



Examining the Impacts of Whales on Commercial Fisheries
A Lenfest Ocean Program Research Project (July 2007 - April 2009)
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Recent studies have proposed that whales are the culprits behind decreased fish populations and as a result they should be culled (Anonymous 2001, Struck 2001, Jackson 2007; Tamura and Ohsumi, 2000). According to Tamura and Ohsumi (2000), the total annual prey consumption by cetaceans in the world is estimated to be 249-436 million tons, representing three to six times the amount taken in marine fisheries. The implication of this estimate is that this biomass represents a surplus resource that would be directly available for human consumption if cetacean numbers were to be reduced. The rationale for such arguments is questionable in light of documented overfishing occurring on a global scale (Jackson et al. 2001; Pauly et al. 2002; Baum et al. 2003; Myers and Worm 2003), the lack of scientific evidence for existing large-scale competition between marine mammals and fisheries (Kaschner 2004, Morissette 2007), and the unpredictable consequences of culling (Paine et al. 1998, Scheffer et al. 2001). Nonetheless, the “whales eat fish” issue has become a significant point of contention at recent International Whaling Commission (IWC) meetings.

To understand the impact of whales on commercial fisheries, it is necessary to analyze the situation in the context of ecosystems in order to consider the complex indirect and direct interactions through which these two groups might influence each other. When complex trophic interactions are taken into consideration, culling of marine mammals does not always lead to recovery of fish stocks (Punt and Butterworth 1995, Plagányi and Butterworth 2002, Morissette in preparation). By feeding on other species that could be competing with fisheries, marine mammals and other high-level predators may, in fact, increase fisheries catches via ‘beneficial predation effects’ (Punt and Butterworth 1995, Walters and Kitchell 2001). Only by considering all possible direct and indirect trophic linkages can the effect of the partial or complete removal of large whales on current fisheries yields be reliably assessed.

The goal of this research project is to examine the scientific evidence for the assertion that commercial fisheries are negatively impacted by whales. The project focuses on three regions where the “whales eat fish” assertion has become a political and management issue. These areas are: (1) the Caribbean, (2) the tropical South Pacific and (3) northwest Africa. Food web models are being constructed using the *Ecopath* and *Ecosim* software (*EWE*, www.ecopath.org). An extensive literature search is being conducted to synthesize available data about ecological parameters and trophic interactions for marine mammals, fish and invertebrates to parameterize models for our three study areas. Models will allow us to characterize the structure and function of these ecosystems in terms of biomass, mortalities, consumption rates, food habits, general ecosystem indicators and fisheries. Faced with sparse data for our study regions, we are explicitly accounting for uncertainty in input data, ecosystem structure, model accuracy, and basic assumptions about marine mammal feeding rates, abundance estimates, or consumption in breeding areas to the extent possible. In addition, we are conducting an extensive sensitivity analysis to examine the effects of model parameters and changes in model assumptions. Each model will be used as a predictive framework for examining the ecosystem impacts of changes in the abundance of large whales, including possible increases or decreases of fisheries catches.

Preliminary results of this research for our focal areas indicate that:

- 1) The overlap between prey species consumed by marine mammal and species targeted in fisheries is low; and
- 2) Given a wide range of assumptions about whale abundances, diet composition and food consumption in breeding areas, we consistently found that: (a) Whale consumption is several orders of magnitude lower than total fishery catches; (b) Food intake of whales in our study area is two orders of magnitude lower than the amounts taken by other trophic groups (e.g. pelagic

fishes); (c) Indirect impacts of great whale consumption on fisheries yield are positive in some cases (beneficial predation); and (d) In preliminary simulations, reducing whale biomass does not influence the biomass of commercially important fish.

