Polar Bear-human conflicts: state of knowledge and research needs

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Abstract

Knowledge of the biophysical and social factors influencing conflicts between people and Polar Bears (*Ursus maritimus*) across the circumpolar north is incomplete and insufficient to guide management. We reviewed the peer-reviewed literature and government reports on Polar Bear-human interactions to assess what is known about their environmental context, relevant bear behavior and life history attributes, and the human dimensions of these events. Polar Bear-human conflicts appear largely driven by the absence of sea ice, which is a normal seasonal occurrence but is increasing in duration due to a warming Arctic climate. Integrated multidisciplinary research is needed to inform Polar Bear conservation efforts and improve human safety. Research priorities should include monitoring spatial and temporal trends of conflicts, understanding variability in incident recording, evaluating mechanisms of climate change effects on Polar Bear-human conflicts, determining risk perception and stakeholder acceptance capacity, and assessing deterrent effectiveness.

**Keywords:** climate change, endangered species, food-conditioning, habituation, Polar Bear, *Ursus maritimus*, wildlife-human conflict.

INTRODUCTION

Scientific understanding of the factors influencing conflict between people and Polar Bears (*Ursus maritimus*) is substantially less developed than it is for other bear species (Osyanikov 1996; Clark 2003) and yet it is important for the species’ conservation, especially in a warming climate (Amstrup et al. 2010). Deaths of Polar Bears shot in defense of life and property are frequent outcomes during conflicts with humans, occurring in 61% (Fleck and Herrero 1988) and 92% of incidents (Gjertz and Persen 1987). In contrast, human injuries or fatalities are infrequent: together comprising only <1% and 6% of incidents for all
North American bear species analyzed by Middaugh (1987) and Herrero and Fleck (1990), respectively. Although rare, each human injury associated with Polar Bears is highly publicized and media coverage shapes public discourse about Polar Bear conservation (Foote et al. 2009).

Polar Bear-human conflicts are neither new nor common (Honderich 1991; Stirling et al. 1977). However, in the context of climate change these conflicts are becoming increasingly important for wildlife managers and circumpolar communities for several reasons (Obbard et al. 2010). Temporal trends in sea ice decline due to climate change suggest that we should expect longer periods of overlap and increased conflict with people throughout much of the species’ range (Stirling and Derocher 1993; Stirling et al. 1999; Stirling and Parkinson 2006). Further, international expectations for Polar Bear conservation are high and likely to only increase (Vongraven and Peacock 2011), underscoring the need for development and dissemination of best management practices (Amstrup et al. 2010; Obbard et al. 2010).

Here, we summarize and assess the state of knowledge on Polar Bear-human conflicts using peer-reviewed literature and government reports, identifying where further research is needed. This review does not attempt to directly address the broader areas of Polar Bear ecology in general (e.g., Stirling 2011), changes in Arctic sea ice (e.g., Parkinson 2006; Stroeve et al. 2012), biological impacts of climate change on Polar Bears and Arctic ecosystems (e.g., Stirling and Parkinson 2006; Amstrup et al. 2007), or northern societies and economic development (e.g., AHDR 2004). Instead, our review is structured around Herrero et al.’s (2005) three-part model in which bear-human conflict outcomes are determined by situation-specific combinations of environmental context, bear behavior, and human responses/dimensions (Figure 1). We follow Hopkins et al.’s (2010) recommended terminology to describe the distinct types of interactions between people and Polar Bears (Table 1). This said, when we report published findings of others, we use their original terminology in order to not incorrectly categorize types of interactions.

Figure 1: Interactions between climate change and the dimensions of Polar Bear-human conflicts. Arrows indicate directionality of effect. Photo: D.A. Clark.
Table 1. Terminology used in bear-human conflict management as recommended by Hopkins et al. (2010).

