Testimony for listing 66 coral species under the Endangered Species Act

Background

In principle, I find that listing many of the proposed coral species under the ESA is warranted, is based on the best available science, and is of value. I commend the biological review team and the other team members involved in this process for undertaking the huge amount of work involved in this process, and for navigating the monumental task of responding appropriately to the proposed listing.

However, a variety of new scientific information has come to light since the period when the proposed listing was drafted which should be taken into account and, in my view, should affect the listing of several species. In addition, I must stress several critically important aspects of implementing the ESA if or when any of these species are listed. Last, coral taxonomy is in flux and I can say with certainty that much of the taxonomy will change within the next few years. These changes need to be anticipated and mechanisms thought out to accommodate substantial changes in what constitutes recognized species, and their listing status.

First, allow me to make specific comments about several of the species proposed for listing which, in my view, should change the proposed listing status. Other than the species specifically discussed below I am either supportive of listing as proposed (either as Endangered or Threatened) or do not have specific views on the proposed listing of the species. As a primer to this discussion I will point to several recent studies which support a change in the proposed listing status.

The first is a study by van Woesik et al. (2012). This study used an a priori trait-based analysis to estimate coral extinction risk and then compared the estimated extinction risk to actual coral extinction events in the Caribbean. They found that, rather than a random or unpredictable event (as would be expected under Neutral Theory) both extinction and persistence (i.e., the lack of extinction) were highly predictable using their trait-based analysis. The authors further applied these criteria to estimate the extinction risk for extant, modern corals. Based on these results, several modifications to the proposed listing status of several species are warranted.

Second is a pair of studies by Maynard et al. (2008) and Guest et al. (2012). Chief among the threats to corals is bleaching due to thermal stress, as related to climate change. However, very few data are available to evaluate the potential for corals to adapt or acclimatize to elevated temperatures. It is often assumed that corals cannot adapt or acclimatize fast enough to keep up with climate change, but this assumption is based on shockingly little data. Maynard et al. (2008) and Guest et al. (2012) provide some of the only datasets available to assess whether this assumption is actually true. In fact, in both datasets many types of coral show surprisingly large (~0.5-1°C) increases in thermal tolerance after a single mass bleaching event, due to either adaptation or acclimatization. Importantly, genera such as *Acropora* and *Pocillopora* which are often among the most thermally sensitive genera, showing severe mortality after thermal stress, were among those showing the greatest increase in thermal tolerance (i.e., the greatest adaptability). These datasets demonstrate that if we assume that coral thermal tolerances will remain the same into the future, under conditions of thermal stress, we will substantially overestimate their extinction risks. Given this background, I will now discuss each species whose listing I propose should be changed and give reasons for this change based on these new data.

Species-specific comments

Atlantic/Caribbean

Montastraea annularis, faveolata, and *franksi; Dendrogyra cylindrus*: Based on the criteria developed by van Woesik et al. (2012) (which proved highly effective at predicting both extinction and persistence of corals in previous geologic time) these four species are very unlikely to go extinct as compared to other corals. Therefore, these four species do no warrant designation as Endangered but should be listed as Threatened.

Agaricia lamarcki: Based on van Woesik et al. (2012) the genus *Agaricia*, including *A. lamarcki,* is expected to be vulnerable to extinction. This species should be listed as Endangered, and not as Threatened. Likewise, other members of the genus *Agaricia* and *Undaria* as well as *Helioceris cucullata* should be seriously considered for listing as Threatened or Endangered in the future.

Acropora palmata and *cervicornis*: Based on recent evidence of recovering populations of these species, and prehistoric declines followed by rebounds of these species, I have mixed feelings about listing these species as Endangered, though I feel the action would be justifiable.

Pacific

Acropora jacquelineae, lokani, and *rudis*: Recent evidence, such as that shown by Guest et al. (2012) shows that many Acropora spp. have far greater potential to adapt or acclimatize to climate change than has been previously recognized. Futhermore, data from van Woesik et al. (2012) suggests that Pacific Acropora like these species are unlikely to go extinct, even when they occur over a limited range. Afterall, a variety of mounting evidence shows that many marine populations (including coral populations) are largely closed and show only moderate levels of gene flow with other reefs. Hence, range size is much less of a significant issue in describing extinction risk. These species should be listed as Threatened and not as Endangered.

