

Behaviors of High Arctic Wolves in Response to Humans

Ulf Marquard-Petersen¹

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ABSTRACT. This paper reports results of the first range-wide study of the behaviors of free-living wolves in the High Arctic in response to human presence and discusses these behaviors from a conservation perspective. The study focused on wolves believed to have had little, if any, contact with humans and excluded data from areas where wolves have become habituated to people. Data consisted of incidental sightings of wolves on the Canadian Arctic Archipelago and in Greenland from 1819 to 2019. A total of 325 behavioral observations were identified: 163 from Greenland and 162 from Canada. The most commonly reported behaviors (71.4%) involved wolves seeking out humans: coming to campsites, following traveling dog teams, closely approaching a person, and following people. These behaviors are not typical of canids in lower latitudes and have the potential to create conflicts with people who might feel threatened owing to the centuries-old belief that wolves are dangerous. Some Arctic wolves have been shot in perceived self-defense, when in all likelihood the animals were only curious. In addition, aggression directed towards domestic dogs was the most common form of wolf-dog interaction and produced another source of conflict. The findings are important from a conservation perspective because of the small wolf population and the fact that vanishing sea ice is increasing human access to the Arctic wolf range. Appropriate and humanely used hazing techniques and outreach to stakeholders on what constitutes normal Arctic wolf behavior can mitigate the risk of conflict and contribute to the conservation of Arctic wolves on the Canadian Arctic Archipelago and in Greenland, while minimizing the risk that the natural behavior of this subspecies is altered by increased human activity.

Key words: Arctic wolf; behavior; conservation; Greenland; Canadian Arctic Archipelago; conflict; hazing; dogs

RÉSUMÉ. Dans cet article, nous présentons les résultats de la première étude à grande échelle sur les comportements des loups en liberté de l'Extrême-Arctique en réponse à la présence humaine et nous discutons de ces comportements du point de vue de la conservation. L'étude portait sur les loups qui semblaient avoir peu, voire pas du tout, de contacts avec les humains et excluait les données en provenance d'endroits où les loups étaient devenus habitués aux gens. Les données consistaient en des observations indirectes de loups dans l'archipel Arctique canadien et au Groenland de 1819 à 2019. En tout, 325 observations de comportements ont été relevées, soit 163 au Groenland et 162 au Canada. Les comportements les plus courants à avoir été signalés (71,4%) concernaient des loups à la recherche d'humains, allant aux campements, suivant des attelages de chiens en déplacement, s'approchant d'une personne de près et suivant des gens. Ces comportements ne sont pas typiques des canidés en plus basses altitudes et ont la possibilité de créer des conflits avec les personnes susceptibles de se sentir menacées en raison de croyances de très longue date voulant que les loups soient dangereux. Certains loups arctiques ont été tirés en situation d'autodéfense perçue quand en réalité, ces bêtes étaient vraisemblablement seulement curieuses. Par ailleurs, les agressions visant les chiens domestiques représentaient la forme la plus courante d'interaction loup-chien et produisaient une autre source de conflit. Ces constatations revêtent de l'importance du point de vue de la conservation en raison de la petite population de loups et du fait que la disparition de la glace de mer accentue l'accès de l'humain à l'aire de répartition du loup arctique. Des techniques d'effarouchement adéquates employées de manière humaine et la sensibilisation des parties prenantes quant à ce qui constitue des comportements normaux pour le loup arctique peuvent avoir pour effet d'atténuer le risque de conflits et de favoriser la conservation des loups arctiques dans l'archipel Arctique canadien et au Groenland tout en minimisant le risque que le comportement naturel de cette sous-espèce soit modifié par l'activité humaine accrue.