<table>
<thead>
<tr>
<th>Scientific term</th>
<th>Definition</th>
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<tr>
<td>Human-bear interaction</td>
<td>An occurrence when a person and bear are mutually aware of each other.</td>
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<tr>
<td>Incident</td>
<td>An occurrence that involved a human-bear conflict or episodes where bears caused property damage, obtained anthropogenic food, killed or attempted to kill livestock or pets, or were involved in vehicle collisions.</td>
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<tr>
<td>Human-bear conflict</td>
<td>When a bear exhibited stress-related or curious behaviour, causing a person to take extreme evasive action, made physical contact with a person or exhibited clear predatory behavior, or was intentionally harmed or killed (not including legal harvests) by a person.</td>
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**ENVIRONMENTAL CONTEXT**

Here we define environmental context as the suite of biophysical conditions and trends across multiple temporal and spatial scales that influence the distribution, reproduction, ecology, and foraging patterns of Polar Bears and people who inhabit Arctic and sub-Arctic marine and coastal ecosystems. Most Polar Bear-human conflicts occur when bears are forced ashore by seasonally melting sea ice (Gjertz and Persen 1987; Fleck and Herrero 1988; Stenhouse et al. 1988; Gjertz et al. 1993; Gjertz and Schie 1998; Dyck 2006). Such seasonal melt is not a new phenomenon but the extent and duration of seasonal melt is increasing rapidly in some regions of the Arctic (Parkinson 2006; Stroeve et al. 2012) and results in Polar Bears being on shore longer (Stirling et al. 1999). The number and frequency of Polar Bear-human conflicts will likely increase in the future because the warming Arctic climate restricts bears’ access to sea ice, forces them to spend more time on land, reduces their feeding opportunities, and thus causes nutritional stress (Stirling et al. 1999; Regehr et al. 2007, 2009; Peacock et al. 2010). Indirect effects of sea-ice decline on Arctic marine food webs likely compound this problem by ultimately reducing the abundance of their preferred prey species, Ringed Seals (*Pusa hispida*) (Ferguson et al. 2006). Polar Bears on shore for longer periods are not only more likely to be nutritionally stressed but may also simply be in greater proximity to people and anthropogenic food sources such as garbage dumps and harvested wildlife (Stirling and Derocher 1993; Stirling and Parkinson 2006; Towns et al. 2009; Peacock et al. 2010). Individual human-bear incidents cannot be directly attributed to climate change (Hulme 2009), but the causal chain of reduced ice/nutritionally-stressed Polar Bears/more conflicts with people is supported by considerable empirical evidence from studies in diverse locations. The nature of this relationship is also something on which scientists and northern indigenous people largely agree (Lemelin et al. 2010). This congruence is important because effective management of Polar Bears requires cooperation between those groups, and, to date, such agreement has been scarce (Dowsley and Wenzel 2008; Tyrrell 2007, 2009; Henri et al. 2010; Peacock et al. 2011).

Shifts in terrestrial distribution during the on-shore period could alter the spatial overlap of Polar Bears and people, making conflicts more likely, although such an effect has not been demonstrated. Several authors hypothesized this was the case with Polar Bears moving northward along the western coast of Hudson Bay, increasing conflicts in communities there (Peacock et al. 2010; Towns et al. 2010). However, Atkinson et al. (2012) document a southward shift in bears observed on shore there over the same period, so this situation and its causes remain unclear.

There is no published long-term documentation of spatial or temporal trends in Polar Bear-human conflicts beyond individual jurisdictions, usually over relatively short time periods: e.g., Svalbard, Norway (Gjertz and Persen 1987; Gjertz et al. 1993; Gjertz and Schie 1998; Peacock et al. 2010), the Town of Churchill in Manitoba (Kearney 1989; Towns et al. 2009), and Canadian national parks (Fleck and Herrero 1988; Leonard 1989; Clark 2003). An exception is Middaugh’s (1987) 86-year review of Alaska, which contained only one Polar Bear-human conflict. Low numbers of reported incidents in those papers and limited spatial coverage preclude detailed statistical analysis, making it difficult to test hypotheses.

