# Evaluation of Bowhead Whale Status: Reply to Taylor

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## Introduction

Taylor's thoughtful response to Shelden et al. (2001) provides an opportunity to clarify our results on determining the status of bowhead whales under the U.S. Endangered Species Act (ESA). We presented two models, one we developed based on World Conservation Union (IUCN) criterion D1 and E and the Gerber and DeMaster (1999) model. Our intent was to compare the results from our model with those developed from the Gerber and DeMaster (1999) model. Because many of the issues raised by Taylor's review focus on the Gerber and DeMaster approach, we have formulated our response to reflect Taylor's comments on both papers. The central focus of Taylor's response is that the model assumptions of Dennis et al. (1991), used to generate the population viability analysis in both models, were not met, and that the short time frames used by Gerber and DeMaster (1999) were not adequate. We address this and related issues raised by Taylor. Because Taylor did not criticize our findings based on the IUCN criteria, however, we assume that he agrees with the conclusions based on those criteria.

### Errors in Estimates

Taylor points out that the statistical error is large for estimates of bowhead abundance and population trends. There is no indication that the bowhead time series has large unexplained variance; in fact, the estimate of trend is very precise for a cetacean. This raises an important issue in decision-making for endangered species, however: What do we do when faced with limited, highly uncertain information? This issue is relevant to most endangered species, and in this respect the ESA provides guidance for decision-making. In particular, the ESA specifies that the "best available science to date" be used in such decisions (16 U.S. Code, section 1533 (b)(1)(A)). Our review of the best available data for the Bering-Chukchi-Beaufort bowhead stock (BCBB) indicates that the population is increasing in size and is likely approaching 10,000 at this time. Furthermore, the best available data show that the BCBB abundance in 2001 was 9860 (SE = 1,222), with a 95% confidence interval of 7700 to 12,600 (George et al. 2002), and the rate of increase from 1978 to 2001 has been 3.3% (95% CI = 2–4.7%), a rate comparable to that calculated from 1978 to 1988 (3.1%, with 95% CI = 0.1–6.2%; Zeh et al. 1991).

Further, it is important to note that the model of Dennis et al. assumes that there is no sampling error, and all observed error is estimated to be process error (environmental variance). Extinction risk is then estimated by extrapolating the model into the future with that much estimated process error. However, we know that the bowhead whale abundance estimates contain sampling error. Therefore, the Dennis et al. model will overestimate the amount of process error, or environmental stochasticity, that the bowhead whale population experiences, and thus will overestimate extinction risk. Given the estimated magnitude of the sampling error of the abundance estimates, process error is likely overestimated by a substantial amount. We cannot be criticized for underestimating extinction risk, as Taylor claims, but only for overestimating it.

### Global Warming

Although Taylor states that downward trends are expected based on "available evidence" (for which he provides no citations), the best available data we are aware of suggests that the population is increasing. Although available data do indicate that the Bering Sea environment is changing (e.g., Angel & Smith 2002), we are aware of no evidence that environmental changes will be detrimental to the population in the foreseeable

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future. In fact, our review of the literature on this issue suggests that climate change may actually result in more favorable conditions for BCB bowheads. In particular, the importance of ice-associated algae and phytoplankton blooms that occur in cold water has been well documented, but so has the importance of open water phytoplankton blooms in comparably warm Arctic waters (as reviewed by Hunt & Stabeno 2002). Secondary productivity was markedly greater in higher-temperature waters (e.g., McLaren 1963; Iguchi & Ikeda 1995), where a larger portion of the primary productivity is likely available to pelagic food webs than in cold years when phytoplankton fall to the benthos (Walsh & McRoy 1986). Warmer waters also benefit phytoplankton and zooplankton by increasing metabolic rates, which in turn accelerate growth and reduce maturation time. In the Arctic, there is a positive correlation between the length of ice-free periods and primary productivity (Rysgaard et al. 1999; Hansen et al. 2003). Without the ice barrier, more light penetrates the water, stimulating photosynthesis in phytoplankton and benthic microalgae (Horner & Schrader 1982). Furthermore, global warming may reduce the ice in arctic straits enough to allow bowheads to travel to areas where stocks are currently isolated, thereby improving opportunities for genetic exchange (Dyke et al. 1996; Savelle et al. 2000). Although Taylor has expressed concerns about global warming being detrimental to bowhead abundance, there is an even higher probability that their abundance could increase under global warming. He does acknowledge that most of the bowheads in the BCB stock taken by commercial whalers were found in the Bering Sea in the summer, far from sea ice.

