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Is the Polar Bear Endangered, or Just Conveniently Charismatic?

By Kenneth P. Green

Environmental groups are intensely aware of the power charismatic species have to both capture the imagination of the public and serve as levers to emplace environmental restrictions and regulations. Polar bears are the latest example of the phenomenon. Environmental groups have called for their listing as a threatened species under the Endangered Species Act, and in late April, a federal judge ordered the Bush administration to make a final listing decision for the polar bear by May 15, 2008. Does the evidence warrant the designation?

Environmentalists have long used charismatic megafauna—large animals that invoke powerful attachments in humans—to raise awareness of and promote policy solutions to perceived environmental threats. Giant pandas, the symbol of the World Wide Fund for Nature, are a type of charismatic megafauna, as are "whales and other sea mammals, salmon and other inspirational fish, eagles and other flashy raptors."[1] Other charismatic megafauna featured in environmental crusades include gorillas, grizzly bears, wolves, great white sharks, the Arctic lynx, African elephants, bighorn sheep, rhinoceroses, and, of course, penguins, which got a movie of their very own.[2]

Such campaigns are highly effective. Environmental activist Eric de Place observes that using these types of animals as "poster children" for broader conservation has worked with grizzly bears, wolves, and sea otters.[3] And the money follows the glamour. Studies have shown that our spending preferences skew to the charismatic species: as economist Robert Stavins points out, the species we protect are generally "warm and cuddly."[4]

The latest animal to become an environmental pet project is *Ursus maritimus*, the Latin name given to the polar bear. In the age of Knut—the polar bear cub orphaned by its mother and raised by humans in a German zoo—media coverage of polar bears has increased dramatically. And, of course, Al Gore featured the plight of the polar bear in his movie *An Inconvenient Truth*.

Polar bears are cute as cubs and majestic as adults. There are few animals with a higher "awwwwww" factor than a baby polar bear, and pictures of adult polar bears standing on icebergs in the far extremes of the Arctic cause an instinctual upwelling of respect for the powerful animals capable of surviving in an environment that humans can tread only with great preparation, and still at great risk. Virtually everyone wishes to ensure that polar bears are protected from excesses of human action that, as we have seen in the past, can indeed drive animal populations to extinction.

Environmental groups, claiming that man-made global warming threatens the polar bears' survival, have called for an endangered species listing that would have far-reaching consequences. Not only would such a listing place the Arctic region off limits for mineral exploration, but it would also open up still another line of attack for environmentalists trying to force emissions of greenhouse gases downward at all costs. Should

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the polar bear be listed as a threatened species, lawsuits to force companies and governments to reduce activities deemed harmful to the polar bear (emitting greenhouse gases) will be quick in coming.

Virtually every major environmental group trumpets the polar bears' peril. The Center for Biological Diversity tells us:

> Polar bears are at risk of extinction because global warming is causing catastrophic environmental change in the Arctic, including the rapid melting of sea ice. Because the bears are deeply dependent on the sea ice for their survival, they stand to become the first mammals in the world to lose 100 percent of their habitat to global warming.[5]

The National Wildlife Federation, which sells cute little plush polar bears, warns us that "[p]olar bears are literally drowning from global warming, unable to swim the increasingly longer distances between land and receding sea ice."[6] The Natural Resources Defense Council (NRDC) cautions:

> Polar bears are completely dependent on Arctic sea ice to survive, but 80 percent of that ice could be gone in 20 years and all of it by 2040. Polar bears are already suffering the effects: birth rates are falling, fewer cubs are surviving, and more bears are drowning.[7]

The World Wildlife Fund warns that "[i]f current climate trends continue unabated, polar bears could become extinct by the end of this century."[8] And Greenpeace tells us:

> Global warming is causing the Arctic ice pack to thin and melt at an unprecedented rate, and as it does, the polar bear is being pushed toward the brink of extinction. Polar bears live only in the Arctic, and they depend entirely on the pack ice—the frozen surface of the Arctic Ocean—as a platform to breed, raise their young, hunt and travel. Scientists are predicting an ice-free Arctic Ocean in summer by as early as 2050, which could quite possibly spell doom for this magnificent creature.[9]

All of these environmental groups favor strong regulatory agendas to reduce greenhouse gases, and all have consistently opposed the use of Arctic regions for resource production. So it was perhaps inevitable that several environmental groups (the Center for Biological Diversity, Greenpeace, and NRDC) would petition the U.S. Fish and Wildlife Service to list the polar bear as a threatened species under the Endangered Species Act.[10] As of this writing, the Bush administration has not rendered a verdict on whether polar bears are to be placed on the endangered species list, but it seems likely that they will be.[11] The legal deadline for doing so was January 9, 2007, a date that the administration missed, but it is claiming that the delay was procedural and not caused by a dispute about endangerment.[12] Now a federal judge has given the administration a deadline of May 15, 2008, to make a final listing determination.