**BEAR BEHAVIOR AND LIFE HISTORY ATTRIBUTES**

Polar Bears are vulnerable to conflicts with humans because they are large-bodied wide-ranging carnivores with high energetic needs, able to challenge (or stalk) people for food. They often exhibit little or no fear of people, and at an individual level display complex behaviors that can increase their likelihood of approaching people or seeking anthropogenic foods. Most Polar Bears killed during conflicts with people are sub-adult males (Lunn et al. 1985; Gjertz and Persen 1987; Fleck and Herrero 1988; Stenhouse et al. 1988; Gjertz et al. 1993; Gjertz and Schie 1998; Dyck 2006). Consistent with other bear species, these outcomes are thought to result from those bears’ inexperience as hunters plus their competitive disadvantage against other bears when seeking and defending food (Herrero and Fleck 1990). The apparent boldness and curiosity of Polar Bears of all age and sex classes towards humans has long been noted, but this behavior is not well understood from a scientific perspective (Amstrup et
Habituation and food conditioning both appear to be important behavioral factors leading individual Polar Bears into conflicts with people, as they are for other bear species (Herrero et al. 2002, 2005; Hopkins et al. 2010). Evidence for this comes largely from Churchill, Manitoba, Canada, where for decades Polar Bears have had access to anthropogenic food sources such as garbage dumps, deliberately-placed baits, and community refuse (Watts and Ratson 1989; Herrero and Herrero 1997). Lunn and Stirling (1985) found that tagged Polar Bears that had fed in the Churchill garbage dump were significantly more likely to be destroyed as problem bears than tagged bears which had not fed there. They also found that tagged bears that had fed in that dump were twice as likely to be harvested by Inuit hunters from communities north of Churchill. However, the overall prevalence of food conditioning and habituation in that western Hudson Bay sub-population or others is unknown, and further investigation may yet reveal differences in how these behaviors manifest in Polar Bears compared to other species. Recently, Inuit and Cree communities have reported increases in Polar Bear–human interactions and conflicts around Baffin Bay and Hudson Bay, as well as bears being more aggressive and less afraid of people (Dowsley and Wenzel 2008; Nirlungayuk and Lee 2009; Tyrrell 2009; Lemelin et al. 2010). In western Hudson Bay, Inuit community members attribute these observed behavioral changes to long exposure of Polar Bears to people and anthropogenic foods in the Churchill region (Nirlungayuk and Lee 2009; Tyrrell 2009).

Control of Polar Bear attractants is important since, like other bear species, they are attracted to odors indicating potential food (Cushing 1983; Herrero and Fleck 1990; Herrero 2002). However, because Polar Bears do at times attempt to prey on people, attractant control alone is insufficient for human safety. Deterrents, including firearms carried by trained and/or experienced people, are also necessary to safeguard human life in certain situations (Herrero and Fleck 1990). Firearms are not completely reliable deterrents though. Smith et al. (2012) found that firearms were successfully used for deterring Polar Bears in only 50% of close range encounters with polar bears. Importantly for conservation, common non-lethal precautions appear to be effective on Polar Bears; notably capsaicin deterrent spray (Smith et al. 2008), and electric fencing and acoustical deterrents — including snowmobiles (Woolridge 1983; Miller 1986; Andersen and Aars 2008).

Experimental testing of a variety of deterrents (38mm and 12-gauge projectiles, electric fences, noisemakers, cracker shells) at a baited site at Cape Churchill, Manitoba over several years yielded variable results (Clarkson 1987). Because of the experimental constraints and potential confounding influences of unknown individual bears’ histories on those tests, questions remain about the effectiveness of most of those deterrents. However, experience with electric and non-electric fencing at research camps since then has shown it can be reliable (Clark 2003). Variations in 12-gauge projectile quality (Clarkson 1987) and possible habituation of bears to cracker shells (Matt 2010) remain potential limitations of these specific deterrents.

