CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

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Fourteenth meeting of the Conference of the Parties
The Hague (Netherlands), 3-15 June 2007

CONSIDERATION OF PROPOSALS FOR AMENDMENT OF APPENDICES I AND II

A. Proposal

Inclusion of the Banggai cardinalfish (*Pterapogon kauderni,* Koumans 1933) in Appendix II of CITES.

The current status of *Pterapogon kauderni* conforms with Article II, Paragraph 2(a) of CITES and satisfies Criterion B in Annex 2a of Resolution Conf. 9.24 (Rev. CoP13). It is projected that regulation of trade in *Pterapogon kauderni* is required to ensure that the harvest of specimens from the wild is not reducing the wild population to a level at which its survival might be threatened by continued harvesting or other influences.

B. Proponent

The United States of America

C. Supporting statement

1. Taxonomy

1.1 Class: Actinopterygii (ray-finned fishes)

1.2 Order: Perciformes

1.3 Family: Apogonidae

1.4 Genus, species or subspecies, including author and year:

Pterapogon kauderni (Koumans 1933)

1.5 Scientific synonyms: None.

1.6 Common names: English: Banggai cardinalfish, cardinalfish, highfin cardinalfish, banner cardinalfish, and outhouse cardinal
French:
Spanish:

1.7 Code numbers: None.

2. Overview

Pterapogon kauderni is an endemic marine fish that has been negatively affected by heavy collection pressure for the aquarium trade. Harvest and trade first began in 1995, and has increased to an estimated 700,000–900,000 fish/yr. This species has an extremely limited geographic range (5,500 km^2) and small total population size (estimated at 2.4 million). It exhibits unique reproductive characteristics that make it vulnerable to overexploitation including 1) low fecundity; 2) an advanced degree of parental care and elevated energy allocation per offspring; 3) direct development; 4) long oral incubation period; 5) lack of a

planktonic interval; and 6) juvenile settlement within parental habitat. Due to several aspects of its biology, coupled with the heavy and unregulated trade in this species, *Pterapogon kauderni* populations are highly vulnerable to extinction. Furthermore, the high degree of genetic structure has profound conservation implications, since failing to detect (and protect) the intraspecific diversity may have grave consequences for a species with such extreme microgeographic genetic structure.

Pterapogon kauderni is composed of isolated populations concentrated around the shallows of 17 large and 10 small islands within the Banggai Archipelago, Eastern Indonesia. A small population also occurs off Central Sulawesi, within Luwuk harbor. One additional population has become established in the Lembeh Strait (North Sulawesi), 400 km north of the natural area of the species distribution, following introduction by aquarium fish traders in 2000. The species has a short life span (maximum ~4 years under ideal conditions in captivity; 1–2 years in the wild) and small spawn size (50–90 eggs), although it can potentially reproduce several times per year (after about 10 months of age). Populations are thought to be primarily self seeding; oceanographic conditions (strong currents and deep channels separating islands), reproductive traits, and lack of a planktonic life-history stage prevent dispersal to nearby islands, thereby isolating populations and preventing recolonization of habitats that are extirpated by fishers.

The species is collected by local fishers and traded as an aquarium species at unusually high levels. *Pterapogon kauderni* first appeared in the international trade in 1995–1996. By 2001, 600,000–700,000 fish were exported annually; trade estimates for 2001–2004 are 700,000–900,000 fish/yr with collection occurring throughout the archipelago. Fishing pressure at current levels has negative impacts on *Pterapogon kauderni* populations, affecting fish density, group size, and the density of its preferred associate (long-spined sea urchin). Surveys identified significant (>90%) declines in two populations that were fished from 2001 to 2004, including extinction of a population off Limbo Island. If collection pressure continues at current rates, extinction of the species may occur within the next decade.

An alterative to wild harvest exists for this species: numerous captive-breeding facilities have emerged. However, the relatively high cost–benefit of its production combined with the large number of less expensive wild-harvested fish has prevented expansion of aquaculture efforts. In addition, a newly emerging threat (a viral disease) has been documented in wild-harvested individuals maintained in captivity.

Pterapogon kauderni is not currently listed on the IUCN Red List of Threatened Animals.

3. Species characteristics

3.1 Distribution

Pterapogon kauderni is found in the Western Central Pacific with populations restricted to 27 islands in the Banggai Archipelago, and in central Sulawesi in Luwuk harbor (Vagelli and Erdmann, 2002; Vagelli, 2005a). There is also a small introduced population in Lembeh Strait (North Sulawesi, Indonesia), approximately 400 km NW of the Banggai Archipelago (Erdmann and Vagelli, 2001). The natural range of the species covers a maximum east–west distance of about 130 km and north–south distance of 70 km, and an overall area of approximately 5,500 km^2 (Fig. 1; 2). The species occurs close to shore at 0.5–4.5 m depth, but is most common between 1.5 and 2.5 m depth. Within the geographic range of the species (i.e., 5,500 km^2), the maximum potential available habitat is about 426 km of coastline extending from the shore to about 100 m off the coast (mangroves, grassbeds, and reef habitats from the shore to the reef slope), or a total area of about 34 km^2 (Vagelli, 2005a).