Listing the polar bear as a threatened species would have significant public policy consequences. It would set a new precedent, representing the first linkage of species endangerment with global warming. Such a listing would basically wall off the entire Arctic region to exploration, resource extraction, and development—at least by U.S. companies—and a threatened species listing would give environmental groups the ability to sue future U.S. governments to force them to reverse climate change by whatever means necessary.

There is little doubt that such lawsuits would be filed quickly. According to the NRDC:

> Listing the polar bear guarantees federal agencies will be obligated to ensure that any action they authorize, fund, or carry out will not jeopardize the polar bears' continued existence or adversely modify their critical habitat, and the U.S. Fish and Wildlife Service will be required to prepare a recovery plan for the polar bear, specifying measures necessary for its protection.[13]

As Carl Sagan observed, "Extraordinary claims require extraordinary evidence." This should be especially true when the stakes are significant and are likely to impose considerable costs or limitations on economic development. Walling off the Arctic and enabling environmental groups to sue greenhouse gas emitters in the name of polar bear protection would certainly impose high costs on future generations for whom environmentalists propose to preserve the polar bear.

So we must ask: is there "extraordinary evidence" that polar bears are threatened by man-made global warming sufficient to justify the remarkable claim of setting aside Arctic development and regulating the

energy economy of the world for the sake of the animal? Truly understanding the state of the polar bear, and the best policy options for protecting this magnificent animal, requires answering three questions. First, what do we know about the health of polar bear populations? Second, what do we know about future threats to polar bears? And third, what is the best policy for protecting them?

The Health of Polar Bear Populations

Though they are highly photogenic creatures, polar bears are difficult to study for a variety of reasons. First, polar bears live in remarkably isolated and inhospitable parts of the Arctic. Second, polar bears are not stationary animals: they have a very large "home range"—the largest area that an animal normally visits during its lifetime—that often exceeds two hundred thousand square kilometers.[14] Figure 1 shows the home range of Arctic polar bears. Note that it encompasses virtually the entire Arctic region. And third, the Arctic is such a hostile environment that one can conduct polar bear surveys only at certain times of year and in areas close to land masses. Survey results, therefore, may or may not be representative of the population as a whole. This makes establishing the health of existing polar bear populations—the very beginning of our inquiry—difficult.

Because they are not able to do a rigorous count of existing polar bears or accurately count the number of polar bear offspring over time, scientists must make population estimates based on limited data. Polar bears are counted by periodic flyovers of suspected polar bear habitat or by capturing and marking a subpopulation of bears, then using the frequency of recapture as a means to estimate the size of a population. Few subpopulations have been surveyed repeatedly, and the surveys that exist were taken over different years, some dating back to the 1980s. Where even these limited data are unavailable, population estimates are created basically from hearsay: local people report seeing a certain number of polar bears to researchers, who then estimate what size population would be needed to support such a number of sightings.[15]

Given these uncertainties, the best estimate—guesstimate might be a better term—published by the International Union for Conservation of Nature (IUCN) Species Survival Commission's (SSC) Polar Bear Specialist Group, is that there are about twenty thousand to twenty-five thousand polar bears worldwide. The bears are spread out around the Arctic in nineteen separate subpopulations that researchers think are largely autonomous (noninterbreeding). The groups range in size from small groups of several hundred bears to a few larger groups of several thousand. Table 1 shows estimates of the individual subpopulations by Arctic location.[16]

FIGURE 1
DISTRIBUTION OF POLAR BEAR POPULATIONS THROUGHOUT THE CIRCUMPOLAR BASIN

SOURCE: Jon Aars, Nicholas J. Lunn, and Andrew E. Derocher, eds., *Polar Bears: Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 20–24 June 2005, Seattle, Washington, USA* (Gland, Switzerland: IUCN, 2006), 33, available at www.polarbearsinternational.org/rsrc/Proc_Seattle05.pdf (accessed April 30, 2008).

