Scientific advice on species at risk: a comparative analysis of status assessments of polar bear, *Ursus maritimus*

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Abstract: The assessment of species believed to be at heightened risk of extinction must be underpinned by scientific evaluations of past and predicted changes in abundance and distribution. When these assessments are communicated to society and (or) government, they provide an informed scientific basis for public policy decisions pertaining to the protection of biodiversity. The provision of advice for high-profile species can be particularly challenging as different interest groups may seek to over- or under-play a species' degree of endangerment. Those challenges are highlighted here by a comparative analysis of assessments of polar bear (*Ursus maritimus*) undertaken recently in Canada, the United States, and by the World Conservation Union (IUCN). Perceived differences in these assessments can be partly attributable to differences in the species status categories used by different organizations, the nature and application of assessment criteria, and the legislative responsibilities of those undertaking the assessments. Our analysis also highlights differences in how status assessments have informed the scientific basis for discordant projections of the future magnitude of polar bear habitat and population change. We conclude that evaluations of the scientific merits associated with any species status are hindered by imperfect understanding of differences in assessment protocols. Scientific advice potentially informed, but ultimately undermined, by personal and institutional biases serves neither decision-makers nor society well.

Résumé : L'évaluation de la situation des espèces soupçonnées d'être à risque d'extinction doit être soutenue par des analyses scientifiques des changements, passés ou prédits, en abondance et en distribution. Quand ces évaluations sont communiquées à la société ou au gouvernement, elles fournissent une base scientifique pour l'adoption des politiques en matière de protection de la biodiversité. La formulation d'avis scientifique sur le statut des espèces avec une forte visibilité médiatique peut être particulièrement complexe étant donné les intérêts divergents de différents groupes d'intérêt cherchant à sous- ou surestimer leur degré de risque. Ce défi est souligné ici en utilisant une analyse comparative des différentes statuts de conservation établis récemment pour l'ours polaire (*Ursus maritimus*) au Canada, aux États-Unis et par l'Union Internationale pour la Conservation de la Nature (UICN). Les diverses perceptions des assignations peuvent être en partie attribuées aux différences dans la catégorisation des statuts utilisées par plusieurs organisations, la nature et l'application des critères d'assignation et les responsabilités législatives des organisations. Notre analyse souligne également comment les assignations peuvent influencer différemment les bases scientifiques qui mènent à l'élaboration de projections divergentes sur la magnitude future du changement populationnel et de l'habitat de l'ours blanc. Nous concluons en suggérant que la valeur scientifique des évaluations du statut de conservation des espèces, et ce peu importe le statut, est limitée par un manque de compréhension des divers protocoles utilisés pour l'assignation des espèces. Les avis scientifiques se voulant à la base soutenus par des données, deviennent peu utiles pour les décideurs en matière de conservation ou pour la société lorsque des biais personnels et institutionnels interviennent.

Introduction

> I recently came across an article written by a Norwegian scientist during the 1970s, when I was Norway's Minister of the Environment. In the article he argued that there was no such problem as acid rain and that 'facts' and 'science' did not belong in the arena of politics and policy. This assertion was counter to my own beliefs and made me react strongly. Politics that disregard science and knowledge will not stand the test of time. Indeed there is no other basis for sound political decisions than the best available scientific evidence. This is especially true in the fields of resource management and environmental protection. (Brundtland 1997).

Gro Harlem Brundtland's unambiguous acknowledgement of the integral role of science in particular realms of public policy underscores a generally accepted premise that the assessment, conservation, and recovery of biodiversity should be underpinned by the best available information and the proffering of objective scientific advice. The former Prime Minister of Norway is well-placed to comment upon the often malleable associations that link science with government policy, although her observation might have more appropriately identified the unlikelihood that *policies*, rather than *politics*, which disregard science will not stand the test of time.

Failure to appropriately incorporate science into government decisions, concomitant at times with efforts to filter

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scientific advice before it is communicated to decision-makers and to society, can have enormous biological, socio-economic, and financial costs. Fisheries management, for example, is frequently influenced unduly by perceived short-term industrial and political benefits, to the detriment of longer-term conservation and socio-economic benefits. The marginalization of science associated with such policies has resulted in massive overfishing and historically unprecedented depletions of commercially exploited fishes in Canada and around the world (Hutchings 2000; Myers and Worm 2003; Hutchings and Reynolds 2004; Worm et al. 2006). From a financial perspective, the World Bank and Food Agriculture Organization (2008) reports that the yearly difference between actual and potential net economic benefits from marine fisheries amounts to US$50billion; the cumulative economic loss to the global economy of overfishing during the past three decades is an extraordinary US$2 trillion.