**HUMAN DIMENSIONS**

Here we define the human dimensions of Polar Bear–human conflicts as the diverse human activities, attitudes, values, knowledge, and institutions influencing the probability and consequences of interactions between Polar Bears and people. Little has been written about human dimensions of Polar Bear–human conflicts. As with other bear species, attractants make Polar Bear–human conflicts more likely to occur. Fleck and Herrero (1988) found that attractants were present in 92% of all incidents and 40% of injurious attacks by Polar Bears. Indigenous peoples’ activities in the Arctic and sub-Arctic often involve storing harvested wildlife, which can attract Polar Bears. Consequently, they face qualitatively different interaction risks than other groups (Stenhouse et al. 1988; Fleck and Herrero 1988; Dyck 2006). Scientists and tourists in remote areas were involved in the majority of polar bear incidents where human activities were analyzed across groups (Gjertz and Persen 1987; Gjertz et al. 1993; Gjertz and Schie 1998; Clark 2003). However, those analyses were of situations where Aboriginal people were absent (Svalbard) or typically engaged in very little harvesting activity (Canadian national parks). As such, direct comparisons of the situations and risks faced by these different groups are not appropriate.

Lethality of people to Polar Bears can be high but is not uniformly so: Polar Bears were killed in only 4% of interactions between people and Polar Bears in Canadian national parks (Clark 2003). Most of those situations involved researchers working from fenced camps with established communication and safety protocols, suggesting that preparation and careful risk mitigation can reduce the likelihood of Polar Bears being killed during conflicts. Indeed, in the recently-established Torngat Mountains National Park in Labrador, Canada, tourism is increasing but to date Polar Bear–human conflicts are few; largely because that park employs effective mitigation strategies which were developed in Wapusk National Park (Lemelin and Maher 2009). Unlike other bear species, the probability of Polar Bear–human interactions in Canadian national parks is independent of the number of visitors (Clark 2003). However, it is not clear whether this relationship will hold for northern parks with more infrastructure development and tourism than was the case at the time of that study. Similarly, increased resource development activity could conceivably increase Polar Bear–human conflicts by simply exposing more people and Polar Bears to each other, but this has not yet been shown. Fortunately, management lessons from national parks suggest that conflicts arising from Polar Bear–human interactions can be minimized, even in areas of high seasonal bear density.
RESEARCH NEEDS

Polar Bear-human conflicts are likely to become more common due to climate change, so specific research is needed to improve conservation efforts and increase human safety. Current knowledge about the basic relationship between reduced sea ice, nutritional stress, and Polar Bear-human conflicts is sufficient to generate hypotheses and predictions that give a general sense of what to expect under future scenarios of regional climatic change. However, it is insufficiently precise to guide management actions. This is especially true at the restricted temporal and spatial scales that are most relevant to wildlife management agencies’ decision processes. Furthermore, there are important regional differences in environmental conditions, land use patterns, and human activities, suggesting that Polar Bear-human conflicts may vary spatially. Mechanistic understanding of the nature and extent of the effects from reduced access to sea ice on Polar Bears and consequent nutritional stress remains incomplete (Molnár et al. 2010, 2011). How that affects the frequency, timing, spatial distribution, or outcomes of Polar Bear-human conflicts is still only known in generalities but if the ice/nutrition relationship is nonlinear, as suggested by Molnár et al. (2010), abrupt rises in bear-human conflicts are likely. At a recent workshop, Polar Bear managers identified conservation and public safety contingency planning as priorities (Matt 2010). We endorse that recommendation, particularly because of the potential for nonlinear changes in the ice/nutrition relationship. We further suggest that such planning would be most practical at local and sub-population scales. Developing predictive capability about Polar Bear-human conflict probabilities based on environmental signals or other relevant indicators identified by local and traditional ecological knowledge would be an obvious benefit to those planning processes.

Documenting spatial and temporal trends of these conflicts is critical information for understanding and resolving carnivore-human conflicts (Packer 2005), but knowledge of these trends for Polar Bears remains incomplete. The US Fish and Wildlife Service is establishing a coordinated international database for recording such incidents (Vongraven and Peacock 2011). Along with such developments, reporting and recording practices need to be examined since different groups of people are likely to report at different rates. Recent works that ascribe apparent increases in Polar Bear-human interaction frequency to climate change did not test whether other factors they identified might have confounded those results, such as changes in management practices (Stirling and Parkinson 2006; Towns et al. 2009; Peacock et al. 2010). Consistency in incident recording practices over time is critical but cannot be assumed in government agencies as both personnel and recording policies change for many reasons (Burrows et al. 2000; Boivin and Cordeau 2011). Further, inconsistent terminology for describing incidents hinders comparison and analysis between and even within agencies (Hopkins et al. 2010; Vongraven and Peacock 2011).