Future Threats to Polar Bears

Because scientists have limited population data for polar bear populations, and even less data on trends in these populations, claims about endangerment are essentially based on assumptions. The first assumption is that global warming has caused, and will cause, a predictable reduction in sea ice. The second assumption holds that polar bear populations will dwindle because they are dependent on sea ice to hunt for prey. But each of these assumptions is fraught with problems.

As with most everything involving climate change, there is a paucity of good-quality, long-term data available.

TABLE 1
ESTIMATED POLAR BEAR SUBPOPULATIONS

Subpopulation	Last aerial or mark/ recapture results (date)	Observed or predicted trend	Status	Estimated risk of future decline (ten years)
East Greenland	Unknown	Data deficient	Data deficient	No estimate
Barents Sea	2,997 (2004)	Data deficient	Data deficient	No estimate
Kara Sea	Unknown	Data deficient	Data deficient	No estimate
Laptev Sea	800–1,200 (1993)	Data deficient	Data deficient	No estimate
Chukchi Sea		Data deficient	Data deficient	No estimate
Southern Beaufort Sea	1,500 (2006)	Declining	Reduced	No estimate
Northern Beaufort Sea	1,200 (1986)	Stable	Not reduced	No estimate
Viscount Melville	161 (1992)	Increasing	Severely reduced	Very low
Norwegian Bay	190 (1998)	Declining	Not reduced	Higher
Lancaster Sound	2,541 (1998)	Stable	Not reduced	Higher
M'Clintock Channel	284 (2000)	Increasing	Severely reduced	Very low
Gulf of Boothia	1,523 (2000)	Stable	Not reduced	Lower
Foxe Basin	2,197 (1994)	Stable	Not reduced	Lower
Western Hudson Bay	935 (2004)	Declining	Reduced	Very high
Southern Hudson Bay	1,000 (1988)	Stable	Not reduced	Lower
Kane Basin	164 (1998)	Declining	Reduced	Very high
Baffin Bay	2,074 (1998)	Declining	Reduced	Very high
Davis Strait		Data deficient	Data deficient	Lower
Arctic Basin	Unknown			

SOURCE: Adapted from Jon Aars, Nicholas J. Lunn, and Andrew E. Derocher, eds., *Polar Bears: Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 20–24 June 2005, Seattle, Washington, USA* (Gland, Switzerland: IUCN, 2006), 34–35, table 1, available at www.polarbearsinternational.org/rsrc/Proc_Seattle05.pdf (accessed April 30, 2008). Several subpopulations lacking aerial or mark/recapture data have less precise estimates from other types of analysis.

NOTE: The Union for Conservation of Nature Species Survival Commission's Polar Bear Specialty Group lists no estimated population counts for three of the nineteen subpopulations, though it is clear that these populations must exist, and some must be fairly robust, as polar bears are killed in significant numbers in these areas every year. The Chukchi Sea population, for example, has a historical "removal" rate (kill rate) of forty-three bears per year. The Davis Strait population has an annual removal rate of sixty-five bears per year, which would also suggest a robust base population. From removal rates and other anecdotal data, the estimate for Chukchi Sea polar bears is 2,000, and a similar estimate for the Davis Strait population is 1,650.

Prior to 1979, the extent of Arctic sea ice was measured haphazardly and sporadically. Some localized, nonstandardized measurements were taken periodically by ships without advanced positioning equipment and are not considered accurate. Satellite imaging has only allowed measurement from about 1979, coinciding with a period of climate warming, which makes it inherently nonrepresentative of longer time periods.[17]

But from the limited data available, it does seem that in recent years the extent of Arctic sea ice has shown steady shrinkage. Overall, Northern Hemispheric ice cover has been trending downward at about 3 percent per decade. Figure 2 shows how the extent of ice in the Arctic has varied compared to an average baseline from 1979 to 2000.[18]

The Intergovernmental Panel on Climate Change (IPCC) summarizes Arctic ice changes in its most recent report:

> Satellite data indicate a continuation of the 2.7 ± 0.6% per decade decline in annual mean arctic sea ice extent since 1978. The decline for summer extent is larger than for winter, with the summer minimum declining at a rate of 7.4 ± 2.4% per decade since 1979. Other data indicate that the summer decline began around 1970.[19]

It is that latter trend that is worrying with regard to polar bear population survival, as a significant number of polar bears use sea ice as a base for hunting, resting, and mating.