### Life-History Parameters

Taylor argues that there will be downward trends in basic life-history parameters as a function of global warming that will result in habitat loss. These parameters were not listed, however, and the "evident" change for each one was not presented; therefore, it is difficult to counter his argument beyond what we present above in regard to population abundance. The robustness of BCB bowheads has been tested extensively by members of the International Whaling Commission Scientific Committee (IWC-SC), in particular "changes in productivity, carrying capacity and mortality, as well as random episodic mortality events" (IWC 2003). When the IWC-SC reviewed Taylor's scenarios, "many members questioned the methods and interpretation given in [his] paper" (IWC 2003).

### Short Time Frames of Model Projection

Taylor states that we used time frames of 25 and 35 years for our population projections and "could more reasonably have used a time frame of 100 years." Indeed, Gerber and DeMaster (1999) used a 35-year time frame based on time periods deemed appropriate by agency scientists for planning. This approach was intended to be applied regularly as census data became available, thus continually updating status determinations. The IUCN-based model we developed, however, uses an extinction probability of 20% in 20 years (or 5 generations) and 10% in 100 years for endangered and threatened status, respectively. This approach also requires that status-determining criteria be revisited and revised every 5 years as part of the formal status review for each species.

### Potential Threats

We appreciate Taylor's perspective that future protection and management actions should be taken into account at the time of delisting, but we do not agree with his conclusion that potential threats should prohibit delisting. There are many potential threats to any recovering population. This includes Taylor's concerns about global warming and the possibilities of a subsequent decline in prey and increase in vessel traffic. If species added to the list of endangered and threatened wildlife are never deemed "recovered," how can the ESA be effective at achieving its goal of recovering listed species? Brownell et al. (1989) appropriately argued that "possible threats are not sufficient to justify listing a species according to the [five] factors. . . . [I]f they were, the majority of the world's animals would need to be included on the list." Indeed, no species is entirely free from possible threats, but it would diminish the effectiveness of the ESA if all known species were included. Although we agree with Taylor that a variety of issues could potentially be of concern in the future, the ESA was enacted to protect species from existing threats, not all potential threats. If the BCBB classification is changed, management will focus on mitigating human-related sources of disturbance and mortality (e.g., Bratton et al. 1993; Richardson & Malme 1993) so that bowhead populations will continue to recover after delisting. Should the BCBB population be delisted, the ESA would provide for a 5-year monitoring period after which final status would be determined (16 U.S. Code, section 1533 (g)); if appropriate, the stock could be promptly relisted. Once delisted, other regulatory mechanisms (as per the ESA's five factors) must be in place to ensure the continued recovery of the population.

### Protective Measures

Regulatory measures currently in place, beyond those required by the ESA, include international protection under the IWC and national protection for stocks in U.S. waters under the Marine Mammal Protection Act of 1972 (MMPA). Since 1981, The Native American harvest of the BCBB stock has been monitored by the Alaska Eskimo Whaling Commission through a cooperative agreement with the National Oceanic and Atmospheric Administration (NOAA). Populations listed under the ESA are automatically classified as "depleted" under the amended MMPA (16 U.S. Code, 1362 section 3 (1)(C)). Stocks not listed under the ESA are granted depleted status when they fall below their optimum sustainable population (OSP) level (16 U.S. Code, 1362 section 3 (1)(A)). For the BCBB stock, the lower end of the OSP range varies between 6500 and 10,500, based on an initial stock size of 12,599 (95% CI 10,945–17,431) (IWC 1995) and the assumption that the maximum net productivity level is 60% of carrying capacity. If it was delisted from the ESA according to our proposed status-determining criteria, the BCBB stock would be within its estimated range of OSP level. At that time, the status of the stock would need to be reevaluated to determine whether classification as depleted under the MMPA should be continued. Under the mandates of the MMPA, depleted-stock status is reviewed annually and the status of a nondepleted marine mammal stock is evaluated at least once every 3 years (16 U.S.Code, 1386 section 117(c)(1)). This is to ensure that the stock is not reduced below its OSP level.

## Conclusion

We appreciate Taylor's concern for the protection of bowhead whales. Fortunately, the species/population is afforded protection under the MMPA, and the hunt by Eskimos is regulated by NOAA Fisheries with quotas set by the IWC. These protections will not be diminished if this stock of bowheads is no longer listed as endangered. Furthermore, if there are environmental changes that cause a severe reduction or decline in abundance, putting this (or any other) stock at risk, the population could then be relisted as threatened or endangered, as appropriate.

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