In many countries, there is widespread support for the creation of independent bodies to draw conclusions about matters of concern to society. Examples include judicial inquiries and royal commissions, usually established by government, and expert panels, usually established by national science academies. These bodies are expected to provide advice to decision-makers and (or) information to society that is unfettered by the consequences of that advice or information. Society believes there is merit in the provision of unbiased advice, not influenced by socio-economic or political concerns.

There are several models for the provision of scientific advice pertaining to species at risk. In Australia, the Environment Protection and Biodiversity Conservation Act (1999) established the Threatened Species Scientific Committee (currently comprised of nine scientists from academia, government, and the private sector) to advise the Federal Minister for the Environment, Heritage and the Arts on the amendment and updating of lists of threatened species. In the United States, the Endangered Species Act (ESA; 1973) makes government departments (e.g., US Fish and Wildlife Service, National Marine Fisheries Service) responsible for advising the Secretary of the Interior on the status of endangered and threatened species. Status assessments published in its Red List of Threatened Species by the IUCN (World Conservation Union) are recommended by its species specialist groups, which mostly include volunteer experts on a particular species or taxonomic group. Members of a specialist group are usually selected by its Chair, who is appointed by the IUCN Species Survival Commission.

In Canada, the Species at Risk Act (2003), or SARA, recognized the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as the national body responsible for advising the Federal Minister of the Environment on the status of Canadian species at risk. The Federal Government considers this advice when making decisions related to the inclusion of species on the national legal list of species at risk (i.e., Schedule 1 of SARA). A species is considered to be at risk in Canada if it has been assigned a status of extirpated, endangered, threatened, or special concern (in order of declining perceived probability of extinction). SARA provides for the assessment of populations, or groups of populations, acknowledging implicitly that such designatable units (DUs) (Green 2005) are irreplaceable units of biodiversity critical to the persistence of biological species. COSEWIC uses discreteness and evolutionary significance as the primary criteria for recognizing DUs.

In accordance with SARA, each member of COSEWIC is required by law to exercise discretion in an independent manner, meaning that species assessments are not influenced by the affiliations of members (e.g., government, university, research programme, non-governmental organization). Although COSEWIC is inclusive of government (jurisdictions are allocated membership on the Committee), status assessments are made independently of government; members are biologists who convey knowledge but do not represent their jurisdictions. Importantly, the status assessment advice provided to the federal government is based only on the best available information, irrespective of any perceived socio-economic or political consequences of that advice (Hutchings and Festa-Bianchet (2009) and VanderZwaag and Hutchings (2005) provide additional information on COSEWIC).

The present study bears upon the general issue of the communication of science to decision-makers and to society (Hutchings et al. 1997; Leiss 2001; Shelton 2007). On matters pertaining to the environment, resource management, and the protection of biodiversity, Environmental Non-Governmental Organizations (ENGOs) and scientists are among the strongest supporters of independent advisory bodies. For example, the Canadian Nature Federation and World Wildlife Fund (WWF) Canada were instrumental in the establishment of COSEWIC in 1976 (Shank 1999), well before it was recognized by SARA. Institutional barriers to, and bureaucratic filters on, the provision of scientific advice associated with industry-driven alterations to Pacific salmon (*Oncorhynchus* spp.) habitat and the collapse of Atlantic cod (*Gadus morhua*) led to calls by academic scientists for greater independence of government scientists in the 1990s (Hutchings et al. 1997). But, in providing strong support for arms-length scientific bodies, some ENGOs and scientists may find themselves unprepared for situations in which the independent advice is at odds with their personal or institutional convictions.

Status assessments of "charismatic" species have the greatest potential for generating discussion on the merits of independent advice because of the social, political and economic consequences of public perception of extinction risk. An excellent example of the challenges faced by those providing independent scientific advice, and by those who have a vested interest in that advice, is provided by COSEWIC's 2008 assessment of polar bear (*Ursus maritimus*). Perceived differences in status assessments of polar bear by the IUCN (Aars et al. 2006; Schliebe et al. 2008), COSEWIC (COSEWIC 2008), and the United States Government (Schliebe et al. 2006; USA 2008) focussed an unprecedented amount of media- and government-related attention on COSEWIC's status assessment protocols and decisions. Here, we compare and contrast the approaches by which each status assessment was obtained. In particular, we focus on differences in species status categories and definitions, application of assessment criteria, and the legislative responsibilities of those undertaking the assessments.

