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Predation of Harp Seals, *Pagophilus groenlandicus*, by Polar Bears, *Ursus maritimus*, in Svalbard

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ABSTRACT. Harp seals (*Pagophilus groenlandicus*) that breed in February and March in the White Sea migrate to open water around Svalbard and Franz Josef Land in the Barents Sea, feeding pelagically while following the receding ice edge northward to the edge of the polar pack. Although harp seals are present throughout the area during the summer, they are primarily pelagic and do not appear to be extensively preyed upon by polar bears (*Ursus maritimus*). However, occasionally, large numbers of harp seals may haul out and rest on the pack ice or feed in the water below the ice and surface to breathe between the floes. When approached by a polar bear while on the ice, harp seals do not exhibit the instant flight response characteristic of the polar bear's primary prey species, ringed (*Pusa hispida*) and bearded seals (*Erignathus barbatus*). In this situation, polar bears may make multiple kills without either consuming their own prey or scavenging seals killed by other bears. This behavior appears not to frighten other nearby harp seals, whether hauled out on the ice or in the water below the floes. These unusual concentrations of harp seals hauled out on sea ice may be related to the distribution and abundance of fish or other epontic prey. Their lack of an escape response to predators on the surface of the sea ice is probably a result of briefly hauling out in large numbers in spring while whelping on the sea ice in areas where the consequences of potential polar bear predation are insignificant. The rare events of harp seal mortality from bears killing them on the surface of pack ice during the summer do not appear to have a significant impact at the population level of either species.

Key words: harp seal; *Pagophilus groenlandicus*; polar bear; *Ursus maritimus*; predation

RÉSUMÉ. Le phoque du Groenland (*Pagophilus groenlandicus*), qui se reproduit dans la mer Blanche en février et en mars, migre vers les eaux libres des environs de Svalbard et de la terre François-Joseph dans la mer de Barents. Il se nourrit d'espèces pélagiques tout en suivant la lisière des glaces en recul vers le nord, jusqu'au bord des glaces polaires. Bien que l'on trouve des phoques du Groenland dans la région pendant l'été, ils sont principalement pélagiques et ne semblent pas beaucoup faire la proie des ours polaires (*Ursus maritimus*). Cependant, à l'occasion, de nombreux phoques du Groenland peuvent sortir de l'eau et se reposer sur la banquise, ou encore, ils peuvent se nourrir dans l'eau, sous la glace, et sortir respirer entre les floes. Lorsqu'un ours polaire s'approche de phoques du Groenland sur la glace, les phoques n'ont pas tendance à se sauver rapidement, comme le font les principales proies de l'ours polaire, soit le phoque annelé (*Pusa hispida*) et le phoque barbu (*Erignathus barbatus*). Dans cette situation, les ours polaires peuvent tuer plusieurs proies sans consommer leurs propres proies, ou sans charogner les phoques tués par d'autres ours. Ce comportement ne semble pas effrayer les autres phoques du Groenland se trouvant à proximité, qu'ils soient sur la glace ou dans l'eau, sous les floes. Ces concentrations inhabituelles de phoques du Groenland se trouvant sur la glace de mer peuvent être attribuables à la distribution et à l'abondance de poissons ou d'autres proies épontiques. Le fait qu'ils ne se sauvent pas en présence des prédateurs à la surface de la glace de mer résulte probablement des brèves sorties en grands nombres au printemps pendant la mise bas sur la glace de mer dans des zones où les conséquences de la prédation potentielle par l'ours polaire sont négligeables. Les rares incidents de phoques du Groenland tués par des ours à la surface de la banquise pendant l'été ne semblent pas avoir d'incidences importantes au niveau de la population de l'une ou l'autre des espèces.

Mots clés : phoque du Groenland; *Pagophilus groenlandicus*; ours polaire; *Ursus maritimus*; prédation

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INTRODUCTION

The primary prey species of polar bear (*Ursus maritimus*) populations throughout the circumpolar Arctic, including Svalbard, are ringed seals (*Pusa hispida*) and bearded seals (*Erignathus barbatus*) (Stirling and Archibald, 1977; Smith, 1980; Derocher et al., 2002; Thiemann et al., 2008). Additionally, where other species of marine mammals are present and there are opportunities to prey or scavenge upon them, polar bears have also been recorded feeding on species as diverse as harp seals (*Pagophilus groenlandicus*), hooded seals (*Cystophora cristata*), beluga whales (*Delphinapterus leucas*), narwhals (*Monodon monoceros*), harbor seals (*Phoca vitulina*), walrus (*Odobenus rosmarus*), and bowhead whales (*Balaena mysticetus*) (Thiemann et al., 2008). However, as climate warming continues to have negative effects on sea ice throughout the circumpolar Arctic (Regehr et al., 2016) and the fast ice pupping habitat of ringed seals in particular (e.g., Stirling and Smith, 2004), the nutritional importance of species such as harp seals to small numbers of polar bears in the northern pack ice areas (Aars et al., 2017) may increase, even if only for brief periods during the summer.