Fig. 1. Geographic distribution of *Pterapogon kauderni*: Surveys were conducted throughout the Banggai archipelago and neighboring habitats surrounding Sulawesi. The dashed line indicates the perimeter of populations in Banggai. One additional small, introduced population exists off Sulawesi (dark circle and arrow). Data source: Vagelli, 2005a.

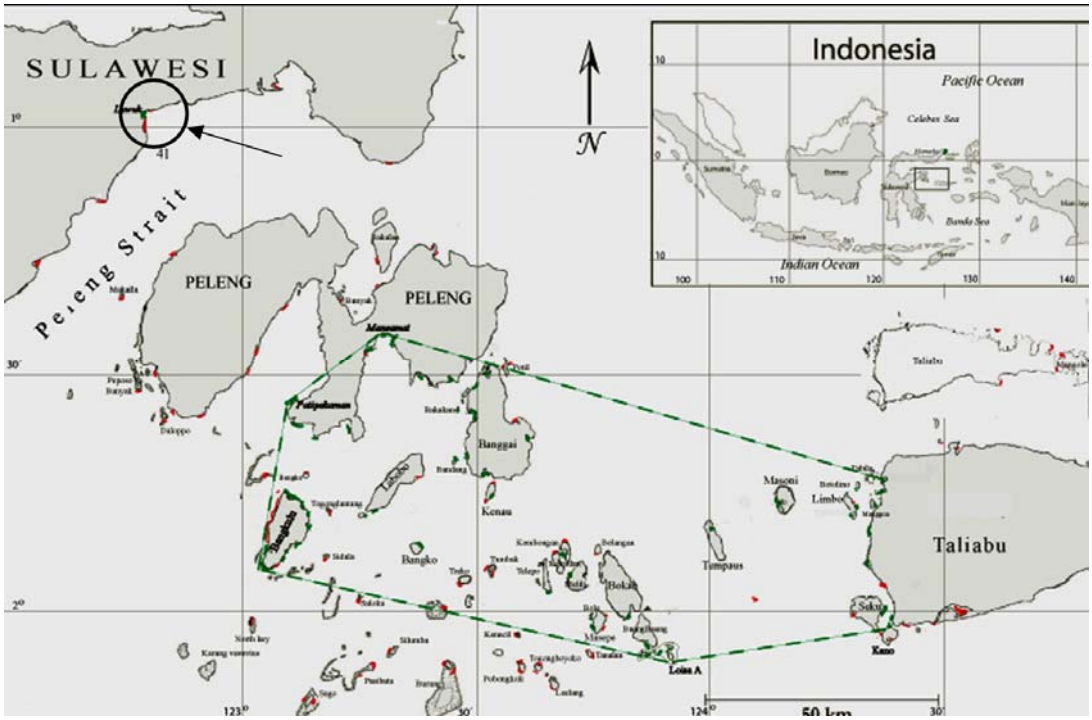
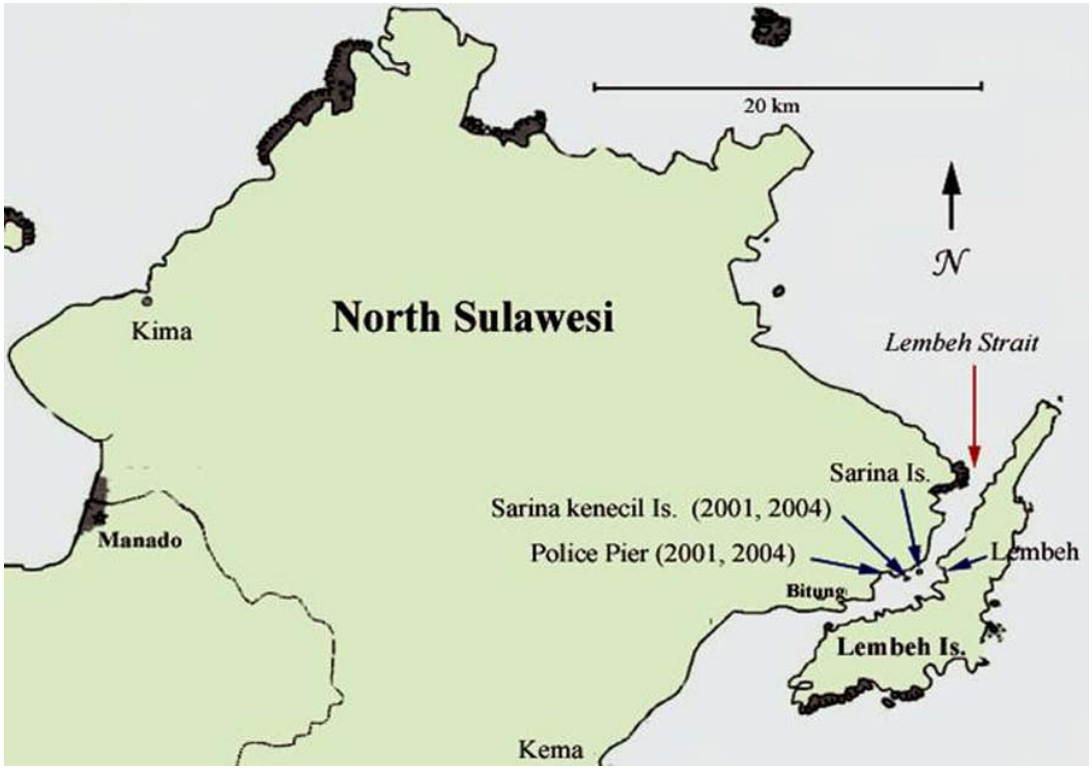