Preliminaries to COSEWIC's 2008 assessment

The polar bear had been assessed by COSEWIC a number of times, the most recent being a status of special concern communicated to the Minister of the Environment in COSEWIC's 2003 Annual Report. The federal government formally rejected COSEWIC's advice in January 2005 by not adding the species to Schedule 1 of SARA and by removing it from Schedule 3 (a decision which meant that no national management plan was developed for this species). In July 2005, the government sent the assessment back to COSEWIC "for further information or consideration", arguing that the advice provided by COSEWIC was based on a status report that was deficient in its consideration of Aboriginal traditional knowledge, or Inuit Qaujimanituqangit, and would benefit from inclusion of more recent abundance estimates. Following an open call for bids from potential status report writers that was widely advertised to polar bear experts, COSEWIC initiated a process of status report preparation and review that extended more than 2 years. All Canadian government jurisdictions (federal, provincial, territorial, wildlife management boards) responsible for polar bear conservation, the Chair of the IUCN Polar Bear Specialist Group, the Polar Bear Technical Committee (which oversees management plans in Canada), and independent scientists were asked to review and provide input on the report.

Based on the best available information, COSEWIC concluded that polar bear was a species at risk in Canada, formally advising the federal government of its assessment of special concern in August 2008. COSEWIC identified the primary threats facing polar bear to be: (1) reduction in sea ice, caused by climate change, particularly for subpopulations in the southern part of the species' range; (2) overhunting for subpopulations shared by Canada and Greenland; and (3) habitat threats from industrial development. Inuit have also observed deteriorated ice conditions in some areas (e.g., reduction in multi-year ice, fewer icebergs, thinner ice, earlier ice break-up) and have expressed concerns about the consequences that changes in sea ice may have on polar bears (Atatahak and Banci 2001; Dowsley 2005; Keith et al. 2005; NTI 2005). While assessing polar bear as a single unit throughout its range, COSEWIC made it clear that some subpopulations of polar bear, such as those in the Southern Beaufort Sea, Western Hudson Bay and Baffin Bay, faced very high probabilities of decline. If COSEWIC's advice is accepted, the federal government must prepare a national management plan that includes measures for the conservation of the species and its habitat (SARA s. 65). Given that polar bear is currently not on any of SARA's species schedules, such a management plan must be in place within 3 years of legal listing, i.e., government's formal acceptance of COSEWIC's advice. By law, COSEWIC must review its assessment of polar bear within 10 years, or earlier if it has reason to believe that its status has changed significantly (SARA s. 24). Although the Minister of the Environment intends to recommend that polar bear be listed as a species of special concern (http://www.sararegistry.gc.ca/virtual_sara/files/statements/rs_167_271_2008-8_e.pdf; access 23 February 2009), the federal government had yet to reach a final decision at the time of writing.

International differences in species assessment protocols

Species at risk are assessed by a number of countries and agencies worldwide. Based on criteria originally developed in the mid 1990s to "flag" species that the IUCN deems to be most in need of conservation action (Mace et al. 2008), the IUCN's Species Specialist Groups, including the Polar Bear Specialist Group (PBSG), apply these criteria to the assessments of species. Among the few countries with national endangered species legislation, the political boundaries of only two encompass the geographical limits of polar bear. The United States is the sole country to date to have included the polar bear on a legally binding list of species at heightened risk of extinction.

Despite what might superficially appear to be similar assessment processes (scientists rendering status designations) and similar status categories (e.g., endangered, threatened), differences between systems affect how status designations should be interpreted. This is particularly important when the status assessments appear to be inconsistent among assessment groups and when the species has a high public profile. Such apparent inconsistencies can negatively affect the communication of scientific advice and potentially the confidence that government and society can have in the quality of the advice.

The status assessment of polar bear is a case in point. The IUCN PBSG assessed polar bear as vulnerable in 2005 (Aars et al. 2006), reaffirming this status in 2008 (Schliebe et al. 2008). The IUCN's "vulnerable" category is equivalent (in that they share the same definition and associated assessment criteria) to COSEWIC's "threatened" category. The United States included polar bear as a threatened species under the ESA in 2008. COSEWIC assessed polar bear as a species at risk in 2008, assigning it a status of special concern.

