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OF WILD FAUNA AND FLORA

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ADDITIONAL INFORMATION ON BIOLOGICAL AND TRADE CRITERIA IN SUPPORT OF AN APPENDIX-II LISTING FOR THE BANGGAI CARDINALFISH, *PTERAPOGON KAUDERNI*

1. The attached document has been submitted by the United States of America.

2. The geographical designations employed in this document do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries.

The Banggai Cardinalfish, *Pterapogon kauderni*

In addition to the information presented in the document CoP 14 Prop. 19, the following new information is available on the biological and trade status of the Banggai Cardinalfish, *Pterapogon kauderni*. This includes information compiled through consultations and new information gleaned from March 2007 surveys conducted by Dr. Alejandro Vagelli (Vagelli, 2007).

Decline in area of distribution: The FAO Expert Advisory Panel (FAO, 2007) concluded that there is no evidence of a decline in the overall area of distribution. While the U.S. agrees with this assessment, it is likely that the species has exhibited a substantial decline within its range, including the loss of subpopulations around specific islands. It is well known that this species is confined to a very small geographic range, and the total area of occupancy within this range is considerably smaller (e.g., 426 km of coastline, within 100 m of shore, with a maximum estimated available area of only 34 km^2). Within its distributional range, the species is reported to be absent from 36% of the islands (20 islands) that comprise the Banggai Archipelago, even though these islands contain suitable habitat. While there is a lack of data on the historic area of occupancy of the species, it is possible that the species was extirpated from these islands due to fishing pressure or other threats, and recovery has been prevented due to factors that preclude natural dispersal and exchange of propagules, including the presence of physical barriers (oceanographic characteristics) within and between islands and the lack of a planktonic dispersal phase.

Decline in population size: The FAO panel stated that the species did not meet the biological criteria for an Appendix II listing due to insufficient evidence of a decline in population numbers or number of subpopulations. The U.S. concludes that there are strong biological indications that populations have declined, including declines in density, mean group size and maximum numbers of fish per group, as well as information on declines in CPUE. These declines exceed the criterion levels that would support inclusion in Appendix II. The best way to assess population status and trends of this species throughout its range is to assess trends in isolated subpopulations inhabiting shallow coral reefs around the islands. Because the first quantitative population surveys were conducted in 2001, 6-7 years after emergence of the fishery, an estimate of the density of the population in unexploited areas provides the best estimate of the maximum population size that could be supported. By comparing this number with mean densities in areas open to fishing, it is possible to obtain a reliable estimate of the extent of decline.

Surveys from a single unexploited area (Pearl Farm site) where fishing is banned reveal an optimal density of approximately 0.6 fish per square meter. In comparison, densities at 77 sites (29 islands) ranged from 0.01-0.23, with a mean density of 0.07 throughout the distributional range. This suggests a minimum decline of about 89%. The decline may be higher, as density estimates are determined from areas where the fish are present, and data from exploratory surveys conducted within suitable habitat that did not contain any fish were not included in these estimates.

The FAO panel also stated these comparisons are not valid, as the densities were determined by different researchers using different methodologies, and there is no evidence that the sampled sites are representative of the full range of the species. The U.S. disagrees with this assessment. The density in the unexploited site was determined independently by two researchers, and both obtained similar values. Furthermore, the estimates of a range wide density of 0.07 was determined from 77 sites in 29 islands, although data from only 7 sites are presented in Vagelli, 2005, as referred to in the FAO report. In addition, Dr. Vagelli has surveyed every island in the archipelago and has characterized habitat characteristics and condition throughout the range of the species. The species prefers shallow grass beds and coral reefs, and is commonly found in calm and protected bays, which is representative of the unexploited site as well as all other locations were the species occurs (Fig. 1).

The FAO panel also notes that fishing pressure at the time of these surveys was confined to locations close to fishing villages, and because not all areas of occurrence were being exploited, the mean density of 0.07 could represent an underestimate and population depletion may be much less. The U.S. acknowledges differences in spatial distribution of fishing pressure between locations, but notes that this varies temporally and this variation is reflected in the differences in density observed between sites and years (e.g., densities varied between 0.01-0.23). In addition, Kolm and Berglund (2003) noted dramatic differences in group size of fish which were related to the degree of fishing pressure.