As figure 3 shows, the IPCC's computer modeling projects that Arctic ice decline will continue into the future.[20]

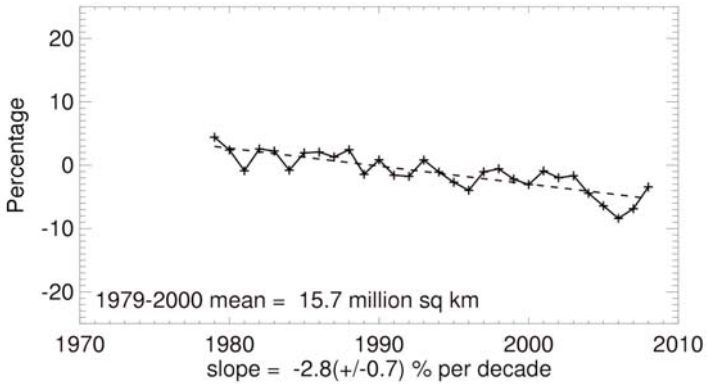
But the IPCC projections are based on the assumption that Arctic ice melting is the result of global warming caused by greenhouse gas emissions—an assumption that was recently shown to be of dubious merit by NASA, which is hardly a hotbed of climate skepticism.

In October 2007, NASA announced the results of an in-depth study of Arctic sea-ice melting and found that what has caused the unusually large melting seen in the last eight years was not greenhouse gas–induced global warming. In the press release describing the study, team leader Son Nghiem explained that the warming of recent years was, in fact, caused by a change in wind patterns. "Unusual atmospheric conditions set up wind patterns that compressed the sea ice, loaded it into the Transpolar Drift Stream and then sped its flow out of the Arctic," he said. When that sea ice reached lower latitudes, it rapidly melted in the warmer waters.[21]

In January 2008, another study, published in the journal *Nature*, also cast doubt on whether greenhouse gas–induced heating is melting the Arctic. In a study looking at the vertical distribution of atmospheric heating, Nordic researchers found that, although models of greenhouse gas–induced warming predict that increased heat will show up close to the surface of the earth, the data show the opposite: Arctic heating has actually been happening too high in the atmosphere to reflect greenhouse gas causation. What the data seem to indicate is that heat from the tropics is being transported to the Arctic by wind patterns that are not well understood.[22]

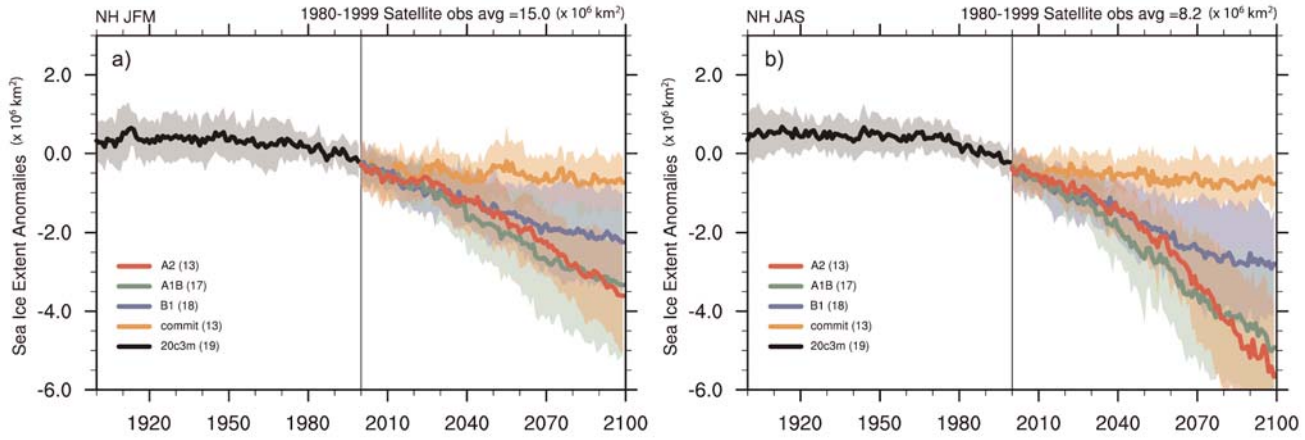
Thus, at present, we cannot assume the IPCC's future predictions for Arctic ice melt trends are meaningful. Recently observed Arctic melting could well be

FIGURE 2
NORTHERN HEMISPHERE EXTENT ANOMALIES, MARCH 2008



SOURCE: National Snow and Ice Data Center, "Sea Ice Index," available at http://nsidc.org/data/seaice_index/n_plot.html (accessed April 22, 2008).