Fig. 2. Geographic distribution of the Lembeh Strait population of *Pterapogon kauderni:* This species was first introduced in 2000, and was documented in four locations in 2004. Source: Vagelli, 2005a).



3.2 Habitat

Pterapogon kauderni is a small (maximum total length [TL]=8 cm) demersal tropical marine fish that forms stable groups (mean=9 individuals) in shallow water (<4.5 m depth), being most common at 1.5–2.5 m depth. The species inhabits a variety of shallow habitats, including coral reefs (51% of identified populations), seagrass beds (35%), and open areas of sand and rubble (14%) (Table 1). It is most common in calm habitats on the protected side of larger islands; isolated populations also occur in areas affected by strong surge and moderate currents (Vagelli and Erdmann, 2002; Vagelli, 2002; Vagelli, 2004a). It occurs among various living benthic substrates such as sea urchins, sea anemones, and branching corals. Individual fish exhibit well-defined homing behaviour and return to the original location of their group when disturbed (Kolm et al., 2005). Water temperatures in these habitats range from 28º to 31º C, and include sites with visibilities ranging from <2 m to 20 m.

The particular oceanographic characteristics of the Banggai region (deep channels between islands, strong currents) have contributed to *Pterapogon kauderni*'s extreme philopatry (Bernardi and Vagelli, 2004). *Pterapogon kauderni* is a site-attached fish that remains very close to the substrate and is associated with various benthic living substrates. Individuals undergo ontogenetic shifts in microhabitat association, although all life stages occur in the same habitats and at the same depth. New recruits are most commonly associated with sea anemones (54.1%; *Actinodendron* sp., *Entacmaea* sp., *Heteractis* sp., *Macrodactyla* sp., and *Stichodactyla* sp.), whereas only 18.3% of juveniles and adults occur among sea anemones. Juveniles and adults occur most frequently among long-spined sea urchins (32%; *Diadema setosum*) and branching corals (44%; *Acropora*, *Anacropora* and *Porites*), as well as sea stars, hydrozoans, and mangrove prop roots (Vagelli, 2004a). Adults hover directly above the urchins, with the younger fish (2–3 cm standard length [SL]) staying closer to the urchins; juveniles and adults retreat among the spines when threatened (Table 1).

Table 1. Habitat and microhabitat preference of *Pterapogon kauderni* based on surveys conducted in 2004. Numbers of animals observed and percent of each size class are shown for three habitats and three microhabitats. Source: Vagelli, 2005a.

	Habitat			**Microhabitat**		
Size Class	**Seagrass bed *Enhalus***	**Coral reef**	**Sandy / rubble patch**	**Urchin *Diadema***	**Coral**	**Anemones**
All groups (373)	132 (35.4%)	190 (50.9%)	51 (13.7%)	119 (31.9%)	163 (43.7%)	91 (24.4%)
Adults only (103)	41 (39.8%)	45 (43.7%)	17 (16.5%)	24 (23.3%)	59 (57.3%)	20 (19.4%)
Juveniles only (118)	39 (33.1%)	64 (54.2 %)	15 (12.7 %)	34 (28.8%)	60 (50.8%)	24 (20.3%)
Adults and juveniles (312)	103 (33.0%)	171 (54.8%)	38 (12.2%)	102 (32.7%)	153 (49.0%)	57 (18.3%)
All new recruits (61)	30 (49.2%)	18 (29.5%)	13 (21.3%)	18 (29.5%)	10 (16.4%)	33 (54.1%)