Decline in number of subpopulations: The FAO panel notes that only limited observations are available to assess potential declines in abundance, including extirpation of a single subpopulation and declines of a second population between 2001 and 2004. The U.S. reported these declines in our proposal, but also notes that there are numerous other sites with reported declines. Recent surveys completed by Vagelli in March, 2007 identified declines in at least six additional locations between 2004 and 2007. Vagelli also recorded further declines and an absence of recovery in sites with reported declines documented between 2001 and 2004. The control (unexploited) area exhibited a decline in density between 2004 and 2007 which is reported to be due to illegal fishing. There were also declines in the introduced Luwuk Harbor population due to pollution and habitat degradation (Vagelli, 2007).

The FAO panel states that recent (2006) surveys found a ratio between juveniles and adults that is higher than at the control site, and suggested that this indicates populations are recovering rather than declining. The United States disagrees with this assessment. While both juveniles and adults are targeted by fishermen, an observed increase in juvenile fish could be solely due to increased mortality of adults from a combination of fishing pressure and natural mortality due to old age. These species have a relatively short lifespan, and over time, in absence of strong pulses of new recruits, it is likely that fewer adults will remain in a subpopulation. In all sites examined to date, very low numbers of new recruits have been documented. If these populations were in fact recovering, there would be indications of an increase in the presence of recruits as well.

Decline in catch per unit effort (CPUE): Indirect estimates of declines in *Pterapogon kauderni* populations were also determined from CPUE data. Off North Banggai, weekly catch declined between 2000 and 2004 by 25-80%, with a decline from a mean catch of over 1000 fish/hour to 25-330 fish/hour. Similar declines were recorded in other sites (EC-Prep Project EP/RO3/R14, 2004).

Extent of trade: The FAO panel concludes that collection pressure has not been at levels that would result in a depletion to 11% of the pre-exploitation level. They propose a minimum cumulative catch of 19.2 million over the duration of the fishery would be required to reduce a population of 21.6 million fish to 2.4 million, based on a worst case assessment of a population without a density dependent response. The United States feels this is an unrealistic estimate, as it does not take into account the effects of removal of individual fish on overall productivity of each subpopulation. Based on a conservative estimate, a single pair could produce 500 offspring in a lifetime, of which a maximum of 5-10% may survive to an adult life stage. Thus, annual removal of 700,000-900,000 fish will result in a much higher cumulative loss of fish due to the effects of this removal on annual production.

The U.S. also notes that there are three principal collecting operations with an estimated current capture magnitude of at least 900,000 fish per year, based on assessments by Vagelli in 2007. This estimate is considerably higher than recent estimates as reported in the FAO panel review (500,000), and is not indicative of a decline in total harvest as suggested by Reksodihardjo-Lilley in the FAO review. While we agree with the conclusion that demand for these species may be 50-60% of the reported capture (500,000), the estimates of mortality reported in the FAO review (10%) are much lower than that reported by collectors and exporters. Interviews with fishermen and buyers within the principal collecting operations reported mortality estimates of 25-30% and rejection of another 15% because of poor health (Vagelli, 2007).

Existing Conservation Efforts: The FAO panel concluded that the Government of Indonesia and NGOs are taking steps to improve management and implement captive breeding in cooperation of local communities. They felt an Appendix II listing would hinder national management, and recommended that existing efforts to strengthen local and National management should be pursued instead. The United States feels strongly that an Appendix II listing in warranted for this species based on the biology and population trends, and we conclude that this listing could help promote implementation of local and national management schemes. Through consultation with local and national government of Indonesia and two local NGOs, we have received information on reported conservation initiatives, including adoption sustainable collection practices, Marine Aquarium Council (MAC) certification and in situ aquaculture programs. Although first proposed in 2001, it appears that these initiatives have not been implemented to date, due to lack of funding and technical capacity. The local government authorized the creation of two small pilot conservation areas on April 10, 2004 (a small bay off Banggai Island and Bangkulu Island), but no actions have been taken to develop a management plan or to exclude fishermen from these areas (Vagelli, 2005b; 2007).

