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## **Cetaceans and climate change – the tertiary level: changing human interactions.**

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*In the original outline for the IWC's Climate Change workshop agreed at the last meeting of the IWC Scientific Committee was a request for a background paper considering the issue of how human-cetacean relations may change with climate change, and this brief working paper provides an introduction to some of the literature that has considered this. It would benefit from the contribution of others with first hand observations to add.*

Reeves (1990) and Würsig *et al.* (2001) provided a model for classifying the potential effects of climate change: *Primary effects* would be those that debilitate or cause death at the level of the individual. This could be when individuals are at the edge of their capabilities, such as old animals, or animals stressed in some other manner, for example from lowered immune response due to toxin loads or disease. *Secondary effects* would be an effect at the population level. For example, prey becomes insufficient to maintain the health status of a community/population, perhaps causing reproduction to decline. The *tertiary effects*, which are the focus of this short essay, would also manifest at this population or community level but 'involve a feedback loop that includes the initiator of the problem (humans in the present scenario of global warming)' (Würsig *et al.*, 2001). For example, if the water becomes too warm and fishes that previously contributed to the human food supply die, humans might begin to target dolphins. They might do this for bait to try to enhance fishing, as a direct source of food or because of real or perceived competition.

Würsig *et al.* (2001) comment that 'in practice, the primary, secondary, and tertiary effects are inter-related and can be difficult to separate'. They also note that predictions at the tertiary level are the most tenuous but suggest a range of potential impacts:

- Fragmentation of river cetacean populations as the number of construction projects to manage flooding increases;
- More hunting pressure on near-shore dolphins and whales off Asia, Latin America, Africa and certain protein-poor island areas, all related to a general increase of human poverty, famine and civil conflict; and
- Overall a decline in conservation efforts – including park designations and resource management – resulting from climate-induced impoverishment of human communities.

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This matter has also recently been looked at in the Arctic context and climate-driven changes resulting from increased industrial activities in the Arctic following ice retreat include (Burek *et al.*, 2008):

- Changes to exposure to toxicants – i.e. contaminants and biotoxins (from algal blooms);
- Increased boat strikes;
- Increased fisheries activities (potentially causing increased bycatch and prey depletion); and
- Increased acoustic injury and exposure to sound pollution.

Hovelsrud *et al.* (2008) considered this in relationship to hunting of marine mammals and noted that climate change could cause increased shipping activity through the Northwest Passage and Northern Sea; a longer navigation season; and the need for recognition of climate change in management regimes. The results of these changes for marine mammals would be increased risk of pollution and increased disturbance of habitat. They also note that changes, including increased unpredictability in ice and weather conditions and shifts in distributions, will affect hunting, causing shifts in hunting seasons and practices. This could include a shift in hunting pressure away from ice-dependent species to others as well, potentially, as increased pressure on the remaining stocks. Hovelsrud *et al.* (2008) also emphasise that reduction in sea ice will lead to increased oil and gas exploration in the Arctic with the introduction of new activities and risks, including potentially increased disturbance and pollution.

Laidre *et al.* (2008) comment that whatever the effects of habitat change on Arctic species might be, this still needs to be considered in the context of other threats and emphasise that hunting and pollution are capable of having an effect on the status of Arctic marine mammals. They note that several populations have been overexploited and not yet recovered (including the bowhead whales *Balaena mysticetus*, in the Northeast Atlantic) and that other populations are currently harvested beyond sustainable levels. Climate-driven habitat changes are unlikely to improve the status of depleted populations and ‘for those populations currently being exploited at some level, it may be impossible (with the current ability to assess population size and trend) to accurately detect and describe some of the more subtle consequences of climate warming given that the effects can only be estimated with reasonable accuracy for a few species... and that the magnitude of the uncertainty surrounding the effects of the simultaneous harvest will be large.’ Despite this, Laidre *et al.* (2008) still believe that it is of critical importance to factor in the consequences of climate change for assessment of population sizes because climate driven changes will be significant.

## **References**

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