FIGURE 3
IPCC MODELED PROJECTIONS OF FUTURE ARCTIC SEA-ICE MELT



SOURCE: United Nations Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis* (Cambridge: Cambridge University Press, 2007), 771, available at http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch10.pdf (accessed April 29, 2008).

NOTE: NH JFM stands for Northern Hemispheric January–March sea-ice anomalies (deviations from the 1980–2000 mean), while NH JAS stands for Northern Hemisphere July–September sea-ice extent anomalies.

a shorter-term phenomenon unrelated to man-made global warming.

Does Less Ice Mean Fewer Polar Bears?

While data on polar bear populations are relatively scarce, data on population trends are nearly nonexistent. Thus, to determine whether polar bears will be endangered by the disappearance of sea ice, trends in population are predicted using something called population viability analysis (PVA), which is statistical modeling used to predict various outcomes within animal populations. The major meta-analysis of polar bear populations is the IUCN/SSC Polar Bear Specialist Group's 2005 report on the status of the polar bear.[23] The report uses a type of stochastic subpopulation viability analysis, meaning that it incorporates random variability terms into PVA to come up with estimates of future sizes for polar bears by region. In the IUCN/SSC models, estimated polar bear mortality rates (from tag-and-recapture studies); litter sizes; sex ratio of cubs; initial subpopulation size; and the sex, age, and family status of killed polar bears are fed into a computer program that forecasts future population rates under a variety of input assumptions and random variation.

Like various statistical models, PVA can be a useful tool in policy cost-benefit analysis, but its results are only as accurate as the data and the model assumptions that go into it. Polar bear populations are difficult to measure, in part because they travel so much, are sparsely populated, and live far from people. The highest-quality data on polar bears come from aerial studies and mark/recapture studies, in which scientists "mark" polar bears and estimate how many are in a population based on sightings of marked and unmarked animals. There are other methods of estimating polar bears, but the report describes those methods as having "unknown and in most cases inestimable errors." Of the nineteen subpopulations of polar bears, the IUCN reports estimates based on aerial or mark/recapture data for fourteen, but of these, only five are based on data collected after 1998. Twelve had sufficient data for the report to predict population trends, and of the five marked as declining, only two of these estimates were based on aerial or mark/recapture data from after 1998. Scientists have collected more recent data on polar bear populations, but from studies with more "inestimable errors."

Even the highest-quality data available on polar bears may not be suitable for precise population predictions or extinction possibilities. The body of scientific literature on this subject shows the difficulties both of making predictions and of deriving confidence intervals. Also, PVA predictions for extinction or other outcomes over *x* number of years requires between 5*x* and 10*x* years of data.[24] Unfortunately, although there are some mark/recapture data going back to the late 1960s and early 1970s for several subpopulations, there certainly are not enough data for anything close to precise estimates of polar bear populations over even the next ten years. There is simply too much uncertainty involved in modeling.

The IUCN report uses sedate statistical language to describe trends in polar bear populations and discusses causes other than climate change. For one of the subpopulations, it writes that the numbers "prohibit an unequivocal statistical conclusion that the sub-population has declined," but that based on observational evidence about polar bear health and data on neighboring groups of polar bears, the subpopulation is classified as declining. The report describes overharvesting by native populations and environmental pollutants, as well as warming temperatures and earlier ice breakup, as possibly negatively affecting various subpopulations.

There are some broader criticisms of polar bear population forecasts that J. Scott Armstrong, Kesten C. Green, and Willie Soon make in "Polar Bear Population Forecasts: A Public-Policy Forecasting Audit."[25] Armstrong, a professor at the Wharton School, has led a movement to codify forecasting procedures and is sharply critical of predictions that fail to live up to these standards, especially when they are invoked in calls for large-scale public policy changes. The types of criticisms that Armstrong et al. make of government reports arguing that polar bears should be listed as a threatened species relate to data, methodology, assessing uncertainty, data presentation and feedback, and independence and heterogeneity of authors. Last year, the U.S. Geological Survey released nine papers on the status of polar bears to inform the U.S. Fish and Wildlife Service in their decision about whether to add polar bears to the endangered species list. By their standards, the two reports Armstrong and his colleagues examined—"Forecasting the Rangewide Status of Polar Bears at Selected Times in the 21st Century"[26] and "Polar Bears in the Southern Beaufort Sea II: Demography and Population Growth in Relation to Sea Ice Conditions"[27]—properly apply only 10 percent and 15 percent of the forecasting principles, respectively.

