their jobs in a conscientious manner.

The legal mechanisms that exist are governed by enactments of the Fauna and Flora Protection Ordinance (Number 2 of 1937 with subsequent amendments such as by number 49 of 1993) and by others such as the Fisheries Ordinance (Ordinance number 24 of 1940 and amendments such as number 856/01 of 30.1.95). Through these legal instruments protection is given to a selected number of species through prohibitive and restrictive laws in relation to endemic species, but it is in no way adequate because it has not been based on scientifically collected data and because the status of a species is dynamic and constantly undergoing change. These enactment, however, are praiseworthy and can form the baseline for a comprehensive set of enactments which would be meaningles unless a proper policy is also enunciated to bring about effective monitoring.

The Customs authorities in their monitoring have experienced various problems such as the use of over 350 terms used by exporters for labelling the species that are exported (meant to create confusion), false declarations, non-declarations, wrong names , incomplete documentation, last minute rush and the above-stated threates to Customs Officers. These matters require urgent attention and redress if any hope for proper monitoring is to be entertained.

Section 8

ACTIVITIES AFFECTING SPECIES SURVIVAL

8.1. EXPORT TRADE RELATED ACTIVITIES

Improper collection, over-collection, selective collection of the more attractively coloured varieties, improper holding and transport as well as packing methods all contribute directly to species survival. These have been expanded on in earlier sections.

8.2. EXTRANEOUS ACTIVITIES

A diversity of factors external to the export trade such as deforestation, improper use of agrochemicals, habitat alteration and destruction, water diversion schemes, introduction of exotic species, infrastructural development in areas of significance to species survival, gemming, etc., affect species survival. Some of these are discussed by Pethiyagoda (1994). All of these are a result of the non-existence of a coherent policy framework for sustained and integrated development and in such a vacuum, it is counter-productive to elaborate on the above factors. The development of an integrated policy is central to addressing these multi-disciplinary issues.

Section 9

A LOOK AHEAD

9.1. SUTAINABLE MANAGEMENT

A practical and coherent policy framework for sustained and integrated multi-sector development taking into consideration biodiversity, conservation, management and socio-economic issues is urgently needed for natural resource management. Piece-meal academic policies from which we are thankfully tending to move away seem to hold some promise for the future. The present time, when there is some political receptivity towards the accceptance of such issues, should be used maximally to advance the cause of sustainable management.

9.2. A PROGRAMME OF ACTION

It has already been said that an integrated programme of action is needed. Having stated that need, a position paper is not the instrument for enunciating its details. Such exercises have been done many a time and what is needed is to integrate the needs of the sustainability of the export trade for fresh-water fish species into this structure and to fine-tune it for optimal and speedy results.This Position Paper puts into perspective the status of the present issues related to the export trade, as discussed above and are summarised below.

A programme for biological research encompassing field surveys and laboratory procedures need to be established. Field surveys should address mainly, in the first instance, the enumeration of populations of fish species over at least an annual cycle and in which area we do not have any reasonable data. Laboratory and field studies should also develop proper collection, transport, holding and packing techniques as well as breeding techniques. Species for which techniques of breeding have already been developed elsewhere can be further developed and adapted for our use, as a first priority, if wild stocks are to be conserved. Wherever possible, community based resource management issues should be developed. The

legal framework and monitoring capacities should be reviewed along with the exporters and needy restructuring should then be carried out.

Section 11

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12. ANNEXES

ANNEX 1. Commonly used vernacular names of exported fresh-water aquarium fish.

Zoological name	English name	Sinhala name
1. *Anguilla bicolor*	Level-finned eel	Kalu aandha
2. *Chela laubuca*	Blue laubuca	Tatu dandiya
3. *Danio malabaricus*	Giant danio	Rath kailaya
4. *Danio pathirana*	Barred danio	
5. *Esomus thermoicos*	Flying barb	Ravul dandiya
6. *Garra ceylonensis*	Stone sucker	Gal pandi
7. *Puntius amphibius*	Scarlet banded barb	Mada ipila
8. *Puntius asoka*	Asoka barb	Asoka pethiya
9. *Puntius bimaculatus*	Redside barb	Ipili kadaya
10. *Puntius chola*	Swamp barb	Kota ipilla
11. *Puntius cumingii*	Cuming's barb	Pothaya
12. *Puntius dorsalis*	Long snouted barb	Katu kureya
13. *Puntius filamentosus*	Filamented barb	Pethiya
14. *Puntius nigrofasciatus*	Black ruby barb	Bulath hapaya
15 *Puntius pleurotaenia*	Black-lined barb	Hitha messa
16. *Puntius ticto*	Tic-tac-toe barb	Thith pethiya
17. *Puntius titteya*	Cherry barb	Lay thiththeya
18. *Puntius vittatus*	Silver barb	Podi pethiya
19. *Rasbora daniconius*	Striped rasbora	Dandiya
20. *Rasbora vaterifloris*	Golden rasbora	Hal mal dandiya
21. *Lepidocephalichthys thermalis*	Common spiny loach	Ehirava
22. *Acanthobitis urophthalmus*	Tiger loach	Vairan ehirava
23. *Schistura notostigma*	Banded mountain loach	Kandu ehirava
24. *Mystus gulio*	Long-whiskered catfish	Anguluwa
25. *Mystus keletius*	Yellow catfish	Path ankutta
26. *Mystus vittatus*	Striped dwarf catfish	Iri ankutta
27. *Ompok bimaculatus*	Butter catfish	Walapoththa
28. *Heteropneustes fossilis*	Stinging catfish	Hunga
29. *Oryzias melastigma*	Blue eye	Hande titteya
30. *Aplocheilus dayi*	Day's killifish	Uda handeya
31. *Aplocheilus parvus*	Dwarf panchax	Udda
32. *Aplocheilus werneri*	Werner's killifish	Iri Handeya
33. *Microphis brachyurus*	Short-tailed pipefish	
34. *Monodactylus argenteus*	Mono	Kapuwa

35. *Toxotes chatareus*	Archer fish	Dhimitta
36. *Scatophagus argus*	Scat	Ilatthiya
37. *Etroplus maculatus*	Orange chromide	Kaha koraliya
38. *Etroplus suratensis*	Pearl spot	Koraliya
39. *Butis butis*	Upside down sleeper	Vaneya
40. *Eleotris fusca*	Brown gudgeon	Puwak badilla
41. *Glossogobius giuris*	Bar eyed goby	Weligowwa
42. *Redigobius balteatops*	Rhino-horn goby	
43. *Schismatogobius deraniyagalai*	Red-neck goby	
44. *Sicyopterus grisseus*		
45. *Sicyopus jonklaasi*	Lipstick goby	
46. *Anabas testudineus*	Climbing perch	Kavaiya
47. *Belontia signata*	Combtail	Thalkossa
48. *Malpulutta kretseri*	Ornate paradisefish	Malpulutta
49. *Pseudosphromenus cupanus*	Spike-tailed paradisefish	Pulutta
50. *Channa orientalis*	Smooth-breasted snakehead	Kola kanaya
51. *Channa striata*	Murrel	Loolla
52. *Macrognathus aral*	Lesser spiny eel	Bata kola theliya
53. *Mastacembelus armatus*	Marbled spiny eel	Gan theliya
54. *Tetratodon fluviatilis*	Common puffer	