The perceived difference in these status assessments prompted some ENGOs and some scientists to question the credibility of COSEWIC and the soundness of its advice. One Canadian ENGO, for example, was highly critical of COSEWIC's assessment, asserting that the Committee had taken "an easy way out" (International Herald Tribune, 26 April 2008), a belittling statement that ignores COSEWIC's arms-length status and obfuscates the important point that COSEWIC's assessments are not influenced by their potential consequences. One member of the PBSG was quoted as saying that if he still worked for Environment Canada he would not recommend that the Minister accept COSEWIC's advice (Edmonton Journal; 23 August 2008). In the same newspaper article, another PBSG member opined that, in making a determination of special concern, COSEWIC had "failed miserably". And an attorney with the US-based Center for Biological Diversity (the ENGO that originally petitioned the US Government to list polar bear) described COSEWIC's decision as "weak", saying that "Polar Bears in Canada should instead be listed as a threatened or endangered species, not a species of special concern" (CBC News; 30 April 2008).

We submit that these reactions were prompted, in part, by a lack of understanding of important international differences in the assessment of species at risk. An informed com-

Table 1. A comparison of population trends (observed or predicted) in polar bear subpopulations as summarized by COSEWIC, the IUCN Polar Bear Specialist Group (Aars et al. 2006), and by the United States (Schliebe et al. 2006).

Subpopulation	COSEWIC (2008)	Aars et al. (2006)	Schliebe et al. (2006)
Southern Beaufort Sea	Declining	Declining	Declining
Northern Beaufort Sea	Stable	Stable	Stable
Viscount Melville	Increasing	Increasing	Increasing
Norwegian Bay	Stable?	Declining	Declining
Lancaster Sound	Stable	Stable	Stable
M'Clintock Channel	Increasing	Increasing	Increasing
Gulf of Boothia	Increasing	Stable	Increasing
Foxe Basin	Not known	Stable	Stable
Western Hudson Bay	Declining	Declining	Declining
Southern Hudson Bay	Stable	Stable	Increasing?
Kane Basin	Declining	Declining	Declining
Baffin Bay	Declining	Declining	Declining
Davis Strait	Not known	Not known	Stable

parison of the threatened status assigned by the US government, for example, with that of special concern assigned by COSEWIC would be cognisant of key differences in the status assessment processes between Canada and the United States.

Firstly, the range of status categories, and thus the range of listing options, differs between countries. Canada recognises three categories for extant species at risk (endangered, threatened, special concern), while the US recognises only two (endangered, threatened). Threatened is the lowest "at-risk" status at which polar bears could have been assessed in the US.

Secondly, a difference in the status category definitions may increase the probability of a threatened status being assigned in the US. In Canada, a threatened species is one "likely to become an endangered species if nothing is done to reverse the factors leading to its extinction or extirpation" (SARA); under the ESA, a threatened species is one that is "at risk of becoming endangered in the foreseeable future". Although these definitions do not differ appreciably, those for "endangered" do. In Canada, an endangered species is one "facing imminent extirpation or extinction". In the US, an endangered species is one that is in "danger of extinction throughout all *or a significant portion of its range* [*italics* added]". Thus, a threatened species in the Canadian context refers to species likely to be imminently lost throughout its entire range if nothing is done to address threats. By contrast, in the American context, a threatened species is one that is at risk of being lost, in the foreseeable future, throughout all or a significant portion of its range, but not necessarily its entire range. *Ceteris paribus*, this difference in definitions makes it more likely that a species will be assigned a threatened status in the US than in Canada.

Thirdly, COSEWIC bases its assessments on quantitative criteria very similar to those developed by the IUCN (IUCN 2008; Mace et al. 2008). By contrast, status assessments in the US are not based on quantitative criteria, but on the qualitative definitions of endangered and threatened mentioned above, including subjective interpretations of "foreseeable future" and "significant portion".

Fourthly, the geographical range of COSEWIC's assessment differed from that of the US and IUCN assessments. COSEWIC's assessment was based on the overall status of the 13 subpopulations that exist within Canada (which represents approximately 60% of the global polar bear population). By contrast, the US and IUCN based their assessments on the 19 subpopulations that are recognized worldwide.

Status of polar bear: Unit of assessment

A key issue that COSEWIC had to address was whether the status of polar bear should be assessed for the species throughout its range in Canada, or as separate units, comprised of one or more of the 13 subpopulations recognized for management purposes. In 2007, COSEWIC revised its guidelines for recognizing designatable units (DUs) (www.cosewic.gc.ca/eng/sct2/sct2_5_e.cfm). Briefly, two criteria need to be met before a population or group of populations can be recognized as a DU. Firstly, there must be evidence that the putative unit is discrete. This may be based on (1) genetic distinctiveness evidenced by neutral genetic markers, life history differences, or behavioural distinctions; (2) natural range disjunctions sufficient to allow the evolution of local adaptations; (3) occupation of different eco-geographical regions, as depicted by appropriate ecozone or biogeographic maps; or (ideally) some combination of these data. Secondly, there must be evidence that differences between putative DUs are likely to be evolutionarily significant. The criteria that COSEWIC use for assessing discreteness and evolutionary significance are very similar to those applied in the United States to identify distinct population segments (DPSs) of vertebrates under the ESA (USFWS 1996).