Given the paucity of data from each of our three focal areas, specific results of this modeling exercise will have to be interpreted with care. Furthermore, to definitively address the “whales eat fish” issue, additional modeling and analytical approaches should be explored. Nonetheless, we expect that our modeling approach will begin to answer questions about the competition between whales and commercial fisheries in these regions, and will allow the identification of data gaps and additional research needs. Our preliminary results will be used as starting points for discussion of the issue at regional workshops and in international fora. Regional workshops will be held in the focal areas to access local data resources and expertise, and to gain feedback from scientists and other local stakeholders that will allow us to improve our models. In June of 2008, we will present our preliminary results at the IWC scientific committee on ecosystem modeling, where we expect to gain further scientific feedback on our methodology and assumptions. Results based on the improved models will then be submitted for publication in peer reviewed scientific journals.

Literature Cited

- Anonymous. 2001. Increasing competition between fisheries and whales. Japan's whale research in the Western North Pacific (JARPN II). Fisheries Agency.
- Baum, J. K., R. A. Myers, D. G. Kehler, B. Worm, J. Harley, and P. A. Doherty. 2003. Collapse and conservation on shark populations in the northwest Atlantic. *Science* 299: 389-392.
- Jackson, J. B. C. 2007. When ecological pyramids were upside down. In: J. A. Estes, D. P. DeMaster, D. F. Doak, T. M. Williams, and R. L. Brownell Jr., eds. *Whales, Whaling, and Ocean Ecosystems*. Pages 27-37 University of California Press, Berkeley and Los Angeles, California.
- Jackson, J. B. C., M.X. Kirby, W. H. Berger, K.A. Bjorndal, L. W. Botsford, B. J. Bourque, R. H. Bradbury, R. Cooke, J. Erlandson, J. A. Estes, T. P. Hughes, S. Kidwell, C. B. Lange, H. S. Lenihan, J. M. Ponder, C. H. Peterson, R. S. Steneck, M. J. Tegner, and R. R. Warner. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293: 629-638.
- Kaschner, K. 2004. Modelling and mapping of resource overlap between marine mammals and fisheries on a global scale. Ph.D., University of British Columbia.
- Morrisette, L. 2007. Complexity, cost and quality of ecosystem models and their impact on resilience: a comparative analysis, with emphasis on marine mammals and the Gulf of St. Lawrence. PhD thesis, Zoology, University of British Columbia, Vancouver BC, Canada.
- Myers, R. A. and B. Worm. 2003. Rapid worldwide depletion of predatory fish communities. *Nature* 423:280-283.
- Paine, R. T., M. J. Tegner, and E. A. Johnson. 1998. Compounded perturbations yield ecological surprises. *Ecosystems* 1: 535-545.
- Pauly, D., V. Christensen, S. Guenette, T. J. Pitcher, U. R. Sumaila, C. J. Walters, R. Watson, and D. Zeller. 2002. Towards sustainability in world fisheries. *Nature* 418:689-695.
- Plagányi ÉE and Butterworth DS. 2002. Competition with fisheries. In: Perrin WF, Würsig B, Thewissen JGM (eds) *Encyclopedia of Marine Mammals*. Academic Press, San Diego, CA, p 268-273.
- Punt A.E., Butterworth D.S. 1995. The effects of future consumption by Cape fur seal on catches and catch rates of the Cape hakes. 4. Modelling the biological interaction between Cape fur seals *Arctocephalus pusillus pusillus* and the Cape hake *Merluccius capensis* and *Merluccius paradoxus*. *South African Journal of Marine Science* 16:255-285.
- Scheffer, M., S. Carpenter, J. A., Foley, C. Folke, and B. Walker. 2001. Catastrophic shifts in ecosystems. *Nature* 413: 591-596.
- Struck, D. 2001. Japan blames whales for lower fish catch. *International Herald Tribune* (July 28-29).
- Tamura, T. and S. Ohsumi. 2000. Regional assessments of prey consumption by marine cetaceans in the world. Publ. The Institute of Cetacean Research, Tokyo, Japan, 45 p.
- Walters C and Kitchell JF. 2001. Cultivation/depensation effects on juvenile survival and recruitment: implications for the theory of fishing. *Canadian Journal of Fisheries and Aquatic Sciences* 58:1-12.