3.3 Biological characteristics

Pterapogon kauderni exhibits unique reproductive characteristics that make it vulnerable to overexploitation, including 1) low fecundity; 2) an advanced degree of parental care and elevated energy allocation per offspring; 3) direct development; 4) long oral incubation period; 5) lack of a planktonic interval; and 6) juvenile settlement within parental habitat. *Pterapogon kauderni* is a paternal mouth brooder. In captivity, gonad maturation in females begins at about 33–35 mm SL (about 6 months of age), and they are capable of reproducing at about 38–40 mm SL (7–8 months of age). The smallest female with mature ova collected from the wild measured 41 mm SL (8–9 months of age) (Vagelli and Volpedo, 2004). Males are capable of brooding at 32–35 mm SL (about 6–7

months of age); in the wild, the mean size of a brooding male is ~43 mm SL (about 11–12 months of age). The species can live for up to 4 years in captivity, with an estimated maximum life span of 2 years in the wild (Vagelli, pers. comm). Females play an active role in courtship and pair formation, which occurs a few hours up to a few days before spawning (Vagelli, 1999); mating pairs establish spawning territories several meters away from the main group and vigorously defend these territories (Kolm and Berglund, 2003).

Under laboratory conditions, the species reproduces throughout the year. Single females in captivity can reproduce once per month, whereas males mouth-brood up to six clutches per year; mating and juvenile release appears to be in synchronization with the lunar cycle (Vagelli and Volpedo, 2004). Females produce a maximum spawn size of 75 large (2.5–3-mm) eggs. The mean clutch size found being incubating by males in the wild was 41 eggs (range=12–73) (Vagelli 1999; Vagelli and Volpedo, 2004). The male broods an egg clutch for about 20 days; after hatching, the embryos remain within the mouth cavity for another 10 days before release. The fertility rate is about 60%; besides normal loss due unfertilized eggs and embryos that do not finish developing, an important percentage of eggs are lost during the clutch transfer. Under laboratory conditions the average number of juveniles released from a brood was 40; the average clutch size of brooding males in the wild was 18 embryos (range=3–33) (Vagelli, pers. comm).

The species is thought to suffer high mortality during the first days after release from the brood pouch due to predation, including cannibalism. The species lacks a larval period; during ontogeny the species does not become part of the plankton nor does it exhibit a pelagic interval (Vagelli, 1999). New recruits (i.e., 6–8 mm SL when released from the oral cavity) immediately seek refuge inside anemones or sea urchins, and remain together throughout their life span (Vagelli, 1999). Juveniles and adults are commonly observed; however, extensive surveys from 2001 to 2004 only identified a total of 81 groups of new recruits. These mostly consisted of one or two individuals; the largest group found consisted of 15 individuals, one of 12, one of nine and the rest of seven or fewer (Vagelli, 2002a; Vagelli 2005a).

Pterapogon kauderni is an opportunistic species that feeds during the day, unlike all other representatives of this family. Diet composition is similar between size classes, including planktonic, demersal, and benthic organisms. Gut contents of examined fish included 29 taxa belonging to 6 phyla: Rhyzopoda, Annelida, Mollusca, Arthropoda, Chaetognatha, and Chordata (Teleost larvae). Copepods make up about 79% of *Pterapogon kauderni* diet; other important components are decapods and isopods. Prey size varies between about 0.1 and 14 mm (Vagelli, 2002; Vagelli, 2005a). Under captive conditions, newly released juveniles are capable of feeding on brine shrimp nauplii (*Artemia* sp.*)* (Marini, 1999; Vagelli, 1999).

3.4 Morphological characteristics

Pterapogon kauderni is a small marine fish (maximum size=80 mm SL) with a distinctive contrasting pattern of black and light bars with white spots. This species is easily differentiated from the other 270 species in the family Apogonidae by its tasseled first dorsal fin, elongate anal and second dorsal fin rays, deeply forked caudal fin, and color pattern consisting of three black bars across the head and body and prominent black anterior edges on the anal and second dorsal fin (Allen, 2000). The species has 7 spines in the first dorsal fin, 1 spine and 14 rays in the second dorsal, and 2 spines and 13 anal soft rays in the anal fin. The high number of rays of the second dorsal fin distinguishes this genus from the rest of the apogonid genera. Males can be differentiated from females by a conspicuous enlarged oral cavity, which is apparent only when they are brooding.

