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Subject: Proposed Threatened Status for Southern Distinct Population Segment of Eulachon
Reference: 0648-XF87

I have one major concern with your proposed listing document and it has two related parts. First, I believe that you should have given much greater weight to the following section from Dulvy et al. 2004, *Fish and Fisheries*, 5, 255-276:

Minimum viable population size

The 'small population' paradigm is derived from a terrestrial perspective where a small population, possibly with a positive intrinsic rate of population increase, typically numbering less than 50-500 individuals, can decline as a result of environmental and demographic stochasticity or catastrophes (Caughley 1994; Simberloff 1998). To date few marine fishes have been considered using the 'small population' criteria of extinction risk assessment schemes, e.g. IUCN *Red List*. While there may be numerous individuals in a threatened population, the key question is what constitutes a 'small' or MVP for highly fecund marine fish. It may be fruitful to consider further the MVP size as there are a number of arguments why marine broadcast spawners may require a higher MVP:

- 1 If the effective population size was less than the census population size. This may occur when there is a high variance in mating success because of assertive mating or high planktonic larval mortality. High larval mortality can mean that only a small minority of individuals achieve breeding success because such success relies on matching reproductive activity with oceanic conditions conducive to fertilization, larval survival and subsequent recruitment (Hedgecock 1994; Nielsen and Kenchington 2001; Hauser et al. 2002; Turner et al. 2002; Hutchings and Reynolds 2004).
- 2 If there is evidence for depensatory or Allee effects, where reduced reproductive output or increased predation mortality may result in declining population growth rate at small population sizes and a spiral towards extinction (Petersen and Levitan 2001; Dulvy et al. 2004; Gascoigne and Lipcius 2004).
- 3 If the population is one of a number of connected subpopulations. A higher threshold would be considered if there was evidence that the population receives a recruitment subsidy.

There are no data to indicate an appropriate threshold for (2) and (3), but population genetic theory suggests the effective population size is at least 2-6 orders of magnitude less than the census population size (Hedgecock 1994; ICES 2004c). Assuming the minimum viable population size is between 50 to 500 individuals, the equivalent MVPs for highly fecund species could be 50 000-500 000 individuals. It is difficult to evaluate this 'back of the envelope' calculation and the only evidence we have to support this is the observation that the last known census population size of the Icelandic spring spawning herring was 700 000 in 1972. The current population size and the fate of this stock is unknown (Jakobsson et al. 1969; Jakobsson 1980; Beverton 1992). There is clearly scope for exploring the minimum viable population size of species with potentially small effective population sizes, such as broadcast spawning fishes and invertebrates.

Eulachon clearly need to be managed by the "Precautionary Principle", where management is conservative in direct proportion to uncertainties about the resource. The lack of quantitative biomass estimates for any U.S. population would certainly qualify as a major uncertainty along with the predominance of males. Further, the qualitative and quantitative biomass trends over time (especially in the Klamath, Columbia and Fraser rivers) all strongly suggest that populations of the species may have an inherent mechanism that causes collapsing stability regions, sometimes known as "multiple domains of attraction" (Peterman, R.M. 1977.