IUCN recently completed an IUCN Red List of Threatened Animals Assessment for the Banggai cardinalfish (IUCN, 2007). This assessment includes a proposal to list this species as vulnerable. This assessment identifies the need for additional conservation measures including 1) regulations to reduce collection and export levels; 2) measures to protect critical habitat; 3) a CITES listing to regulate trade; 4) expansion of captive breeding efforts in Indonesia; and 5) efforts to reduce post capture mortality.

Conclusion: The U.S. strongly supports the proposal to list this species on Appendix II based on concerns of both a historical extent of decline and recent rates of decline in the size of subpopulations, and the role of harvest and trade in this decline. We are also concerned about recent observed increases in the use of destructive fishing techniques in the Banggai Archipelago which are destroying the habitat required by these fish, as well as increased occurrence of diseased and dying corals within shallow water which will further reduce available cardinalfish habitat. These emerging threats are compounding impacts associated with over-collection for the marine aquarium trade, and are likely to result in accelerated declines of subpopulations unless actions are taken to implement measures that promote sustainable harvest of the species. The proposed Appendix II listing is appropriate, based on the biological and ecological characteristics of the species, the magnitude and trend of international trade, and the status and trends of subpopulations. Furthermore, an Appendix II listing could protect the ability of local communities to sustainably harvest the species over the long term.

Annex I. Summary of biological data

Decline criterion levels required for Appendix II listing proposals

- It is not possible to determine the historical abundance of the species. The first quantitative surveys of this species were conducted in 2001, after collection had begun (Vagelli, 2002). Assessments made within unexploited areas provide a reasonable estimate of the baseline or historic abundance, and any significant departure is related to human intervention. The only known site where no collection has occurred is within a protected bay off Banggai Island (Pearl Farm site). This site had a historic abundance that ranged from 0.58-0.63 fish/m^2, as determined by two independent groups of researchers in 2001 and 2004 (Vagelli, 2002; Lunn and Moreau, 2004; Vagelli, 2005a). A mean density of 0.07 fish/m^2 was estimated based on quantitative surveys conducted throughout the natural distributional range of the species (Vagelli, 2005a). Individual sites show variations both between and within sites and between years that ranged from about 0.01 to 0.2 fish/ m^2 (Vagelli, 2005a, 2007). It is important to note that the total number of fishes in each site overall is relatively small and populations are concentrated around limited number of substrates in shallow water. Some of the variation between years can be explained by changes in fishing pressure, as well as loss of habitat due to dynamite fishing and other human impacts (Kolm and Berglund, 2003).
- The full range of the species was documented for the first time in 2004, through an expansion of effort begun in 2001 (Vagelli, 2002; 2005a, 2007). The recent nature of these surveys precludes the ability to determine whether there has been an overall decline in area of occurrence, although there have been observed declines in abundance and density of numerous subpopulations over the last 6 years.
- It is important to note that the density estimates presented in the literature only reflect densities in sites of suitable habitat where the fish were observed, and this does not take into account sites with no fish. There have been numerous sites with suitable habitat identified within the range of *P. kauderni* that appear to lack individuals, and the species is absent from 36% of the islands, even though appropriate habitat is found around these islands (IUCN, 2007). These may represent a decline in area of occurrence due to human intervention.
- There are several recent examples of declines observed between 2004-2007 (Vagelli, 2007):

    a. **Limbo Island:** A population of that contained an estimated 50,000 fish in 2001 was extirpated by 2004.
    b. **Masoni Island:** The population increased in density from 0.03 to 0.06 fish/ m^2 between 2001-2004, with up to 300 fish in an area of about 70 x 70 m, in absence of fishing. This population has since declined to 0.008 fish/m^2, with a total of 38 fish recorded over the entire census site (the largest group consisted of 2 individuals) in 2007. An extensive search around the entire island identified only 150 fish.
    c. **South East Peleng Island:** The population (followed since 2002) which showed a reduced density of 0.04 fish/ m^2 in 2004, has been practically extirpated; only 27 fish were found at the census site in 2007.
    d. **Bakakan island:** A population that contained 6,000 fish in 2001 (0.02 fish / m^2) was reduced to 17 individuals in 2004. This site has shown no recovery over 3 years. Only four fish were identified in the census area in 2007.
    e. **Northwest Limbo Island:** A small population that has a density of 0.03 fish/ m^2 in 2004 has further declined.
    f. **Luwuk harbor:** The population in that was relatively stable between 2001-2004, but showed a dramatic decline in 2007.
    g. **Sarina Kenecil Island:** populations showed a significant reduction in density, a reduction in the mean group size, and a reduction in the size of the largest recorded group within two years after collection began (Vagelli, 2005a)