As COSEWIC's guidelines articulate, "Designatable Units should be discrete and evolutionarily significant units of the taxonomic species, where 'significant' means that the unit is important to the evolutionary legacy of the...species as a whole and if lost would likely not be replaced through natural dispersion". Notwithstanding limited evidence for genetic distinctiveness and a more substantial basis for differences in diet (Thiemann et al. 2008), COSEWIC judged there to be insufficient evidence for discreteness and evolutionary significance to warrant the identification of separate DUs. The US, which uses the same two criteria to identify

Table 2. Predicted changes in various metrics of polar bear habitat.

Variable	Location	Time period	Reduction (%)	Reference
Optimal polar bear habitat	Canada/Greenland	2001–2050	13	Durner et al. (2007)
Total polar bear habitat	Seasonal Ice Ecoregion (BB, DS, FB, WHB, SHB)	2006–2051	7–15	Amstrup et al. (2007)
	Archipelago Ecoregion (KB, NW, LS, VM, MC, GB)	2006–2051	3–14	Amstrup et al. (2007)
	Polar Basin Divergent Ice Ecoregion (SB)	2006–2051	21–33	Amstrup et al. (2007)
	Polar Bear Convergent Ice Ecoregion (NB)	2006–2051	11–15	Amstrup et al. (2007)
	All Ecoregions Combined	2006–2051	15–24	Amstrup et al. (2007)
Global Arctic	Winter extent of sea ice	2004–2050	15–20	ACIA (2005)
Global Arctic	Summer sea ice extent	2004–2050	30–50	ACIA (2005)
Global Arctic	September sea ice extent	2007–2043	~30	Ensemble mean Stroeve et al. (2007)

Note: BB, Baffin Bay; DS, Davis Strait; FB, Foxe Basin; GB, Gulf of Boothia; KB, Kane Basin; LS, Lancaster Sound; MC, M'Clintock Channel; NB, Northern Beaufort Sea; NW, Norwegian Bay; SB, Southern Beaufort Sea; SHB, Southern Hudson Bay; VM, Viscount Melville; WHB, Western Hudson Bay.

DPSs, also concluded that there was insufficient evidence to assess the polar bear below the biological species level (USA 2008). Polar bear was thus assessed as a single unit throughout its Canadian range, consistent with the assessments of a single global unit by the IUCN and the United States. It is important to note, however, that the assessment of a single unit in Canada does not in any way preclude the development of recovery strategies or management plans, required by SARA, at smaller spatial scales on what others might identify as management or conservation units.

Status of polar bear: Population projections

The IUCN PBSG based its status assessment of vulnerable on the inference that the species as a whole will decline by 30% or more over the next three polar bear generations. An inferred decline of this magnitude, over this time frame, would be sufficient to trigger the quantitative threshold for a vulnerable status under Criterion A3 of the IUCN. The PBSG estimated the three-generation time frame to be 45 years, an estimate that calculated generation length by adding the age at first reproduction (5 years) to half the length of the reproductive period in a complete life cycle (20 years) (Aars et al. 2006). In the absence of data on age-specific survival and cub production, such an estimate might have merit, despite having neither a theoretical nor empirical basis in population biology (e.g., Roff 2002; Krebs 2009). However, these data do exist (COSEWIC 2008), which allowed COSEWIC to estimate the mean age of reproductive individuals (i.e., generation time; Gotelli 2008) to be 12 years, yielding a three-generation time frame of 36 years. The IUCN estimate of 45 years is also confounded by the absence of a biologically accepted definition of "complete life cycle" for polar bear, or for any other mammal, and by the fact that the median probability of maturity at age 5 is only 0.26 (for the 11 Canadian subpopulations for which data exist; COSEWIC 2008), as opposed to the implicit probability of 1 assumed by the IUCN PBSG. Despite these problems, the PBSG's estimate of generation time was adopted by the US, using 45 years as the time frame that would constitute "foreseeable future" under the ESA. Notwithstanding the differences in generation time, predicted trends in polar bear subpopulations are similar among the US (Schliebe et al. 2006), the IUCN PBSG (Aars et al. 2006), and the COSEWIC assessments (Table 1). By contrast, based on Inuit Qaujimanituqangit, Inuit have asserted that polar bears in Baffin Bay, Western Hudson Bay, and Southern Hudson Bay are increasing, rather than decreasing, in abundance (COSEWIC 2008).