The harp seals seen around Svalbard breed in February and March in the White Sea and molt on the sea ice in the White Sea and southern Barents Sea during April to June. They then feed pelagically while following the receding ice edge northwards in the Barents Sea, including around the coastlines of islands and interisland channels in the Svalbard archipelago (Haug et al., 1994; Svetochev et al., 2016). The harp seals primarily remain in open water where they are not accessible to polar bears. However, small groups regularly make brief forays into areas of drifting pack ice, probably in search of Arctic cod (*Boreogadus saida*), which may aggregate there. While in the pack ice and surfacing to breathe between the floes, harp seals are vulnerable to predation by polar bears. In recent years, the coastal ice around Svalbard melts completely in summer, after which the harp seals remain totally pelagic and are mainly available to bears only when they enter the edges of the polar pack ice some distance off the northern coast of Svalbard.

STUDY AREA AND METHODS

While working as naturalists on ecotourism expedition ships, we documented observations of polar bears hunting harp seals in Svalbard. Whenever these ships were in or near pack ice along the coastlines of the archipelago or offshore of the north coast, staff and passengers constantly searched the sea ice for polar bears, using binoculars and telescopes. There was no predefined schedule or pattern of searching for polar bears but the routes followed by most ecotourism ships are similar between ships and years (Fig. 1), so that the areas searched regularly are broadly comparable. Consequently, observations of bears were opportunistic, and we kept descriptive notes of predation events, including of harp seals, whenever possible.

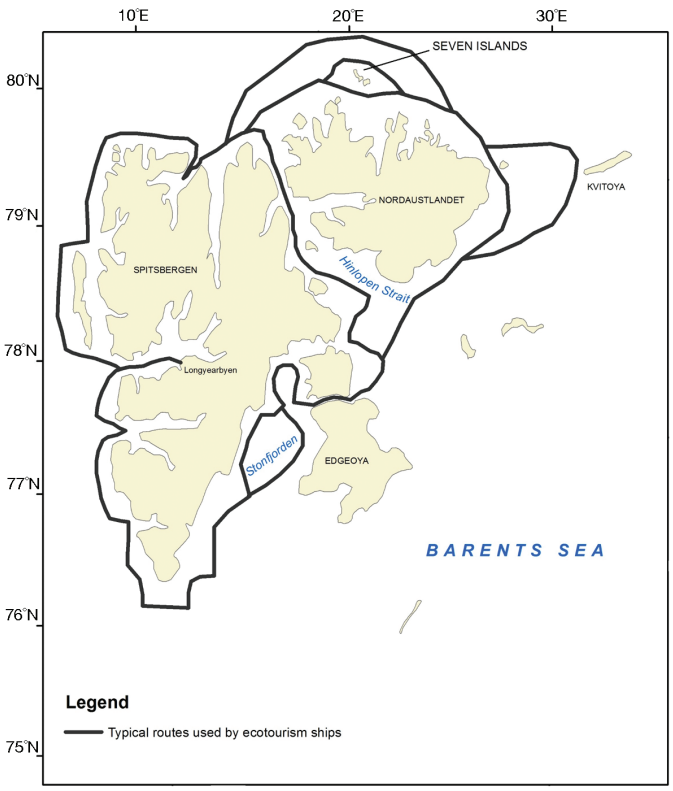

FIG. 1. Typical routes used by ecotourism ships searching for polar bears in Svalbard.

While working on different ships, we recorded observations of polar bears and their predation on seals in Svalbard during 14 seasons, which varied in duration from 3 to 8 weeks between June and early August 2003–17 (T.G. Smith, 15 seasons, 2003–17; I. Stirling, 12 seasons, 2006–17). We recorded the species of seals killed whenever possible. In a few cases we were able to identify the bear that made the kill and could document its size and probable sex.

During a typical 7- to 10-day trip, most ships sailed north from Longyearbyen along the west and northern Spitsbergen coast, searching a number of fiords along the route. On some trips the ships then sailed north to the edge of the polar pack ice and returned south through Hinlopen Strait or around Nordaustlandet into Storfjorden and finally back north along the west Spitsbergen coast to port in Longyearbyen (Fig. 1).