- Catch per unit effort (CPUE) declined by 30-50% between 2000 and 2004. For example, catch per week in BoneBaru (North Banggai) ranged from 5000-10,000 fish, with catch in excess of 1000 fish/hour. By 2003-2004 the average weekly catch declined to about 2000, with a catch of only 25-330 fish per hour (EC-Prep. Project EP/R03/R14, 2004).

Historic population size versus current population size

- The natural geographic range of *P. kauderni* extends from 01° 24′ 57.6″ South latitude (Monsamat, east Peleng) as its north most distribution point to 02° 05′ 53.5′′ South latitude (Loisa A), and from 123° 34′ 11″ East longitude (Patipakaman, central Peleng) as its westernmost distribution to approximately 124° 23′ 30″ East longitude (Kano) and the south-east tip of Taliabu (Vagelli, 2005a). This distribution covers an area of about 5,500 km^2. Within the distributional area, populations are restricted to approximately 426 km of coastline extending from the shore to about 100 m offshore, with a maximum area of occupancy within this range of only 34 km^2 (Vagelli, 2005a)
- The fish has been reported from 74 sites in 30 islands, including 17 of the 20 major islands and 10 of the 27 minor islands. Despite the availability of suitable habitat around all islands, the species was absent from 20 islands (36%) within the distributional area including Belangan, Tanalan, Bongko, Sidula, Togonglantan and Tabija Islands (IUCN, 2007). Because of the occurrence of suitable habitat features and close proximity to islands that support cardinalfish populations, it is possible the species formerly occurred around these islands, but fishing pressure led to their extirpation.
- The FAO panel suggests that Banggai cardinalfish had a baseline population size of 21.6 million fish, based on a current population size of 2.4 million and a depletion to 11% of the pre-exploitation level. The FAO report concludes that the cumulative catch since the fishery first started in 1995 would have to be 19.2 million fish to support the proposed level of decline, which is not supported by the estimated annual harvest of 700,000-900,000. While we feel the data does support the proposed decline to 11%, the suggested cumulative catch is inconsistent with available data on the biology and density records. The natural density of the fish between sites is highly variable, depending on the scale of surveys, particular habitat features, and degree of fishing. While the species occurs throughout all shallow habitats in the Banggai Archipelago, at a low overall density (0.07), densities varied from 0.01-0.23 and within certain microhabitats (at a scale of meters) the fish may occur in very large schools of 100s of fish. Furthermore, this assessment assumes that the total number of fish removed from the population is directly equivalent to declines in overall population size. The FAO assessment does not take into account the effects of removal of individual fish on overall productivity of each subpopulation. For example, removal of a single juvenile would reduce the subsequent numbers of offspring produced by that fish over its expected lifespan (e.g., 6 reproductive periods per year, 40 surviving offspring per brood, and 500 or more offspring during the reproductive lifespan of a single fish; Vagelli, 1999; Vagelli and Volpedo, 2004). Removal of a single fish in a breeding pair may prevent the other fish from mating due to their pair bonding character. If all fish from a subpopulation are removed, that subpopulation is unlikely to recover due to lack of a planktonic dispersal phase.
- In addition to the declines associated with fishing pressure, the habitats are being degraded at an accelerating rate by other factors, including dynamite fishing for subsistence and run-off associated with poor land practices, all of which are likely to affect habitat quality, and ultimately this affects the size of populations that can be supported.