Deeper insights into the human dimensions of Polar Bear-human conflicts are necessary (Vongraven and Peacock 2011). How northern inhabitants perceive and respond to the risk of Polar Bear-human conflicts or how they are adapting to long-term changes has not been studied, but such knowledge would ultimately allow managers and other communities to respond more effectively. A participatory, community-based research approach (e.g., Wolfe et al. 2011) would be the most appropriate model and should focus on: i) interpreting local observations of Polar Bear-human conflicts; ii) documenting perceptions of risk from bears (e.g., Gore et al. 2007); iii) determining stakeholder acceptance capacity—a measure of stakeholders’ tolerance for Polar Bears (Carpenter et al. 2000); iv) evaluating the impact dependency of such tolerances – i.e., how the range of observed and perceived impacts by polar bears on those stakeholders affects their attitudes about management actions (Decker et al. 2006); and v) comprehensively understanding the social-ecological context that stakeholders consider relevant to Polar Bear-human conflicts (Clark 2011).

Further research into Polar Bear deterrents is needed too, especially addressing outstanding concerns about Polar Bear habituation to deterrents. Notably, Smith et al. (2008) recommended continued research on capiscum spray’s efficacy and we concur. Questions remain about the effectiveness of other deterrents, techniques for safely storing food in Polar Bear country, and indeed the social acceptance and utility of different approaches in Arctic indigenous communities (Matt 2010). Better understanding these issues could reduce conflicts and bear mortalities. Appraisal of emergent local strategies for preventing, responding, and adapting to Polar Bear-human conflicts, such as community patrols in Russia, Canada, and Alaska, is also needed (Matt 2010).

Given the prominence of attractants and the apparent insensitivity of interaction rates to regional human densities (as indicated by national park visitation), we hypothesize that unfavorable environmental conditions and resulting nutritional stress on Polar Bears may ultimately be the most important determinant of the frequency of Polar Bear-human conflicts. This hypothesis requires testing, which ought to be feasible in situations where accurate records of Polar Bear-human interactions, a series of estimates or indices of Polar Bear populations, and information on human population and activities are all available over time. Even if such a relationship were established though, such a finding would not detract from the importance of human dimensions in determining the outcomes of Polar Bear-human interactions, or even their likelihood under circumstances that are shaped by proximate human behavior (e.g., where anthropogenic foods remain available to bears).

There is unlikely to be a single solution to Polar Bear-human conflicts given their complexity and contingency. Integrated multidisciplinary research can describe and inform strategies and tactics for both preventing and mitigating Polar Bear-human conflicts. Such responses may be based on scientific understanding or local
and traditional knowledge (or both since these approaches are often complementary), and will have to be applied flexibly across a range of diverse and changing ecological and social situations. Documenting, evaluating, and widespread sharing of reliable knowledge about 'what works' will be critical to ameliorating Polar Bear-human conflicts, and assisting with the species’ conservation.

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Main Points

- The majority of Polar Bear-human conflicts occur when bears are forced ashore by seasonally melting sea ice.
- Polar Bear-human conflicts are neither new nor common but will likely increase as the warming Arctic climate restricts bears’ access to sea ice.
- Sub-adult male Polar Bears are involved in most conflicts, and attractants make Polar Bear-human conflicts more likely to occur.
- Lethality of people to Polar Bears can be high but can be reduced through deliberate, situation-specific practices.
- There is a need to accurately and comprehensively document spatial and temporal trends in Polar Bear-human conflicts, and to understand variability in incident recording.
- Further research is needed on human dimensions of Polar Bear-human conflicts and deterrent effectiveness.
- A community-based research approach is needed to more fully understand what works to prevent and mitigate conflicts.

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