3.5 Role of the species in its ecosystem

Pterapogon kauderni is a very unusual apogonid with life-history traits that differ from other apogonids. Because of its unique life history, it has special scientific and evolutionary significance. Apogonids are normally cited as one important nocturnal component of coral reef fauna, yet this species is the only representative of the family that is diurnal. It is a planktivore, feeding mostly on copepods as well as many other crustaceans. It is always found associated with living substrates including anemones, branching corals, sea urchins, sea stars, and mangrove roots. Sites occupied by *Pterapogon kauderni* show a strong positive correlation between sea urchin density and fish density (Kolm and Berglund, 2003). *Pterapogon kauderni* often coexists with various anemonefish and anemone shrimp when sheltering in anemones and corals; when found among sea urchin spines, it associates with several other genera of cardinalfish (Vagelli, 2002). Following removal of

the fish by aquarium collectors, the abundance of associated invertebrates has been shown to decline.

It serves as an important food source for several species of lionfish, *Pterois* (Scorpaenidae), the grouper *Epinephelus merra* (Serranidae), a crocodilefish *Cymbacephalus beauforti* (Platycephalidaemorenas), a moray eel *Echidna nebulosa* (Muraenidae), a stonefish *Synanceia horrida*, and the sea snake *Laticauda colubrina* (Elapidae) (Vagelli, pers. comm.).

4. Status and trends

4.1 Habitat trends

Coral reef ecosystems throughout the Banggai Archipelago have experienced widespread damage from destructive fishing methods (dynamite and cyanide fishing), overfishing of food fish species, and increased siltation and nitrification associated with uncontrolled clearing of forests for agriculture (Harborne et al., 1997; Allen, 2001). Habitats occupied by *Pterapogon kauderni* are especially susceptible to anthropogenic stressors because they are confined to areas close to shore, and most islands rapidly slope into deep water. The Banggai Islands have a total human population of about 151,000; poverty is widespread and the population is largely dependent on farming and fishing for sustenance and capital (Allen et al., 2001).

4.2 Population size

The total wild population of *Pterapogon kauderni* was estimated to be 2.4 million fish in 2004, of which 90% occur around 27 islands in the Banggai Archipelago (Table 2; Vagelli, 2005a). In most sites, *Pterapogon kauderni* exist at densities of about 200–700 fish/ha. The mean density of *Pterapogon kauderni* based on surveys in seven locations in 2004 was 0.07 individuals per m^2 (Vagelli, 2005a). In the only de facto protected site within the species' entire geographic range (a small bay located off southwest Banggai Island that is closed to fishing), densities ranged from 0.28 to 1.22 fish/m^2, with a mean overall density of 0.63 ± 0.39 fish/m^2 (Lunn and Moreau, 2004).

Table 2. Estimated population sizes of *Pterapogon kauderni* based on surveys completed in 2004. Perimeter (km) and area (km^2) of maximum habitable area and density (individuals/m^2) were determined from quantitative transect surveys. Population estimates for each island were determined from an estimate of the total habitable area and the mean population density recorded in 2004. Source: Vagelli, 2005a.

Island	Perimeter	Inhabitable Area	Density	Estimated Population
Bandang	2.8	0.224		15,680
Bakakan	0.7	0.056		3,920
Banggai	46.2	3.696	0.07	258,720
Bangko	4.2	0.336		23,520
Bangkulu	39.2	3.136	0.03	219,520
Bole	1.7	0.134		9,408
Bokan	35.0	2.800	0.21	196,000
Botolino	3.5	0.280		19,600
BuangBuang	16.1	1.288		90,160
Kano	2.3	0.184		12,880
Kembongan	5.6	0.448		31,360
Kenau	2.8	0.224		15,680
Labobo	21.0	1.680	0.05	117,600
Labobo kcl	2.5	0.200		14,000
Limbo	11.2	0.896	0.03	62,720
Loisa A	3.5	0.280		19,600
Loisa B	3.5	0.280		19,600
Loisa C	7.0	0.560		39,200
Manggoa	2.8	0.224		15,680
Masoni	9.2	0.736	0.06	51,520
Masepe	8.4	0.672		47,040
Melilis	13.3	1.064		74,480
Peleng	110.6	8.848	0.04	619,360
Seku	16.8	1.344		94,080
Taliabu	36.4	2.912		203,840
Telopo	11.2	0.896		62,720
Tempau	9.2	0.736		51,520
Mean			0.07	
Total	426.7	34.134		2,389,408

4.3 Population structure

Pterapogon kauderni lives in small groups consisting of 2 or more fish (mean group size=9.5, maximum=500), although group size rarely exceeds 85 individuals (3.3% of observations) (Vagelli, 2005a). Most fish encountered are large juveniles (6–9 months old), whereas newly released recruits (<15 mm TL) are rare (Vagelli and Erdmann, 2002). For example, surveys conducted in 2004 identified a total of 37% adults, 58.3 % juveniles and 10.4% new recruits and small juveniles up to about 2 months of age (n= 3,023 fish). Approximately 12% of the groups examined were formed only by recruits (< 30 mm TL), 11% consisted only of juveniles, 39% consisted only of adults, and 38% were formed by mixed size classes (Vagelli, 2005a). Populations are characterized by a near equal (1:1) sex ratio. They exhibit a minimum population doubling time of 1.4–4.4 years, and a life span of up to 4 years in captivity and 2 years in the wild.