Mots clés : loup arctique; comportement; conservation; Groenland; archipel arctique canadien; conflit; effarouchement; chiens

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¹ Greenland Wolf Research Program, PO Box 11, Calder, Saskatchewan S0A 0K0, Canada; ulf.petersen@live.com

INTRODUCTION

For centuries, sea ice has impeded ship access to large parts of the Arctic. But this formidable barrier to vessels is now quickly disappearing as the Earth's climate warms (Wang et al., 2018). By 2040, summers in the Arctic could be ice-free (Overland and Wang, 2013). This new reality will increase the number of people traveling to the region for resource exploration and extraction, tourism, shipping, military activities, and more (Meier et al., 2014; Wezeman, 2016; Runge et al., 2020). This influx will increase contact with wildlife and will inevitably affect the animals. Impacts are likely to vary by species, but wildlife traditionally considered a potential threat to humans, for example, polar bears (*Ursus maritimus*), could experience increased mortality, if they are shot at a higher rate in self-defense or because of public safety concerns (Dyck, 2006). Species with relatively small populations and low birth rates are of particular concern. One way of mitigating this risk is to develop a better understanding of the normal behavior of at-risk species and to communicate that information to stakeholders to provide an improved foundation for making informed decisions in the field during an encounter with one of these species.

What constitutes normal behavior, however, is not always well understood in the northernmost regions of the world because of a lack of published studies. In the case of the gray wolf (*Canis lupus*), the animal has been hated and feared by humans for centuries (Fritts et al., 2003). To this day, fear of wolves persists in many countries (Linnell et al., 2003; Treves et al., 2013). Conversely, wolves in lower latitudes fear people and avoid us (Zimen, 1987; Theuerkauf et al., 2003a; Carricondo-Sanchez et al., 2020). High Arctic wolves (*C. l. arctos*), however, have had less contact with people and respond differently to humans than most wolves elsewhere (Mech, 1988). Hunting and trapping of wolves in the High Arctic occur in some areas, but overall persecution is reduced relative to lower latitudes. In the farthest North, wolves are rare or absent over large areas, and conservation concerns have been raised due to an overall low population size with low birth rates (Miller, 1978, 1993; Marquard-Petersen, 2012, 2021). Those concerns are intensified by the fact that some Arctic wolves closely approach people (Parmelee, 1964; Pruitt, 1973; Miller, 1995). This behavior may have conservation implications because the gray wolf in general has a bad reputation, and some behaviors observed in Arctic wolves have therefore alarmed people unfamiliar with the animal. Disturbing behaviors include an Arctic wolf briskly approaching a person, which is interpreted as an attack (e.g., Koch, 1927), or an Arctic wolf following a person; interpreted as stalking (e.g., Rasmussen, 1921). Accordingly, some wolves have been shot in perceived self-defense (Gray, 1995; Marquard-Petersen, 2008) when perhaps they were merely curious. In recent years, several documentary films have been made about wolves on Ellesmere Island that could motivate more

southern-based people to travel there, which could increase the number of interactions. The Committee on the Status of Endangered Wildlife in Canada has listed the conservation status of this subspecies as “Data Deficient” (COSEWIC, 2021:65).

Little information has been available to evaluate the normalcy of such behaviors other than two studies on wolves at a weather station (Eureka) and at a military outpost (Alert) on the Canadian Arctic Archipelago. Those studies documented various aspects of the behavior of wolves in regular contact with people and showed that an important attractant involved the opportunity to feed at station garbage dumps with the possible additional attraction from feeding by station personnel (Grace, 1976; Gray, 1995). No range-wide analysis and synthesis have been completed of the behavior of wolves that have had little, if any, contact with humans. Thus, it has not been clear if behaviors that alarm people were aberrations exhibited by a few wolves at a small number of sites or were the norm for the subspecies across its range. However, what is clear from a conservation perspective is that the projected increase in human activity across the Arctic wolf range, combined with an age-old fear of wolves, will create a scenario that might result in more interactions where wolves are harmed. More wolves might get shot in the future because of a lack of understanding of what constitutes their normal behavior and because limited information is available to assist stakeholders in determining how to react in the field during an encounter.