Species productivity and relationship with harvest levels

- As indicated in the FAO assessment, this species exhibits several factors indicative of high productivity: a relatively short life span (ca. 2.4 years), early maturity (average of 0.8 years) and short generation time (1.5 years). However, a closer evaluation of the life history of this species suggests it may better qualify as a medium to low productivity species. It exhibits a very low fecundity (male incubates about 41 eggs per brood, with up to 6 broods per year). It also exhibits paternal oral incubation of eggs and releases free-living embryos that lacks a pelagic phase. In addition to limited dispersal capabilities, the species exhibits localized settlement and recruitment (Vagelli, 1999; 2002).
- The U.S. acknowledges the fact that subpopulations can increase relatively rapidly in absence of fishing pressure, if reproductive fish are present. The FAO assessment reports a doubling of population density over three years in the Masoni area in response to a collection ban. While this only represents an increase to about 300 fish, the Masoni population has largely collapsed (primarily due to illegal collection) between 2004 and 2007, with only 38 fish remaining, emphasizing the vulnerability of the species.

Relationships between juvenile and adult density

- The FAO evaluation concludes that high proportion of juveniles in a population suggests there is good recruitment. However, this is not necessarily the case, as this may be an indication that the adults have been overfished for the aquarium trade.
- The size class structure reported in 2001 and 2004 surveys indicates most fish are large juveniles (58% were 6-9 months old and 37% were adults), whereas newly released recruits and juveniles up to 2 months old are rare, suggesting the survival of new recruits is actually much lower than indicated in the FAO evaluation (Vagelli, 2005a).

Establishment of new subpopulations (including areas outside its range)

- The United States agrees with the FAO assessment that the species can become established in new areas relatively quickly, but this will only occur if the species is artificially introduced by man through accidental or intentional release, and if the particular habitat and microhabitat features are suitable. These species lack an effective means of dispersal, and are incapable of naturally expanding their range due to their brooding life history strategy, lack of pelagic larval phase, and the large expanses of deep water and strong currents between islands in the Banggai Archipelago.
- Even though several new introduced populations have become established due to human introductions, their long term persistence is threatened by collection. For instance, the introduced population in Lembeh Strait (Erdmann and Vagelli, 2001) did not exhibit substantially higher densities or abundance in 2007 (0.05 fish/m^2) from levels reported in 2004 (0.04 fish/m^2) (Vagelli, 2007). This population has failed to expand over a three year period even though considerable suitable habitat occurs, and it remains well below densities reported for unexploited populations.
- *Pterapogon kauderni* is especially susceptible to collection pressure because of its association with shallow microhabitats and its sedentary nature within those habitats. If all fishes are removed from a particular area, several factors preclude *Pterapogon kauderni* from dispersing to nearby islands or repopulating areas from which it is extirpated. This includes: 1) a lack of planktonic dispersal; 2) particular oceanographic characteristics of the Banggai region (deep channels, strong currents); 3) its within-parental habitat recruitment, sedentary nature, and shallow habitat preference (Bernardi and Vagelli, 2004).

Comparison of density/abundance between fished and unfished sites

- Scientific assessments of density and abundance of cardinalfish in an unexploited site have been conducted by two groups of researchers. One group (Lunn and Moreau, 2004) surveyed an unexploited site (Pearl Farm site) and reported a density of 0.63 fish/m^2. While concerns were expressed that the data between the protected area and areas open to fishing are not comparable due to different survey methodologies, Vagelli (2004) estimates within the protected area are similar and comparable to data from Lunn and Moreau, 2004 (~ 0.6 fish/ m^2 in 2001 and 0.58 fish/ m^2 in 2004).
- The FAO panel also noted that the Pearl Farm site may not be representative for the habitat of the species overall, and data from this site may not be comparable to the region-wide estimates. However, Dr. Vagelli (pers. Comm, 4/17/07) indicates 1) this bay is very representative of any bay within the Archipelago; and 2) his data from the site are similar to publications by Lunn and Moreau (2004).