Pterapogon kauderni exhibits the highest degree of population subdivision ever documented for a marine fish over such a small geographic scale (Hoffman et al., 2005). Genetic structure of populations varies over distances as small as 2 km; even populations occurring on reefs of the same islands are genetically isolated from one another, suggesting limited gene flow between reefs within individual islands. This is thought to be due to 1) a lack of a pelagic larval stage; 2) a sedentary, site-attached nature of all life stages; 3) an association with shallow substrates; and 4) the presence of deep channels and strong currents between islands isolating populations (Bernardi and Vagelli, 2004; Hoffman et al., 2005). Populations group into two well-separated clades; three southernmost sites show a strong phylogenetic break from northern sites on Bangkulu Island, with a lack of gene flow between the southern Bangkulu group and other populations (Bernardi and Vagelli, 2004). Moreover, assignment tests performed in 23 populations from all over the Archipelago showed that 20 had a significant self-reassignment (Vagelli, pers. comm). This high degree of genetic structure has profound conservation implications, since failing to detect (and protect) the intraspecific diversity of *Pterapogon kauderni* may have grave consequences for a species with such extreme microgeographic genetic structure (Palumbi, 2003). Genetic data also suggest that *Pterapogon kauderni* populations have experienced bottlenecks (Bernardi and Vagelli, 2004).

4.4 Population trends

The species was first described from collections made in the 1920s (Koumans, 1933), but was unknown to western nations until 1995, when it first appeared in the marine aquarium trade (Allen and Steene, 1995). The earliest known quantitative population surveys (2001) identified *Pterapogon kauderni* on 16 out of 37 islands searched; based on these census data and calculations of the total available habitat, the species was estimated to have a total population size of 1.7 million fish (Vagelli, 2002). Additional surveys between 2001 and 2004 covering the entire Archipelago (50 islands, 159 sites) expanded the range to 17 major islands and 10 minor islands (34 sites), with a total population size estimated at 2.4 million fish (Table 2; Vagelli, 2005a).

Population trends, as determined from field data and fisheries data, demonstrate significantly lower densities in sites affected by collection pressure for the aquarium trade. Three sites examined in January and February 2001 (Bokan, Limbo and Masoni) showed densities of 0.027–0.031 fish/m^2 (Vagelli and Erdmann, 2002), whereas more extensive surveys in seven locations reported densities of 0.07 individuals/m^2 (Vagelli, 2005a). At one of these sites (Masoni) the density increased from 0.03 to 0.06 between 2001 and 2004; these increases are thought to have occurred in response to a collecting ban that the local people imposed in early 2003 (Vagelli, pers. comm.). A localized population off Banggai island (in a bay that is off limits to all fishing) exhibited densities of 0.63 individuals/m^2 (Lunn and Moreau, 2004), which is about 900% higher than the average of the seven censuses completed in 2004 (0.07 individuals/m^2; Vagelli, 2005). Several populations affected by the aquarium fishery exhibited dramatic declines between 2001 and 2004: 1) a complete extinction of a population was documented off Limbo Island (total population of 50,000 fish and densities of 0.002 fish/m^2 were observed in 2001, whereas fish were absent within the distributional limits identified in 2001 and fish were absent from surrounding areas); and 2) a population off Bakakan Island that harbored 6,000 fish in 2001 was reduced to 17 individuals in 2004 (Vagelli, 2002; Vagelli, 2005a). The group size of fish (and urchins) was also negatively affected by the degree of fishing: in sites affected by high levels of fishing pressure the mean group size of fish was 5.7 compared to 11.5 fish/group at low-intensity fishing sites (Kolm and Berglund, 2003).

Introduction of *Pterapogon kauderni* in the Lembeh Strait, Sulawesi (through escapes and intentional release from aquarium fish traders holding cages), occurred in September 2000 (Erdmann and Vagelli, 2001); by 2004 the species consisted of three separate populations (Fig. 2). The founder

population (31 adults and 18 newly released juveniles) increased in size to 644 individuals (173 newly released recruits, 302 immature juveniles and 169 adults) by June 2001 (Vagelli and Erdmann, 2002). By 2004, one of the sites declined in density (0.11 fish/m^2 in 2001 and 0.03 fish/m^2 in 2004) and group size (6.4 to 4.7), whereas a second population increased from 0.02 to 0.1 fish/m^2 (Vagelli, 2005a). This location is about 400 km north of the Banggai Archipelago and is isolated from the rest of the range of the species.