Even with an adequate data set, it is possible that a PVA can still have large errors in extinction rate predictions. It is impossible to incorporate all future possibilities into a PVA: habitats may change, catastrophes may occur, and new diseases may be introduced. PVA utility can be enhanced by multiple model runs with varying sets of assumptions, including the forecast future date. Thoughts about the utility of PVA are mixed among scientists: PVA may be more useful when it is used to evaluate relative rather than absolute risks to populations under different policies.[28]

Conclusion

At present, polar bear populations are robust and, according to native people, are considerably larger than they were in previous decades.[29] Predictions of polar bear endangerment are based on two sets of computer models: one set predicts how much Arctic sea ice will melt as a result of global warming, and the other predicts how polar bear populations will respond. But computer models of climate are known to be fraught with problems, and the ecological models used to predict polar bear response are equally limited.

Because of extreme limitations in data, it is essentially impossible to decide whether polar bears are endangered and whether their habitat is threatened by man-made global warming or other natural climate cycles. This is acknowledged by the experts themselves—the actual IUCN/SSC report is more broad in naming causes and more conservative about estimating their effects.

What we do know about polar bears is that, contrary to media portrayals, they are not fragile "canary in the coal mine" animals, but are robust creatures that have survived past periods of extensive deglaciation. Polar bear fossils have been dated to over one hundred thousand years, which means that polar bears have already survived an interglacial period when temperatures were considerably warmer than they are at present and when, quite probably, levels of summertime Arctic sea ice were correspondingly low.[30]

In discussions of whether to drill in the Arctic, one of the arguments raised by environmentalists is that this would harm the habitats of the many creatures, including polar bears, that make their homes in Alaska. If polar bears are placed on the endangered species list, the legal hurdles to oil and gas drilling will increase. There are two subpopulations of polar bears in Alaska. One of them, the Southern Beaufort Sea population, is shared with Canada, and the other, the Chukchi Sea population, with Russia.[31] Best estimates for these areas show approximately 3,500 polar bears total in these two subpopulations. Last year, Shell Offshore Inc. was about to start drilling in the Beaufort Sea area when a court order halted the activity on the grounds that the federal government did not thoroughly assess the environmental impact before granting permission to drill.

In petitioning against the drilling, environmental groups invoked sea ducks, whales, and, of course, polar bears,[32] as well as the effect that drilling could have on native populations. The U.S. Minerals Management Service estimates that the area holds the potential for 7 billion barrels of recoverable oil and 32 trillion cubic feet of recoverable natural gas. With oil at over $100 a barrel and natural gas at $7.60 per one thousand cubic feet,[33] these are some very expensive polar bears.

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Notes

1. "Birth and Rebirth," *USA Today*, August 23, 1999.

2. *March of the Penguins*, directed by Luc Jacquet (Burbank, CA: Warner Home Video, 2005).

3. Eric de Place, "Not-So-Charismatic Megafauna," The Daily Score, September 8, 2006.

4. Peter Passell, "Economists Point to Values beyond Price," *New York Times*, June 2, 1998.

5. Center for Biological Diversity, "Polar Bear," available at www.biologicaldiversity.org/swcbd/species/polarbear/index.html (accessed January 7, 2008).

6. National Wildlife Federation, "Polar Bears and Global Warming," available at www.nwf.org/polarbearsandglobalwarming/ (accessed April 17, 2008).

7. Natural Resources Defense Council (NRDC), "Polar Bear SOS: Take Action," available at www.nrdconline.org/campaign/polarbearsos_0407 (accessed April 30, 2008).

8. World Wildlife Fund, "Polar Bear," available at www.worldwildlife.org/polarbears/ (accessed April 17, 2008).

9. Greenpeace, "Project Thin Ice 2006: Save the Polar Bear," available at www.projectthinice.org/bears/index.php (accessed April 17, 2008).

10. Juliet Eilperin, "U.S. Wants Polar Bears Listed as Threatened," *Washington Post*, December 27, 2006.

11. NRDC, "Bush Administration to Miss Deadline for Polar Bear Endangered Species Act Listing," news release, January 7, 2008, available at www.nrdc.org/media/2008/080107.asp (accessed April 17, 2008).