Spatial distribution of collection effort

- The collection for the aquarium trade began in 1999, expanding from Bangaai Island and Bandang Island to villages in the Bokan area, Bangkulu Island, Labobo Island and Pelang Island.
- Lunn and Moreau (2004) indicate 17 out of 47 villages (230 fishermen) were involved in the trade in 2001 and all fishing occurred close to their villages, but they noted collection was rapidly expanding to other islands. While it is still likely that there are places where no collection occurs, the number of sites that have not been exploited are declining. The three major collecting operations are organizing weekly collecting trips to neighboring islands, including areas where fishing did not previously occur on a large scale 9Vagelli, 2007).

- Lunn and Moreau (2004) reported monthly sales of 118,000 Banggai cardinalfish, but trade volumes are thought to be higher, as this only considers Tumbak and Palu-based buyers, and not individuals collected and shipped from alternate locations or pre-sale mortalities of fish in holding pens.
- In addition to individual fishers, there are three principal collecting operations within the Banggai region today:
  1) The Bone Baru Village in Central west Banggai Island. They collect around Banggai (including the Pearl Farm), Labobo, Bakakan, and Peleng Islands.

  2) Bone Bone Village in Southeast Bangkulu Island. They collect mostly around Bangkulu Island.

  3) Tarapat Village in Southeast Bokan Island. They collect on Bokan, Buang Buang, Loisa Masepe and Kokudan Islands (Vagelli, 2007).

- Monthly collection estimates obtained during 2007 surveys include: Bone Baru, 35,000/month; Bone Bone, 15,000 month and Tarapat, 50,000/month. While some of these collecting figures may be lower during some periods (e.g., due to weather/logistical problems), the current capture magnitude is at least 900,000 fish/ year (Vagelli, 2007).
- Recent interviews with collectors, buyers and exporters report mortality estimates at each level in the trade stream of 25-30% and discards of up to 15% (Vagelli, 2007).

Current rates of exploitation

- The FAO review suggests the annual production levels of this species may be at least 30% based on assumed increases in stock size from 49 to 662 fish within one (unfished) population between Sep 2001 and June 2002. If this figure reflects productivity of the species throughout its range, the FAO report suggests the overall population (2.4 million fish) could support removal of about 800,000 fish per year as catch levels of 700-900,000 are equivalent to an instantaneous fishing mortality of 0.34-0.48, or exploitation rate of 29-38%.
- The productivity is likely to be much less than stated in the FAO report. The actual abundance of fish in this site in Sep 2001 is unknown, as no surveys were conducted in this area. The 49 fishes reported in Vagelli, 2002 represent the total number of fishes observed in one location by the owner of a resort, and not the total number of fish throughout this location. Numerous additional fishes may have been released (but undocumented) during this period. In addition, the 49 fish consisted of 31 juveniles and adults and 18 (non-reproductive) newly released recruits. The presence of new recruits in this location September 2001 suggests that adults existed here prior to September 2001, and these subsequently mated and produced offspring.
- If we assume the 31 juveniles and adults were all reproductively mature, and they produce one brood every other month, there would be a total of 4-5 broods produced by 15 pairs between September and June (e.g., up to 75 broods total). If each brood contained the maximum reported offspring (40 offspring), a maximum of 3000 offspring could be produced. These are expected to experience about 90% mortality during the first week, resulting in a maximum of 300 surviving juveniles. This would reflect a productivity of about half (up to 15% and not 30%) that indicated in the FAO report. Hence, the maximum removal a population of this size could sustain would be 400,000 fish, or half of the estimated current harvest.
- Fishing to supply international aquarium markets is the most significant threat affecting these species, and it appears to be occurring unsustainably, as reflected by changes in population structure. For example, the average group size of fish in areas with high fishing pressure is about half that found in sites with low fishing pressure, which is reported to have negative impacts on individual fitness in the future (e.g., Allee affect) (Kolm and Berglund, 2003).

Other threats are compounding mortality associated with fishing

- In addition to collection pressure, a viral disease has been documented in wild-harvested individuals maintained in captivity.
- Harvest of associated species for the aquarium trade, including anemones and sea urchins affect local populations of cardinalfish that use these microhabitats.
- Prevalence of blast fishing for subsistence is reported to have increased in recent years, causing increasing habitat degradation and loss of microhabitats for cardinalfish (Vagelli, 2007).