This study sought to address that gap in knowledge by compiling a long-term record of reported behaviors in response to human presence across the Arctic wolf range on the Canadian Arctic Archipelago and in Greenland. The goal was to conduct a comprehensive analysis aimed at creating an overall behavioral profile of the most frequently reported behaviors. The results can help promote greater awareness among visitors to the Arctic wolf range of what constitutes normal behavior in these animals and can help reduce the potential for conflict by decreasing the likelihood that people who face an approaching Arctic wolf conclude that shooting it in perceived self-defense is their only option.

Based on the limited information available on the behavioral characteristics of wolves of this subspecies that have had little, if any, contact with people, I hypothesized that a large dataset collected from throughout the Canadian Arctic Archipelago and Greenland would provide evidence that the behaviors described in a few reports involving non-habituated wolves were not aberrations but were characteristic of the subspecies as a whole. I predicted that the data would provide quantitative evidence of a high proportion of behaviors that 1) have not been documented in wolves in lower latitudes on a range-wide scale, 2) are likely to cause an increased number of conflicts with humans as the High Arctic continues to become more accessible, and 3) will make Arctic wolves more likely to be destroyed by people who feel threatened by some of these behaviors.

TABLE 1. Behavioral categories and definitions used in this study.

Behavioral category	Definition
Came to camp	Wolves coming to cabins, tent camps, garbage dumps, permanent facilities, and ships regardless of whether people were present or temporarily absent.
Follow person(s)	Following someone who was walking, skiing, or traveling by snowmobile.
Approach person(s)	Walking or running towards a person(s).
Avoid person(s)	Staying at a distance, showing wariness, and failing to engage with person(s).
Withdraw	Retreating and fleeing. It was not always clear from the description if the animal ran away out of fear or if it pulled back in a more controlled manner, so I categorized both the actual act of fleeing and the act of retreating as withdraw.
Camp raiding	Entering campsites or depots whether people were present or temporarily absent. Gaining access to tents, chewing on items, destroying equipment and goods, or eating provisions.
Stealing	Removal or attempted removal of any item from a campsite or traveling party.
Aggression towards a human	Leaping directly at a person and making contact or attempting to bite a person or object, causing people to fear for their safety and to defend themselves.
Follow dog team	Walking behind a traveling dog team. I also used this term to describe instances where wolves approached a traveling dog team from other directions because the attraction was the important factor, not the approach direction.
Hostile contact with dogs	Fighting with dogs.
Friendly contact with dogs	Playing or mating with dogs.
Neutral contact with dogs	Interactions that were neither hostile nor friendly, for example, dog and wolf standing and looking at each other with no further interaction.

METHODS

Data collection from the Greenland wolf range was simplified because I had already compiled a database of incidental wolf sightings. That source contained 836 records dating back to 1869, of which 163 met the criteria for inclusion in this study; the sightings had details on wolf behaviors. No similar data source was available from the Canadian High Arctic, and it was necessary to create one. Accordingly, I consulted published and unpublished sources dating back to 1819 when British naval men were the first Europeans to make contact with wolves in the High Arctic. I continued the data collection by examining records produced through 2019. Because there were some relevant differences between Canada and Greenland that could impact the findings, my goal was to achieve an approximately equal sample size from both regions to avoid a potential geographical bias associated with a high number of samples from one region that might not be representative of normal wolf behavior in the other region.

Canadian data sources included my own field experience, 91 articles, books, or industry reports, 6 expedition reports, 20 diaries or notebooks, 36 military reports, 19 websites, and 2 newspaper articles. Some sources were available only in archives in foreign countries which I consulted as needed. I supplemented this effort through 15 outreach efforts to researchers. I was looking for the following information on each sighting: year, date, month, region (in Greenland), island or locality (in Canada), source,

number of wolves seen, and circumstances associated with each sighting to make possible a classification of the observed behaviors. I also generated behavioral data from descriptions of the reactions of wolves in response to the presence of domestic dogs (*Canis familiaris*), either as pets or in a transportation capacity as dog teams.

I accepted reporters' omission of some variables. For example, people often did not list an actual date of a sighting, but I accepted this exclusion of an otherwise useful identifier and incorporated the data point, because that variable was not of overall importance to my study. Having as much detail on each sighting, however, was desirable to help differentiate one sighting from another sighting made around the same time but reported by a second author and, thus, to avoid double counts.