Euphyllia paradivisa, cristata, and *paraancora*: Based on criteria established by van Woesik et al. (2012) we would expect that species of the genus *Euphyllia* should be highly resistant to extinction, and most especially these three branching species. I have personally witnessed thousands of individuals of each of these species being grown in captivity across the world. Each of these species, and the genus generally, shows very high resilience to bleaching and to ocean acidification as compared to most other corals. All of these species show very high rates of recovery after bleaching, rapid growth rates, and, due to the relatively small quantity of skeleton produced in combination with large amounts of tissue, very high tolerance to low pH. Based on these scientifically robust criteria and my firsthand experience with these species I am confident in suggesting that these species are likely to be among the most tolerant corals to both global and local stressors. Therefore, in my view none of these species warrants listing either as Threatened or Endangered species. However, if these species are ultimately listed it should only be as Threatened species and not as Endangered. To be clear, *E. paradivisa* absolutely does not warrant listing as Endangered.

Considerations for implementing the ESA

There are two critical areas in which I strongly urge NOAA to enact a "4d rule" for the coral species listed as threatened. The first purpose is for scientific research. Clearly new scientific knowledge is needed to protect and effectively manage these species for recovery. The second purpose is in situ and ex situ mariculture or aquaculture of these species. These activities are of great value to the goal of protecting and restoring these corals for four reasons:

(1) Mariculture activities are rapidly spreading across poor, coral reef nations, for example Indonesia and the Marshall Islands and provide the people in these areas a source of income that is both sustainable and does not damage the reef. The vast majority of alternative sources of income directly damage reefs, imperiling corals.

(2) Placing a high dollar value on protecting coral health provides a major incentive to local communities not only to take an alternative route of mariculture, but to engage in active enforcement and protection of their reefs. For example, my Ph.D. advisor was recently in Bali contributing to a NOAA-sponsored workshop on coral mariculture. He related to me that all the reefs where people are mariculturing coral are in great shape because people police the areas whereas other, nearby reefs where no aquaculture occurs were in poor condtion.

(3) More than half of the Pacific species proposed for listing under the ESA are currently being actively propagates in Indonesia and other countries. In Indonesia the mariculturists are required to restock the reef with a minimum of 10% of their total production of corals, though I have heard (again, from my Ph.D. advisor who was recently in Bali) that most operations are exceeding this 10% minimum requirement. Thus, mariculture has another direct benefit to these corals, helping them to increase in population and grow in nature.

(4) Maricultured or aquacultured corals are sold mostly to marine aquarists in the USA, Europe, Japan, and other countries to be grown in coral reef aquariums. Over the last 12 years I have personally interacted with thousands of aquarists around the world. The vast majority of these aquarists are much more aware of the problems facing coral reefs, much more concerned about these problems, and much more determined to solve them than the average citizen, in my experience. Allowing coral mariculture, especially of the proposed Threatened species, strongly encourages the type of concern and environmental ethic that is sorely needed to protect and preserve coral reefs. By far the most important predictor of the future of coral reefs is societal concern for their well-being. Mariculture and the live coral trade are among the most effective tools available to foster this concern.

Changing taxonomy

Last, as mentioned above, there is mounting evidence that substantial portions of current coral taxonomy are completely wrong. Many well-recognized species are not real species at all, but rather various growth forms of a variety of species. Likewise, many supposedly wide-ranging species are actually made up of a series of highly distinctive species which simply appear similar. Coral taxonomy is going to change drastically in the next few years and many of the species proposed here likely do not constitute real species and will need to be delisted. Likewise,

many species which are not listed here will turn out to be quite rare and vulnerable as we get better data and will be important candidates for listing at that time. Mechanisms to cope with these changes should be considered carefully and structured now.

Sincerely,

Christopher P. Jury
Hawaii Institute of Marine Biology
University of Hawaii at Manoa

References

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