- Other signs of recent habitat degradation include increased presence of pest species such as macroalgae, fungus and cyanobacterial mats that are overgrowing and killing corals, and are resulting in the loss of critical high relief structure used by these fish (Vagelli, 2007).

Local conservation efforts and relationship with CITES Appendix II Listing

- The FAO study concludes that a CITES listing may deter local conservation efforts and it could have significant socioeconomic implications. They highlight reports of local conservation projects to protect the species, including implementation of MPAs, a captive breeding program and a certification scheme through the Marine Aquarium Council.
- Vagelli (2007) reports that the above mentioned proposed conservation programs, aquaculture/captive breeding projects and MAC certification efforts have been implemented to date. A CITES listing may actually increase the likelihood of implementation, as these alternatives provide rational mechanisms for implementation of management plans and sustainable mariculture alternatives as a mechanism to assist in determination of non-detriment. Furthermore, reduced levels of harvest, as required to ensure non-detriment, are likely to have minimal socioeconomic implications. Only a small number of fishermen rely on Banggai cardinalfish for their livelihood, as indicated above (Vagelli, 2007). While a CITES listing may result in a reduction in the levels of harvest and trade; the lower availability will drive the prices up, increasing the revenue fishermen receive.
- The species can be successfully raised in captivity, but it is currently not viable due to the cheap alternative of wild-harvested fish. A CITES Appendix II listing would provide incentives for development of aquaculture activities to reduce demand for wild harvested fish, thereby protecting wild populations