Behavioral Categories

I identified 12 categories and coded behaviors accordingly (Table 1). The wording of each category was influenced by the need for concise labeling. I recorded up to three separate behaviors during a single contact. For example, if a wolf had reportedly entered a tent in an expedition camp and tried to escape with a bag of tobacco (Koch, 1925), I recorded the event as both came to camp and stealing. If a wolf on the other hand had engaged in a single behavior, for example, came to a camp before continuing its travels, I coded the event as came to camp only.



FIG. 1. Spatial distribution of 325 Arctic wolf observed behaviors, 1819–2019, superimposed on the current, probable distribution of *C. l. arctos* based on Nowak (1995) but updated for Greenland (red area). In North Greenland, the eastern distributional limit is uncertain due to scarce data, and it may extend farther than shown here. Data from Northeast Greenland were from two earlier wolf populations that flourished then disappeared during the 20th century (Marquard-Petersen, 2012, 2021).

Behaviors of Conservation Concern

The following behaviors have the potential to cause conflicts with humans and are therefore of conservation concern: 1) came to camp (because this behavior exposes wolves to the risk of being shot by people who misinterpret an approach for aggression), 2) hostile contact with dogs (because fights with tethered sled dogs can result in a wolf being shot as a problem animal; Marquard-Petersen, 2008), 3) camp raiding (due to the damage wolves tend to cause to tents and food stores when raiding a camp site; Roots, 1960; Adams, 2009), 4) approach person(s) (people may perceive themselves as under attack; Marquard-Petersen, 2008), 5) follow person(s) (which has been interpreted as stalking and caused people to fear for their safety), 6) follow dog team (because this behavior may result in fights with dogs over food scraps, territory, or dominance, which ultimately may end badly for the wolf; Miller, 1978; Marquard-Petersen, 2008, 2021), 7) stealing (because visitors to the Arctic wolf range generally will be unhappy if their personal belongings are lost), and 8) aggression towards human (because most people will try to defend themselves if they feel threatened by a wild wolf).

Data Exclusion

Wolves in a few areas of the High Arctic have had extensive contact with people and have become habituated to humans: at Eureka and Alert on Ellesmere Island (Grace, 1976; Gray, 1995; Mech, 1995; Anderson et al., 2016) and at Danmarkshavn, Northeast Greenland (Maagaard, 1988, 1994). I excluded all data from these locations except

sightings at Danmarkshavn that were likely to represent wolves that are new immigrants (Marquard-Petersen, 2011a), because my research focus involved the natural behavior of wolves in the High Arctic that have had little, if any, contact with people.

I limited data collection to the range of *C. l. arctos* as recognized by Nowak (1995); that is, the Canadian Arctic Archipelago from Banks and Victoria Islands in the south to the northern tip of Ellesmere Island and the narrow strip of ice-free land on the coast of North and Northeast Greenland (Fig. 1). To avoid inclusion of data that reflected the effects of repeated conditioning of wolves through multiple contacts with any one expedition, I counted the first contact only and excluded repeat sightings or those suspected of same. I also excluded the following reports: 1) when a pack had been frequenting a weather station for some time, receiving periodic exposure to humans, 2) when wolf behavior was manipulated, for example, when the animal was coaxed to come closer by a person offering food, 3) when the observer was vague about how close the wolf came, for example, using the term “close” without specifying an actual distance, and 4) sightings that did not describe wolf behavior. If an approach range was given, for example, to within 20–30 m, I accepted the more conservative value of 30 m.

I pooled samples from the two regions because my research focus was the subspecies at large, but where a large sample size (≥ 30) from both areas was achieved in a single behavioral category, I analyzed the data separately by region to look for evidence of geographical differences in behaviors. I was conscious of avoiding a possible, personal selection bias and accepted sightings that met my

criteria regardless of age, geographical location within the range specified, nationality or profession of reporter (for example, scientist versus lay person), or other factors if there was no reason to suspect a sighting reflected habituated or semi-habituated wolves. I assumed that the total dataset represented a random collection of all sightings made in the Arctic wolf range, and that these data could be used to create an overall behavioral profile of this animal in response to human presence. I used open source QGIS and the National Snow and Ice Data Center QGreenland package (Moon et al., 2021) to create the base map in Figure 1.