Surveys conducted in the Lembeh Strait clearly illustrate impacts of commercial capture on population dynamics of *Pterapogon kauderni*. For Sarina Kenecil Island, surveys from May 2001 (prior to establishment of a fishery) showed a density of 0.11 individuals/m^2 and a mean group size of 6.4 individuals. The census carried out in 2004, 2 years after the initiation of a fishery for *Pterapogon kauderni* in this location, showed a significant reduction in density (0.03 individuals/m^2), a reduction in the mean group size (4.7), and a reduction in the size of the largest recorded group (from 49 to 22 individuals). The opposite trend was documented in the population inhabiting the Police Pier (off Sulawesi margin in the same strait), which was not exploited until after the 2004 surveys: 1) in 2001 the population density recorded was 0.02 individuals/m^2 and the mean size group was 4.1 individuals; 2) in 2004 the density of this population increased to 0.1 individuals/m^2 and the mean group size increased to 24.1 individuals (the largest recorded in all censused populations). Moreover, the size of the largest recorded group in this unfished population increased from 21 individuals in 2001 to 102 individuals in 2004 (Vagelli, 2005a).

4.5 Geographic trends

The historic geographic range of the species is unknown, because the first quantitative surveys of this species were conducted in 2001, and additional sites have been examined during subsequent years. Through the examination of new sites during 2002 and 2004, the species was found to occur off additional islands within a specific portion of the Banggai Archipelago. In addition, the species has expanded outside of its native distribution into a new location through accidental introduction by aquarium fish traders. The only known reduction in geographic extent over this short time period (2001–2004) is due to the extirpation of a population off Limo Island (Vagelli, 2005a).

5. Threats

The primary threat to *Pterapogon kauderni* is over-harvesting for the aquarium trade since 1999, with secondary impacts associated with habitat degradation and destruction. This species is especially susceptible to unsustainable collection due to its ease of collection; the species is a site-attached fish found only in shallow water in association with sedentary benthic invertebrates. Furthermore, the level of fishing pressure has grown dramatically as other livelihood options (e.g., live reef food fish trade) have declined and demand has increased. Fisheries for *Pterapogon kauderni* were initially concentrated on Banggai Island and have recently expanded to all of the major islands in its range, including many previously unexploited areas (Lunn and Moreau, 2002; 2004). In the late 1990s an estimated 5,000 individuals were collected per week and a minimum of 600,000–700,000 individuals were exported each year by local fishers (Allen, 2000). While trade estimates for 2001–2004 are 700,000–900,000 fish/yr, it is likely that total collection pressure is substantially higher because many fish die during collection, holding, and transport (Vagelli, 2005a). The lack of dispersal and particular geomorphology of the area make it almost impossible for this species to re-colonize areas where they have been depleted.

Besides the direct threat imposed by collection, *Pterapogon kauderni* is threatened by loss of habitat due to 1) destructive fishing practices, including cyanide use for the capture of other ornamental fish and live reef food fish, along with the use of dynamite for subsistence fisheries; and 2) siltation and polluted runoff from land clearing and poor agricultural practices (Harborne et al., 1997; Allen, 2001). The Banggai archipelago is located in the center of the "coral triangle," an area that harbors the world's richest biodiversity, but due to high human population and other environmental pressures, it also includes the most threatened marine ecosystems (Allen and Werner, 2002). Significant changes in living coral coverage and fish diversity on these reefs have been observed since 2001 (Allen et al., 2001; Vagelli, 2005a). In addition, frequent earthquakes recently affected several zones within the Banggai Archipelago and had a detrimental impact on localized *Pterapogon kauderni* populations (EC-Prep, 2004).

A newly emerging threat (a viral disease) has been documented in wild-harvested individuals maintained in captivity. The origin of the virus, as well as the prevalence in and impacts to wild populations, is unknown (Vagelli, pers. comm.).

6. Utilization and trade

Pterapogon kauderni is a popular fish among hobbyists and public aquarists due to its attractive appearance and the ease with which most individuals adapt to aquaria (Michael, 1999).

6.1 National utilization

The local trade in *Pterapogon kauderni* began in 1992 with traders from Tumback and Bali coming by boat to the Banggai Islands to fish for the species. Local fishers began collecting this species in 1995. Since 1999, the fishery has expanded from Banggai Island and Bandang Island to villages in the Bokan area, on Bangkurung Island, Labobo Island, and Peleng Island, with most collection occurring near their own villages. By 2001, at least 17 villages and 230 fishermen were involved in the *Pterapogon kauderni* trade (Lunn and Moreau, 2004). An estimated minimum of 600,000–700,000 individuals were collected per year by local fishers prior to 2001 (Vagelli and Erdmann, 2002; Lunn and Moreau, 2002); current harvest rates are believed to exceed 700,000–900,000 fish/yr (Vagelli, 2005a).