Status of polar bear: Application of assessment criteria

Based on the best available information, there are two IUCN criteria on which COSEWIC could have based a status assessment. The first is Criterion A3 which states, in effect, that if polar bears are predicted to decline by more than 30% in the forthcoming three generations, then a status of threatened may be warranted. The IUCN PBSG justified its application of Criterion A3 as follows (Aars et al. 2006; Schliebe et al. 2008):

> "There is little doubt that polar bears will have a lesser [area of occupancy, extent of occurrence] and habitat quality in the future. However, no direct relation exists between these measures and the abundance of bears. While some have speculated that polar bears might become extinct within 100 years from now, which would indicate a population decrease of >50% in 45 years based on a precautionary approach due to data uncertainty [sic]. A more realistic evaluation of the risk involved in the assessment makes it fair to suspect [a] population reduction of >30%".

Use of the term "precautionary" in this regard is curious, given that it is based on a single unreferenced estimate of extinction probability that "some have speculated" might have some merit.

Such a weak empirical basis for inferring a greater-than-30% decline in the forthcoming three generations might be acceptable when the primary purpose of the assessment is to raise awareness and to encourage conservation action, and when there are no direct legislative consequences to the assessment. Those are both characteristics of the IUCN Red List. By contrast, COSEWIC's responsibilities are recognized by legislation and its assessments trigger a variety of government actions. COSEWIC must establish as firm an empirical basis for its assessments as possible, given the legislated consequences that its advice, if accepted by government, can have on limiting human activities that threaten species persistence. An additional responsibility of COSEWIC is to ensure that governments and Canadians receive credible advice on the status of all species it assesses, re-

Table 3. Extinction probabilities of Polar Bear between 2006 and 2051, as estimated by Amstrup et al. (2007).

Ecoregion	Canadian polar bear subpopulations	Extinction probability (%)
Seasonal Ice	Baffin Bay, Davis Strait, Foxe Basin, Western and Southern Hudson Bay	54–77
Archipelago	Kane Basin, Norwegian Bay, Gulf of Boothia, Lancaster Sound, Viscount Melville, M'Clintock Channel	8–11
Polar Basin Divergent Ice	Southern Beaufort Sea	80–87
Polar Basin Convergent Ice	Northern Beaufort Sea	35–46

gardless of the attention directed to the species by ENGOs or the media.

Among the reports available to COSEWIC and to the US government were four that specifically included projected changes in polar bear habitat (Table 2). Durner et al. (2007) estimated that 'optimal polar bear habitat' will decline 13% by 2050. Amstrup et al. (2007) used IPCC (International Panel on Climate Change) projections to predict changes in habitat for four 'ecoregions' between 2006 and 2051 (45 years). Within ecoregions, the estimated decline in 'total polar bear habitat' (essentially, ice coverage that is actually used by polar bears) ranged between 3 and 33%; pooling all ecoregions yielded a predicted decline of 15 to 24%. In addition to these estimates of decline that incorporate all elements of polar bear habitat, there are estimates of decline in particular aspects of polar bear habitat by 2050: winter extent of sea ice (15%–20%; ACIA 2005); summer extent of sea ice (30%–50%; ACIA 2005); extent of sea ice in September (~30%; Stroeve et al. 2007). Based on the best available information on habitat trends (Table 2), COSEWIC judged there to be insufficient empirical support for the application of Criterion A3 and its implicit inference that polar bear area of occurrence, extent of occurrence, or habitat quality will decline by more than 30% in the next 36 years.

COSEWIC might have based its assessment solely on estimates of extinction probability. In accordance with IUCN Criterion E, a species may be assessed as vulnerable (COSEWIC's threatened) if the probability of extinction is estimated to be greater than 10% in the forthcoming 100 years. Using a Bayesian Network (BN) model, Amstrup et al. (2007) estimated extinction probabilities for polar bear in four ecoregions that encompass the global range of polar bear (Table 3). A BN model combines expert judgement and interpretation with quantitative and qualitative empirical information. As Amstrup et al. (2007) caution, BN models require input from multiple experts before they can be considered "final". The BN model upon which Amstrup et al.'s (2007) predictions were based incorporated the judgment of a single polar bear expert. COSEWIC agreed with Amstrup et al. (2007) that the BN model be viewed as a prototype, and concluded that there was insufficient scientific justification to assess the polar bear under Criterion E.