12. Jim Snyder, "Panel Questions Delay on Polar Bear Ruling," *The Hill*, January 8, 2008.

13. NRDC, "Bush Administration to Miss Deadline for Polar Bear Endangered Species Act Listing."

14. Ian Stirling and Andrew E. Derocher, "Melting under Pressure: The Real Scoop on Climate Warming and Polar Bears," *The Wildlife Professional* (Fall 2007), available at www.wildlifejournals.org/archive/1933-2866/1/3/pdf/i1933-2866-1-3-24.pdf (accessed April 29, 2008).

15. Jon Aars, Nicholas J. Lunn, and Andrew E. Derocher, eds., *Polar Bears: Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 20–24 June 2005, Seattle, Washington, USA* (Gland, Switzerland: IUCN, 2006), 33, available at www.polarbearsinternational.org/rsrc/Proc_Seattle05.pdf (accessed April 30, 2008).

16. Ibid.

17. National Snow and Ice Data Center, "Arctic Sea Ice News Fall 2007," available at http://nsidc.org/news/press/2007_seaiceminimum/20070810_index.html (accessed April 17, 2008).

18. National Snow and Ice Data Center, "Sea Ice Index," available at http://nsidc.org/data/seaice_index/n_plot.html (accessed April 22, 2008).

19. United Nations Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis* (Cambridge: Cambridge University Press, 2007), 339, available at http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch04.pdf (accessed April 30, 2008).

20. Ibid., 771, available at http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch10.pdf (accessed April 30, 2008).

21. NASA, "NASA Examines Arctic Sea Ice Changes Leading to Record Low in 2007," news release, available at www.nasa.gov/vision/earth/lookingatearth/quikscat-20071001.html (accessed on April 23, 2008).

22. R. G. Graversen et al., "Vertical Structure of Recent Arctic Warming," *Nature* 451 (January 3, 2008): 53–56.

23. Jon Aars, Nicholas J. Lunn, and Andrew E. Derocher, eds., *Polar Bears: Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group*.

24. B. W. Book et al., "Predictive Accuracy of Population Viability Analysis in Conservation Biology," *Nature* 404 (March 23, 2000): 385–87.

25. J. Scott Armstrong, Kesten C. Green, and Willie Soon, "Polar Bear Population Forecasts: A Public-Policy Forecasting Audit" (working paper, version 75, April 28, 2008), available at www.forecastingprinciples.com/Public_Policy/PolBears.pdf (accessed April 30, 2008).

26. S. C. Amstrup, B. G. Marcot, and D. C. Douglas, "Forecasting the Rangewide Status of Polar Bears at Selected Times in the 21st Century" (administrative report, U.S. Geological Survey [USGS] Alaska Science Center, 2007).

27. C. M. Hunter, H. Caswell, M. C. Runge, S. C. Amstrup, E. V. Regehr, and I. Stirling, "Polar Bears in the Southern Beaufort Sea II: Demography and Population Growth in Relation to Sea Ice Conditions" (administrative report, USGS Alaska Science Center, 2007).

28. See discussion of population viability analysis in Stephen P. Ellner et al., "Precision of Population Viability Analysis," *Conservation Biology* 16, no. 1 (February 2002).

29. Don Martin, "Polar Bear Numbers up but Rescue Continues," *National Post* (Canada), March 6, 2007.

30. Jonathan Amos, "Ancient Polar Bear Jawbone Found," BBC News, December 10, 2007.

31. U.S. Fish and Wildlife Service, "Polar Bear Conservation Issues," available at http://alaska.fws.gov/fisheries/mmm/polarbear/issues.htm (accessed April 17, 2008).

32. Earthjustice, "Shell Oil Can't Drill This Year in Beaufort Sea, Court Rules," news release, August 15, 2007, available at www.earthjustice.org/news/press/007/shell-oil-cant-drill-this-year-in-beaufort-sea-court-rules.html (accessed April 30, 2008).

33. This is the average price to industrial customers for 2007. It is higher for residential and commercial use. (U.S. Department of Energy, Energy Information Administration, "Table 20: Average Price of Natural Gas Sold to Industrial Customers, by State, 2006–2008," *Natural Gas Monthly* (March 2008), available at www.eia.doe.gov/pub/oil_gas/natural_gas/data_publications/natural_gas_monthly/current/pdf/ngm_all.pdf [accessed April 30, 2008].)