6.2 Legal trade

Pterapogon kauderni are shipped primarily by boat from the Banggai archipelago to national exporters via Tumbak and Manado and to a Bali exporter via Palu, and also direct to Bali exporters. An estimated 115,000 fish/month were transported on the Tumbak–Manado route, 3,000/month along the Palu to Bali route, and up to 10,000 fish/month were sent direct to Bali in 2001 (Lunn and Moreau, 2004). These numbers are close to earlier estimates of 50,000–60,000 fish/month arriving in North Sulawesi for exportation, with total estimated trade for 2000–2001 of 700,000 fish (Vagelli and Erdmann, 2002). A minimum of four aquarium fish export companies operate in Bali; others exist in Kendary and Manado (Sulawesi). The majority of *Pterapogon kauderni* captured in the Banggai archipelago are destined for the international aquarium trade, with most exported to the United States, Europe, and Asia.

When the species was first introduced to the aquarium trade in 1995, retail prices for individual fish was about US$100. Current retail prices for wild-harvested fish is about US$15–25 and a captive-bred fish is US$25; wholesale prices are US$5–7 (Hopkins et al., 2005). Collectors are reported to only receive US$0.02–0.05 per fish, while exporters pay buyers US $0.10–0.12 per fish (Vagelli, 2002).

6.3 Parts and derivatives in trade

None. The fish is only traded as live individuals.

6.4 Illegal trade

There is no illegal trade between countries because trade is not internationally regulated. Indonesian fishermen from outside Banggai Islands have been reported to illegally fish for this species and export them to nearby islands.

6.5 Actual or potential trade impacts

During a recent rapid assessment of coral reef fishes in the Banggai Archipelago, Allen and Werner (2002) observed about 5,000 *Pterapogon kauderni* in holding cages in one small village, illustrating the large volume of harvest in this species. They concluded that the species could go extinct within the next decade if conservation measures were not implemented, and have recommended the fish for inclusion on the IUCN Red List and a CITES listing (Allen and Werner, 2002).

7. Legal instruments

7.1 National

In 1995 regional fishing regulations were changed to prohibit people living outside the Banggai district from fishing in the area without purchasing government permits.

7.2 International

Currently, there are no international regulations protecting *Pterapogon kauderni*.

8. Species management

8.1 Management measures

There are no specific fisheries management plans or regulations for *Pterapogon kauderni*, although only local fishermen from the Banggai archipelago are allowed to collect this species.

8.2 Population monitoring

None. However, several researchers have conducted sporadic field surveys to characterize population distribution, sizes and trends. Limited socio-economic monitoring of fisheries occurred from 2001 to 2004 by independent researchers.

8.3 Control measures

8.3.1 International

None.

8.3.2 Domestic

None.

8.4 Captive breeding and artificial propagation

Captive breeding of *Pterapogon kauderni* is a viable alternative to wild harvest of the species; this fish can be reared in captivity through its entire life cycle, and numerous commercial operations exist. In 1997, the New Jersey Academy for Aquatic Sciences began a captive-breeding program, and all aspects of the reproductive biology of this species have been described (Vagelli, 1999). Using cage grow-out systems, facilities can raise marketable-sized fish within 100–130 days; survival rates from the time of release of juveniles to market size ranged from 66 to 95% (Marini, 1998; Vagelli, 2004b; Hopkins et al., 2005).

8.5 Habitat conservation

The Indonesian government prohibits the use of chemicals or explosives to catch fish (Fisheries Law No. 31/2004, Art. 8(1)). There was authorization to create two pilot marine protected areas in Kokungan Bay, Banggai Island, and Latinbung, Bangkulu Island

9. Information on similar species

There are no similar species. *Pterapogon kauderni* is easily distinguished from other apogonids.

10. Consultations

The Government of Indonesia was consulted on this proposal, and while declining to co-sponsor, did not express opposition to submission of this proposal by the United States.

11. Additional remarks

Dr. Alejandro Vagelli, Director of Science and Conservation at the New Jersey Academy for Aquatic Sciences is working with an NGO based in central Sulawesi (Yayasan Pemerhati Linkunga; YPL) to implement a conservation project in the Banggai region. In 2001, two areas localized on the Islands of Banggai and Bangkulu were identified as possible marine sanctuaries based upon the following criteria: 1) high comparative biodiversity–conservation value; 2) presence of *Pterapogon kauderni*; 3) logistically viable; 4) potential acceptance and support from local communities. The NGO conducted field surveys, held formal meetings with the local communities and the regional government, and presented findings to the local regional government in 2004. Based on these efforts, the Chief of Fisheries and Natural

Resources of the Bangkep Regency signed the authorization for the creation of the two selected conservation areas (Kokungan Bay, Banggai Island; and Latinbung, Bangkulu Island) (Vagelli, 2005b).

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