RESULTS

Despite the presence from June to August of large numbers of pelagic harp seals in and near coastal and offshore pack ice in the Svalbard archipelago, only seven confirmed instances of one or more harp seals being killed or scavenged by polar bears were observed (Table 1). All observations were seen on floes in the pack ice. Two of these observations were made north of 79° N, well offshore from the coast of Svalbard.

TABLE 1. Predation of harp seals by polar bears in Svalbard.

Date	Location	Bear hunting	Bear on fresh kill	Harp seal carcass
7 July 2005	76˚32.69′ N		1 seal	
	23˚32.31′ E		pack ice	
14 July 2005	76˚45.17′ N		1 seal	
	24˚51.66′ E		pack ice	
8 July 2008	76˚24.63′ N		1 seal	
	15˚34.15′ E		pack ice	
21 July 2012	76˚51.5′ N		1 seal	8+ seals
	17˚01.6′ E		pack ice	pack ice
12 August 2012	80˚36.33′ N		5 seals	
	08˚24.43′ E		pack ice	
22 July 2013	80˚54.36′ N		1 seal	
	19˚31.42′ E	pack ice		

Six of the bears observed hunting or feeding on a fresh kill of a harp seal had captured their prey by lying at the edge of a large ice pan and either seizing the seal with their teeth when it surfaced to breathe between ice floes or, probably in fewer cases, by diving into the water and successfully securing the seal below the surface as it first tried to escape before dragging it back onto the ice to feed. By analyzing the blood trails on the ice when we were watching a bear with the carcass, we saw evidence in three instances of how the kills had been made.

When we witnessed the actual seal kills, the bears that were still-hunting on ice pans appeared to select their hunting spot both by visual identification and apparently by olfactory examination of areas where seals had exhaled when surfacing to breathe and had left detectable scents on the ice edge. One such bear was observed on 22 July 2013 lying at the edge of a large ice pan (approximately 250 m in diameter). The wind was blowing from behind the bear towards our ship, which was also downwind of the ice pan. The first year ice of the floe was in an advanced state of melting, and there were a number of open melt holes approximately 75 m behind (upwind) the bear. Suddenly, the bear lifted its head after either hearing or (more likely) smelling a seal breathing, instantly got up, turned around, charged upwind towards the melt hole, dove into the water, and immediately emerged with a harp seal in its jaws. This incident clearly illustrates a bear's ability to modify its hunting behavior in an instant when an unseen and unexpected opportunity is detected.

On 12 August 2012, only one observation was made of a bear in Svalbard actively hunting harp seals hauled out on the ice in a large group. While sailing along the edge of an extensive area of 6–8/10 pack ice, T.G. Smith sighted approximately 1500 harp seals (adults and juveniles) hauled out on small ice pans, which covered an area of approximately 3 km^2 at (80˚36.33′ N, 08˚24.43′ E), approximately 70 km north of the northern coast of Spitsbergen (Fig. 2).

As the ship approached, an adult bear was sighted approaching the outer edge of the concentration. It was mainly swimming, but occasionally exited onto small ice pans to use scent to confirm the presence of the seals, which were upwind. The bear was observed for approximately two hours while it hunted harp seals. Using an aquatic stalk (Stirling, 1974), the bear cautiously swam toward two adult harp seals lying with their heads down on a small ice pan, which measured approximately 30 × 20 m, located 400 m from the stationary ship. When the bear reached the edge of the floe, it sprang out of the water and landed with its front feet on one of the seals while the other seal fled into the water. The bear held the seal captive with his feet while biting it on the head and neck. When the bear turned to look at two more seals on a nearby floe, the severely wounded seal slipped into the water. The bear did not try to retrieve it. After a short pause, the bear turned its attention to the seals on the next ice pan. It dove into the water and, after a short swim, climbed out on the ice and captured another seal by biting its head. The bear fed briefly on that seal, tearing open the back but consuming only a small amount of fat.

FIG. 2. A single polar bear killing several harp seals that were hauled out on the pack ice at 80º36.33′ N, approximately 70 km north of the Svalbard coast.

Over the next hour, the bear continued to travel over the ice floes through the aggregation of hauled-out harp seals that, surprisingly, did not flee into the water en masse, even when the bear was nearby. It killed three more seals after aquatic stalks and paused only briefly to partially consume the carcasses. We eventually lost sight of the bear as it moved into heavier pack ice where fewer hauled out seals were visible.