The potential bias associated with models based on single expert opinions is reflected by a recent compilation of expert knowledge (O'Neill et al. 2008) that documented considerable disparity in predicted changes to polar bear abundance by 2050. Based on feedback obtained from 10 members of the IUCN PBSG, median predicted declines were 18% for the Canadian Archipelago (range: 30% increase in abundance to 50% decline), 30% for Beaufort Sea (range: 50% increase to 70% decline), and 45% for Hudson Bay (range: 12%–85% decline). Despite the considerable range in population projections by individual scientists, however, the median estimates of population change were consistent with those articulated by COSEWIC (2008).

Concluding remarks

We used a case study and comparative analysis of the assessment of polar bear to highlight some of the challenges associated with the provision to government of independent scientific advice pertaining to endangered species. A key challenge faced by status assessment scientists arises when their conclusions are interpreted by parties with vested interests as being inconsistent with other assessments and, thus, scientifically suspect. We conclude that science-based evaluations of the merits associated with any species assessment are hindered by an imperfect understanding of international differences in species assessment protocols, including factors such as the number and definitions of species status categories, the nature and application of assessment criteria, the geographical scale of the assessment, and the legislative responsibilities of those undertaking the assessments. We also suggest that differences in species status can be influenced by differences in the primary function(s) of the assessment body and by the strength of its association, if any, with national legislation.

One theme interwoven throughout our analysis is the fundamental value of advisory bodies that are independent of political and bureaucratic interference and of other biases that might influence their advice, be it the research programmes of academic scientists, the fund-raising campaigns of ENGOs, the business development plans of industry, or the possible consequences on public opinion and (or) voting intentions. Any action that erodes this independence will erode the confidence that decision-makers and society have in the integrity of the advice, weakening the ability of governments to fulfil national and international obligations to protect, conserve, and recover biodiversity.

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References

Aars, J., Lunn, N.J., and Derocher, A.E. 2006. *In* Proceedings of the 14th working meeting of the IUCN/SSC Polar Bear Specialist Group, 20–24 June 2005, Seattle, WA: Polar bears. IUCN, Gland, Switzerland.

ACIA. 2005. Arctic climate impact assessment. Cambridge University Press. 1042 p.

Amstrup, S.C., Marcot, B.G., and Douglas, D.C. 2007. Forecasting

the range-wide status of polar bears at selected times in the 21st century. USGS Alaska Science Center Administrative Report, Anchorage, AK.

Atatahak, G., and Banci, V. 2001.Traditional knowledge polar bear report. Dept. Sustainable Development, Govt. Nunavut, Kugluktuk, NU. 15 p.

Brundtland, G.H. 1997. The scientific underpinning of policy. Science, **277**: 457. doi:10.1126/science.277.5325.457.

COSEWIC. 2008. COSEWIC assessment and update status report on the polar bear (*Ursus maritimus*). Committee on the Status of Endangered Wildlife in Canada, Ottawa.

Dowsley, M. 2005. Inuit knowledge regarding climate change and the Baffin Bay polar bear population. Final Wildlife Report 1. Dept. Environment, Govt. Nunavut, Iqaluit, NU. 43p.

Durner, G.M., Douglas, D.C., Nielson, R.M., Amstrup, S.C., and McDonald, T.L. 2007. Predicting the future distribution of polar bear habitat in the Polar Basin from resource selection functions applied to 21st century general circulation model projections of sea ice. ISGS Alaska Science Center, Anchorage, AK.

Gotelli, N.J. 2008. A primer of ecology. Sinauer, Sunderland, MA.

Green, D.M. 2005. Designatable units for status assessment of endangered species. Conserv. Biol. **19**: 1813–1820. doi:10.1111/j.1523-1739.2005.00284.x.

Hutchings, J.A. 2000. Collapse and recovery of marine fishes. Nature, **406**: 882–885. doi:10.1038/35022565. PMID:10972288.

Hutchings, J.A., and Festa-Bianchet, M. 2009. Canadian species at risk (2006–2008), with particular emphasis on fishes. Environ. Rev. **17**: In press.

Hutchings, J.A., and Reynolds, J.D. 2004. Marine fish population collapses: consequences for recovery and extinction risk. Bioscience, **54**: 297–309. doi:10.1641/0006-3568(2004)054[0297:MFPCCF]2.0.CO;2.

Hutchings, J.A., Walters, C., and Haedrich, R.L. 1997. Is scientific inquiry incompatible with government information control? Can. J. Fish. Aquat. Sci. **54**: 1198–1210. doi:10.1139/cjfas-54-5-1198.

