USGS Science to Inform U.S. Fish & Wildlife Service Decision Making on Polar Bears

Executive Summary

- In January 2007, the U.S. Fish and Wildlife Service proposed listing the polar bear (*Ursus maritimus*) as a threatened species under the Endangered Species Act. The polar bear depends on sea ice as a platform to hunt seals, their primary food, and projected loss of sea ice due to global warming was believed to jeopardize polar bears throughout their range.

- To ensure that the best information was available to inform the final listing decision, due in January 2008, the Secretary of the Interior asked the U.S. Geological Survey (USGS) to generate new scientific data, models, and interpretations on polar bears and their sea ice habitats, to be available within the decisionmaking timeframe.

- Specifically, USGS was asked to

    1. Develop population projections for the Southern Beaufort Sea polar bear population and analyze existing data on two polar bear populations in Canada.

    2. Evaluate northern hemisphere sea ice projections, as they relate to polar bear sea ice habitats and potential future distribution of polar bears.

    3. Model future rangewide polar bear populations by developing a synthesis of the range of likely numerical and spatial responses to sea ice projections.

- The USGS assembled a team that included scientists from within USGS, specifically from the Alaska Science Center and Patuxent Wildlife Research Center, polar bear scientists from Canada, and scientists from academia, the private sector, and other federal agencies.

- The USGS science team has presented its findings in nine administrative reports. These reports were released to the FWS on September 7, 2007.

- USGS findings were of two basic types

    1. **New observational data** on polar bears, including updated information on the current status of 3 of the world's 19 subpopulations of polar bears as defined by the Polar Bear Specialists Group of the International Union for the Conservation of Nature and Natural Resources. Because each of the 3 subpopulations represented a distinct ecological region, understanding their status helps provide insight into the current status of polar bears rangewide; and,

    2. **Projections or forecasts** of the future distribution and abundance of polar bears in the rest of the 21st century, given changes expected in future sea ice conditions.

- **<u>The overall conclusion of the USGS research effort is:</u>**

  Projected changes in future sea ice conditions, if realized, will result in loss of approximately 2/3 of the world's current polar bear population by the mid 21st century. Because the observed trajectory of Arctic sea ice decline appears to be underestimated by currently available models, this assessment of future polar bear status may be conservative.

- <u>Below we summarize key findings which led to this conclusion</u>:

  1. We divided the range of the polar bear into 4 ecoregions based on major differences in current and projected sea ice conditions. These "ecoregions" were the:

     - *Seasonal Ice Ecoregion* which includes Hudson Bay, and occurs mainly at the southern extreme of the polar bear range,

     - *Archipelagic Ecoregion* of the Canadian Arctic,

     - *Polar Basin Divergent Ecoregion* where ice is formed and then drawn away from near-shore areas, especially during the summer minimum ice season, and

     - *Polar Basin Convergent Ecoregion* where sea ice formed elsewhere tends to collect against the shore.

     Dividing the range of the polar bear into these 4 ecoregions allowed us to make inferences from available knowledge about subpopulations in each ecoregion to the entire ecoregion.

  2. We incorporated projections of future sea ice in each ecoregion, based on 10 general circulation models (GCMs), chosen from among 20 available. These 10 models did the best job of simulating current ice conditions and thus could be expected to do the best job of simulating future ice conditions. Use of 10 models allowed us also to incorporate the considerable variability among the models in our analyses for future polar bear habitat and populations. We used outputs for "business as usual" greenhouse gas forcing, known as the SRES-A1B scenario, for most of our analyses.

  3. An important conclusion from a review of current knowledge about sea ice and sea ice modeling is that Arctic sea ice decline is likely underestimated by the available models.

  4. Based on new findings from the Northern Beaufort subpopulation, polar bear subpopulations in the *convergent ice ecoregion* of the polar basin are likely currently stable; most available information about the status of populations living in the 4th ecoregion, the *archipelagic ecoregion*, suggests relative stability.

5. For two subpopulations of polar bears, Western Hudson Bay in the *seasonal sea ice ecoregion*, and Southern Beaufort Sea in the *divergent ecoregion*, it is now possible to relate declines in the availability of sea ice to declines in metrics of population status.

6. Knowledge of how polar bear population growth rates relate to specific changes in sea ice (e.g., length of the ice-free season) provides a mechanism for developing projections of future populations under different sea ice scenarios.

7. Under a range of future sea ice scenarios for the 21st century and modeling approaches, the Southern Beaufort Sea subpopulation of polar bears is projected to decline severely by the end of the century, and in many scenarios, by mid-century.

8. Polar bears primarily use sea ice over the continental shelf. They also prefer ice that is greater than 50% in concentration. Taking these habitat features into account, we projected future polar bear habitat within the polar basin for the *divergent* and *convergent ice ecoregions* using the available sea ice models. We also evaluated how availability of polar bear habitat in the polar basin has changed in recent years.

9. Optimal habitat in the polar basin (including both the *divergent* and *convergent ice* ecoregions) declined between the early (1985-1995) and latter decades (1996-2006) of the observational record of sea ice (based on passive microwave data). Most pronounced polar bear habitat loss in the past decade has occurred in peripheral seas of the Arctic Ocean--the Chukchi Sea and Barents/Greenland Seas.

10. Similarly, we projected losses of polar bear habitat within the polar basin to be greatest for the peripheral seas of the polar basin (e.g., the Chukchi Sea and Barents Sea).

11. The largest reductions in habitat in the polar basin are predicted for spring and summer. Sea ice will reform each winter, but the large retreats of sea ice in summer may ultimately preclude bears from returning to onshore denning habitat. Low productivity of the polar basin appears to preclude bears from adapting a seasonal ice lifestyle here.

12. Ultimately, we projected a 42% loss of optimal polar bear habitat during summer in the polar basin by mid century.

13. Due to unavailability of telemetry data showing habitats chosen by polar bears in the *archipelagic* and *seasonal sea ice* ecoregions, we were unable to project habitat changes in these ecoregions for this analysis.

14. Using a simple deterministic model of future carrying capacity for polar bears, we forecasted that polar bears could be extirpated in the *divergent ice ecoregion* within 75 years, assuming that sea ice decline follows the mean trajectory predicted by the 10 models we used. If sea ice decline follows the minimum trajectory predicted, extirpation in this ecoregion could occur by year 45.

15. Using the carrying capacity model, we projected populations of polar bears in all other ecoregions to decline at all time steps, with severity of decline dependent upon whether minimum, maximum or mean ice projections were used. The only exception was a slight, temporary, increase in the polar basin convergent ice ecoregion for the 45 year timestep and the maximum ice scenario.

16. Based on a first-generation Bayesian Network model* incorporating a range of factors affecting polar bears, we forecasted extirpation of polar bear populations in the *seasonal sea ice* and the *polar basin divergent ecoregions* by 45 years from present.

17. We forecasted extirpation of polar bear populations in the *polar basin convergent ecoregion* by 75 years from present. In the a*rchipelagic ecoregion*, polar bears could occur through the end of the century, but in smaller numbers than now.

18. Sea ice conditions would have to be substantially better than even the most conservative GCM projections to result in qualitatively different outcomes for polar bears in any of the ecoregions.

* Bayesian Network models represent a set of interacting variable that are linked by probabilities. They provide an efficient way to represent and summarize understanding of a system, and can combine empirical data and expert knowledge into the same modeling structure. They are also particularly useful in synthesizing large amounts of quantitative and qualitative information to answer “what if” kinds of questions.