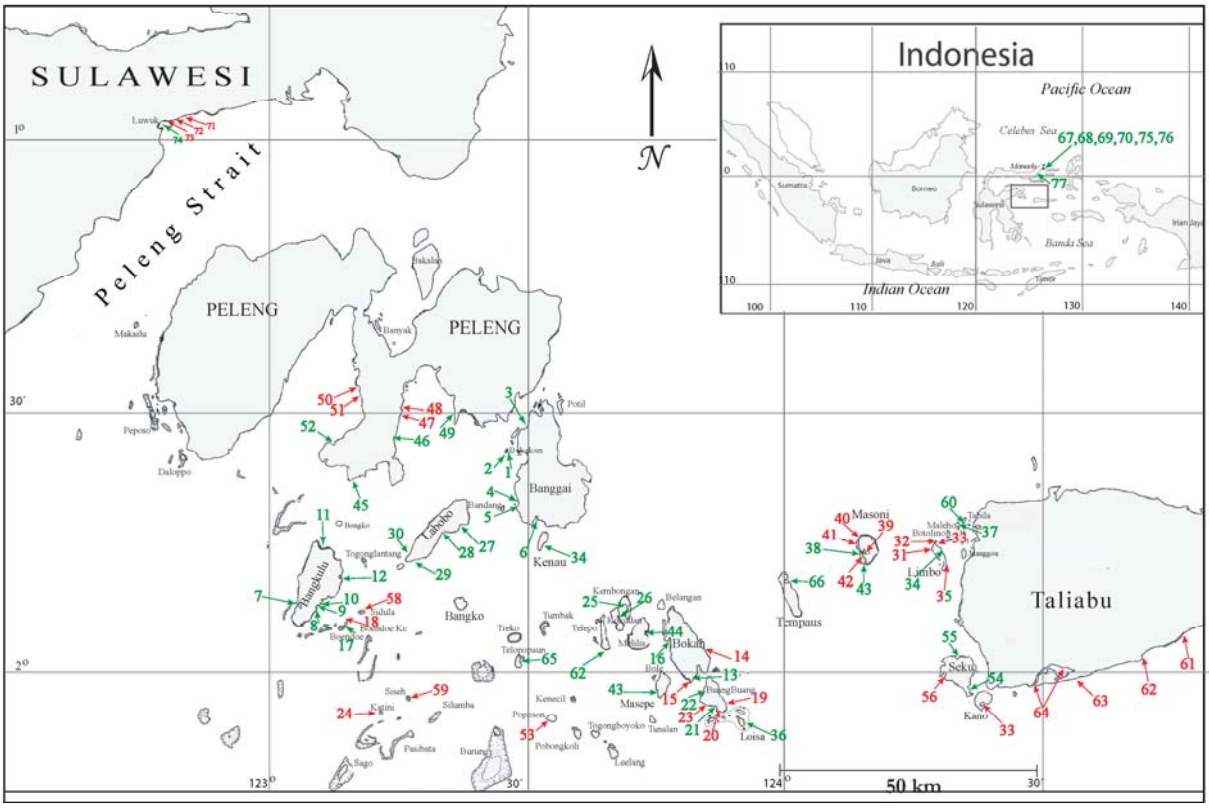

Fig. 1. Locations of *Pterapogon kauderni* surveys within the Banggai Archipelago during 2007. Numbers in green represent locations with extant populations of the Banggai cardinalfish and red numbers are sites characterized by an absence of this fish.

Source: Vagelli, 2007.

References

Bernardi, G. and A. Vagelli. 2004. Population Structure in Banggai Cardinalfish, *Pterapogon kauderni*, a Coral Reef Fish that Lacks a Pelagic Larval Phase. Mar. Biol. 145:803-810.

EC-Prep Project EP/RO3/R14. 2004.The Indonesian Ornamental Fish Trade: Case Studies and Options for Improving Livelihoods while Promoting Sustainability in Banggai and Banyuwangi. www.ec-prep.org.

Erdmann, M. and A. Vagelli. 2001. Banggai cardinalfish invade Lembeh Strait. Coral Reefs 20:252-253.

FAO. 2007. SECOND FAO AD HOC EXPERT ADVISORY PANEL FOR THE ASSESSMENT OF PROPOSALS TO AMEND APPENDICES I AND II OF CITES CONCERNING COMMERCIALLY-EXPLOITED AQUATIC SPECIES. Rome, 26–30 March 2007. FAO Fisheries Report No. 833. 140 pp.

IUCN. 2007. Taxon Datasheet for the Banggai Cardinalfish. Assessors: Dr. Terry Donaldson and Gerald Allen, in collaboration with RLA and Coral Reef Fishes Specialist Group members. Feb.2007. 33 pp.

Kolm, N. and A. Berglund. 2003. Wild Populations of a Reef Fish Suffer from the 'Nondestructive' Aquarium Trade Fishery. Conservation Biology. 17: 910-914.

Lunn, K. and M. Moreau. 2004. Unmonitored Trade in Marine Ornamental Fishes: the Case of Indonesia's Banggai Cardinalfish (*Pterapogon kauderni*). Coral Reefs. 23: 344-351.

Vagelli, A. A. 1999. The Reproductive Biology and Early Otogeny of the Mouthbrooding Banggai Cardinalfish *Pterapogon kauderni* (Perciformes, Apogonidae). Env. Biol. Fish. 56:79-92.

Vagelli, A. A. 2002. Notes on the Biology, Geographic Distribution, and Conservation Status of the Banggai Cardinalfish *Pterapogon kauderni* Koumans 1933, with Comments on Captive Breeding Techniques. Trop. Fish Hobb. 51: 84-88

Vagelli, A. A. 2005a. Reproductive Biology, Geographic Distribution and Ecology of the Banggai Cardinalfish *Pterapogon kauderni* Koumans, 1933 (Perciformes, Apogonidae), with Considerations on the Conservation Status of this Species on its Natural Habitat. PhD. Dissertation, University of Buenos Aires. 276 pp

Vagelli, A. A. 2005 b. The Banggai Conservation Project. *Working for the creation of a network of small marine sanctuaries in the Banggai Archipelago, Indonesia.* Communiqué. Am. Zoo & Aquarium Assoc. July 2005: 47-48.

Vagelli, A. A. and M. V. Erdmann. 2002. First Comprehensive Ecological Survey of the Banggai Cardinalfish, *Pterapogon kauderni*. Env. Biol. Fish. 63: 1-8.

Vagelli, A. A. and A. Volpedo. 2004. Reproductive Ecology of *Pterapogon kauderni*, an Endemic Apogonid from Indonesia with Direct Development. Env. Biol. Fish. 70: 235-245.

Vagelli, A. 2007. Letter to Division of Management Authority, U.S. Fish and Wildlife Service. April 27, 2007.