IUCN. 2008. Guidelines for using the IUCN Red List categories and criteria, version 7.0. IUCN, Gland, Switzerland.

Keith, D., Arqvig, J., Kamootak, L., Ameralik, J., and Gjoa Haven Hunter's and Trappers' Organization. 2005. Inuit Qaujimanituqangit Nanurnut, Inuit Knowledge of Polar Bears. Gjoa Haven Hunters' and Trappers' Organization and CCI Press, Edmonton, Alta.

Krebs, C.J. 2009. Ecology: The experimental analysis of distribution and abundance. 6th ed. Benjamin Cummings, San Francisco, Calif.

Leiss, W. 2001. In the chamber of risks: understanding risk controversies. McGill-Queens, Montreal and Kingston.

Mace, G.M., Collar, N.J., Gaston, K.J., Hilton-Taylor, C., Akçakaya, H.R., Leader-Williams, N., Milner-Gulland, E.J., and Stuart, S.N. 2008. Quantification of extinction risk: IUCN's system for classifying threatened species. Conserv. Biol. **22**: 1424–1442. doi:10.1111/j.1523-1739.2008.01044.x. PMID:18847444.

Myers, R.A., and Worm, B. 2003. Rapid worldwide depletion of predatory fish communities. Nature, **423**: 280–283. doi:10.1038/nature01610. PMID:12748640.

NTI. 2005. What if the winter doesn't come? Inuit perspectives on climate change adaptation challenges in Nunavut. Summary Workshop Report, 15–17 March 2005. Nunavut Tunngavik Inc., Iqaluit, NU.

O'Neill, S.J., Osborn, T.J., Hulme, M., Lorenzoni, I., and Watkinson, A.R. 2008. Using expert knowledge to assess uncertainties in future polar bear populations under climate change. J. Appl. Ecol. **45**: 1649–1659. doi:10.1111/j.1365-2664.2008.01472.x.

Roff, D.A. 2002. Life history evolution. Sinauer, Sunderland, Mass.

Schliebe, S., Evans, T., Johnson, K., Roy, M., Miller, S., Hamilton, C., Meehan, R., and Jahrsdoerfer, S. 2006. Range-wide status review of the polar bear (*Ursus maritimus*). U.S. Fish and Wildlife Service, Anchorage, AK.

Schliebe, S., Wiig, Ø., Derochers, A., and Lunn, N. 2008. Ursus maritimus. *In* IUCN 2008, 2008 IUCN Red List of Threatened Species. Available from www.iucnredlist.org [Accessed 23 February 2009].

Shank, C.C. 1999. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC): a 21-year retrospective. Can. Field Nat. **113**: 318–341.

Shelton, P.A. 2007. The weakening role of science in the management of groundfish off the east coast of Canada. ICES J. Mar. Sci. **64**: 723–729. doi:10.1093/icesjms/fsm008.

Stroeve, J., Holland, M.M., Meier, W., Scambos, T., and Serreze, M. 2007. Arctic sea ice decline: faster than forecast. Geophys. Res. Lett. **34**: L09501. doi:10.1029/2007GL029703.

Thiemann, G.W., Derocher, A.E., and Stirling, I. 2008. Polar bear conservation in Canada: an ecological basis for identifying designatable units. Oryx, **42**: 504–515. doi:10.1017/S0030605308001877.

USA. 2008. Endangered and threatened wildlife and plants; determination of threatened status for the polar bear (*Ursus maritimus*) throughout its range. Federal Register 73. Fish and Wildlife Service. pp. 28212–28303.

USFWS. 1996. Policy regarding the recognition of distinct vertebrate population segments. Federal Register 61. U.S. Fish and Wildlife Service. pp. 4722–4725.

VanderZwaag, D.L., and Hutchings, J.A. 2005. Canada's marine species at risk: Science and law at the helm, but a sea of uncertainties. Ocean Dev. Int. Law, **36**: 219–259. doi:10.1080/00908320591004333.

World Bank and Food and Agriculture Organization. 2008. The sunken billions: The economic justification for fisheries reform. Agriculture and Rural Development Department, The World Bank, Wash.

Worm, B., Barbier, E.B., Beaumont, N., Duffy, J.E., Folke, C., Halpern, B.S., Jackson, J.B.C., Lotzke, H.K., Micheli, F., Palumbi, S.R., Sala, E., Selkoe, K.A., Stachowicz, J.J., and Watson, R. 2006. Impacts of biodiversity loss on coean ecosystem services. Science, **314**: 787–790. doi:10.1126/science.1132294. PMID:17082450.