On the morning of 21 July 2012, while on a ship cruising slowly in 7–8/10 pack close to shore in SW Storfjorden (76˚51.5′ N, 17˚01.6′ E), I. Stirling observed several harp seal carcasses on the surface of the ice. An adult bear of unknown sex was spotted and shortly thereafter, an additional five or possibly more bears, as well as the carcasses of at least eight harp seals that were either being eaten by the successful hunters or scavenged by others. Some carcasses were at least several hours old. Because both the ship and pack ice were moving and there were many pressure ridges, neither the exact number of bears nor seal carcasses could be confirmed. Although unknown, it is possible that the clumping of seals and subsequent predation events began while the seals had been hauled out in a group on the surface of the ice in a situation similar to that in the observation described above. Additional bears were probably attracted to scavenge and hunt by the smell of seal carcasses in the area with the result that finally all seals that may have been on the ice returned to the water. Regardless, no seals were seen hauled out on the ice. However, small groups of harp seals continued diving and breathing between the ice floes near the ship and between nearby floes throughout the afternoon, indicating the continued presence of prey species for the seals in the water beneath the floes. The clumping of so many harp seal kills in a relatively small area, plus their continued activity in the water nearby through the night, suggests they had been there for some time, probably feeding, and were not deterred by the presence of either the bears or the ship. At 0730 on the following morning, an adult female and its yearling cub were observed feeding on a harp seal, killed only moments before by the female when the seal surfaced to breathe at a crack between the ice floes. They fed for 1.3 hours, uninterrupted by other bears. A separate, apparently satiated, adult female continued to sleep nearby on the ice beside the ship and ignored them. Several small groups of harp seals continued to surface among the ice floes and in the open water beside the ship throughout the morning. A large adult male, also apparently satiated, lay on the ice watching other bears while another female with two yearling cubs scavenged on a harp seal carcass a few hundred meters away. It was unknown if the seals being scavenged had been caught previously while hauled up on the ice or in a crack between floes when they surfaced to breathe. The ship departed in the early afternoon.

On 8 August 2012, while sailing north into the Hinlopen Strait at 79˚20.3 N, we encountered a large concentration of harp seals actively swimming and feeding on what we assumed to be a high concentration of invertebrates, fish, or both. They were also in the company of humpback whales, *Megaptera novaenglieae*, that were actively bubble-netting prey at the same location. A large number of kittiwakes, *Rissa tridactyla*, and fulmars, *Fulmarus glacialis*, were also taking advantage of this feeding opportunity. We continued to sail north and determined that the area of this high density feeding measured approximately 108 km^2. The factors related to the location and duration of areas of high productivity are not yet defined. The presence of such an area is certainly part of the reason for the aggregation of harp seals described above.

DISCUSSION

During the summer, harp seals infrequently haul out on ice floes in Svalbard, where that behavior would make them particularly vulnerable to polar bear predation. Even so, when harp seals do haul out on the ice or feed in substantial numbers beneath the floes, they appear relatively undisturbed by the presence of predaceous bears, which contrasts markedly with the instant escape responses of ringed and bearded seals, the primary prey species of the bears.

We compare our summer observations of harp seal predation in Svalbard to observations of a whelping patch of harp seals made by I. Stirling on the Labrador coast in March 1994 (in the general area of 53˚ N, 54˚ W), during ship-based research focused on concentrations of whelping harp and hooded seals. At that time of year, hundreds of thousands of individuals haul out at high densities near the edge of the pack ice off the coast of northern Labrador (Sergeant, 1991). Only a small number of polar bear tracks and seal kills were observed. The total number of bears in the area occupied by the seals was roughly estimated to be 10–12, of which seven adult males were captured, tagged, and marked to facilitate recognition from a distance. The presence of marked animals also helped to approximate the number of bears in the area. All of those for which sex could be confirmed were adult males. Relative to the previously described accounts of polar bears and harp seals in Svalbard in early summer, several observations are noteworthy. The harp seals paid little attention to the bears unless they came very close, but even if the adult females fled into the water, the pups remained on the ice, apparently unconcerned. Several partially eaten harp seal carcasses and one dead hooded seal were observed, with no tracks of additional scavenging bears, probably because most of the apparently small numbers of bears present were already satiated by the abundance of easily accessible seals. When an adult male bear walked near two lone adult seals and two adult females with pups on March 20, the adults retreated to the water when the bear was within a few meters, but the bear simply walked past and ignored the pups. Two adult harp seals were killed on March 22 but not eaten, and one adult harp seal and a weaned hooded seal pup were found still alive, with bites taken out of their backs, but not killed or further eaten by the bear that inflicted the wounds. We suggest the lack of a predator escape response in these two species likely evolved because of the relatively unlikely threat of predation from polar bears in the more southerly areas with less stable sea ice where the seals whelp and haul out for relatively brief periods during their breeding season.

Why large numbers of normally pelagic harp seals haul out on ice floes in summer remains unexplained. Most harp seals we observed in late spring and early summer in

Svalbard, when they are primarily pelagic, are in groups of 5–50, occasionally reaching 100–200, swimming and diving together but not hauling out on adjacent ice floes (T.G. Smith, unpubl. observ.). However, in an apparently small number of instances, such as those described above, 1500 or more harp seals may haul out together. Similarly, apparently numerous (but unknown numbers) of seals may dive and continue feeding as a group beneath a localized area of ice floes for an extended period and continue to breathe in cracks between the floes despite the presence of polar bears hunting on the surface of the ice.

There may be several possible explanations for why harp seals might haul out on ice floes. For example, several other species of ice-breeding seals, such as ringed seals, regularly haul out to bask and rest in midday between bouts of feeding in the water column when ice floes or fast ice are available (McLaren, 1958; Smith, 1973). However, only three times have we seen aggregations of harp seals hauled out on pack ice or remaining in the water in a localized area for an extended period, as described above. In addition, we are aware of only one similar though unpublished sighting of several hundred harp seals hauled out on ice floes in Lancaster Sound in the Canadian High Arctic on 7 July 2007, though no polar bears were present (David Willmott, One Ocean Expeditions, pers. comm. 2018). Thus, we conclude that hauling out simply to bask and rest is unlikely.

Second, although harp seals appear to have had insufficient contact with surface predators to evolve escape behaviors, they may be vulnerable to aquatic predators such as killer whales, *Orcinus orca* (e.g., Ferguson et al., 2010), and possibly Greenland sharks, *Somniosis microcephalus* (Leclerc et al., 2012; McMeans et al., 2013). In neither of the observations of harp seals on the ice in Svalbard was there any evidence that marine predators were present.

A third possibility is that pelagic harp seals are attracted to a high density food source in the water column below the pack ice, possibly Arctic cod, which are themselves feeding on invertebrates; the seals may simply be resting on the surface after feeding heavily. In a study of the distribution of Arctic cod in the Eurasian Basin of the Arctic Ocean, David et al. (2016) found that while this fish was ubiquitous, the greatest numbers occurred under areas of greater ice cover, possibly for protection from aerial predators, but also because their primary invertebrate prey species are concentrated there. They also suggested that the best body condition of the cod sampled was recorded from fish recovered from beneath the ice, which indicated that the under-ice environment was important for their survival as a species. In the Barrow Strait region of the Canadian High Arctic, Welch et al. (1993) reported exceptionally large schools of Arctic cod nearshore, albeit in the open water, occupying up to 130 000 m^2 surface area and containing on the order of 4×10^8 fish, weighing approximately 12 000 tonnes. When such concentrations were present, they were heavily preyed upon by harp seals, beluga whales, and seabirds.

Throughout our ship travels in Svalbard, we regularly observed smaller groups of harp seals (up to 20 or occasionally more) in open water and swimming in search of food into areas largely covered by ice floes. When the seals located their prey, they continued to dive and feed, while surfacing to breathe between the ice floes. Usually such feeding groups of harp seals keep moving rather than remaining in the same location for an extended period, which suggests that their prey species are widely distributed, but usually at relatively low densities. The pelagic distribution of Arctic cod and the possible occurrence and extent of aggregations beneath areas of pack ice in Svalbard are not understood. However, it seems possible that large aggregations of fish, similar to those documented in open water in the Canadian High Arctic, may occasionally occur beneath areas of pack ice as well. If so, such aggregations are likely to occasionally be discovered by a traveling group of harp seals. Also, it is well documented that harp seals are highly vocal in the water and such calls can travel several tens of kilometers (Perry and Terhune, 1999). Thus, we speculate that if a smaller group of travelling harp seals encountered one of the very large concentrations of fish beneath the pack ice, they may remain and feed intensively for an extended period. If so, the seals' underwater vocalizations may attract progressively more seals hunting within range of the vocalizations. If the fish school is large enough and remains under the ice in the same area for long enough, seals that become satiated may haul up on the ice, because it is there, to sleep and digest their food. Those seals remaining in the water while their prey is still present likely continue to feed, as we described above, even when polar bears are hunting. Seals that discover large concentrations of prey species in open water probably feed intensively as well, but in the absence of pack ice, simply move on when they are finished.

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