RESULTS

A total of 189 sources contained behavioral data that met my criteria. Internet searches aimed at gathering data from the Canadian Arctic Archipelago, using key words combined with a geographical location, were particularly effective at identifying obscure records, such as expedition blogs, environmental remediation reports, personal travel narratives, and websites that provided information on encounters with Arctic wolves and contained enough detail to warrant inclusion in the dataset. Diaries and notebooks from well-known expeditions were available in electronic format on the Internet and contained details on wolf behaviors not included in published accounts. Some older, published sources from the Canadian Arctic proved difficult to access except through archival services, and many diaries from Greenland had not been digitized but were available only through in-person visits to archives in Denmark and Norway (Table 2).

A total of 285 incidental sightings of wolves on the Canadian Arctic Archipelago and in Greenland (1819–2019) met my criteria for inclusion in the dataset. When each sighting was broken into distinct behavioral components, a total of 325 behaviors were observed during 94 separate years and reported from throughout the range of this subspecies (Fig. 1). Thirty-nine behaviors originated in the 19th century, 228 in the 20th century, and 58 in the 21st century. A total of 162 behaviors were observed in the Canadian Arctic wolf range; 163 were from Greenland.

Twelve behavioral categories were identifiable in the dataset (Fig. 2). The eight categories that had potential to create conflicts with humans constituted 82.5% of the sample. Coming to camp was the only category with a large sample size from both regions; it was the most frequently reported behavior in both the Canadian sample at 42.6% ($n = 69$) and the Greenland sample at 29.4% ($n = 48$). There were 49 instances of a wolf or wolves, following traveling dog teams; 14 in Canada and 35 in Greenland. In the latter region, there were 11 cases of single wolves following military patrols for up to a month.

A total of 30 reports involved a wolf approaching a person(s) to within 50 m; 15 in Canada and 15 in Greenland (Fig. 3). None of these approaches involved reported injuries to wolves or people, except in a single case where

TABLE 2. Locations and number of archival data sources.

Archive	Sources
Canada	
University of Manitoba Libraries, Archives and Special Collections	6
Canadian Museum of Nature, Archives and Library	2
Denmark	
Danish Military: Patruljetjenesten Nord- og Nordøstgrønland	4
Arctic Institute, Copenhagen	6
Private Collections	2
Norway	
Norwegian Polar Institute, Tromsø	10
USA	
Peary-MacMillan Arctic Museum, Brunswick, Maine	2
Total	32

a female wolf in Northeast Greenland was shot and killed by ecotourists who interpreted a close approach behavior to within 5 m as an attack.

Contact with domestic dogs was predominantly hostile (50.0% of 38 contacts) as opposed to friendly (31.6%) or neutral (18.4%). Mean wolf group size in hostile interactions was 3.7 wolves (SD 3.7), in friendly interactions it was 1.3 (SD 1.2) and in neutral interactions 1.1 SD 0.4).

There were two events that met my definition of aggression towards a human. The first took place on Ellesmere Island in 1977, when a wolf in a pack of six leapt at the head of a scientist, leaving saliva on her cheek (see Munthe and Hutchison, 1978). The second event took place on Victoria Island in July 2012 and was documented in a video which shows what appears to be an unprovoked attack by an Arctic wolf that approached a man standing next to his canoe on a riverbank (see Plante, 2012). The man is forced to defend himself with his paddle, as the animal repeatedly comes at him and the canoe in an aggressive manner. The man eventually flees in his canoe, but the wolf pursues him into the water, swimming after the canoe and biting the bow of the craft with enough force to puncture it, despite the man beating the animal over the head with his paddle.

DISCUSSION

This study provided the first large-scale, long-term account of the behavior of free-living, non-habituated wolves in the High Arctic in response to humans. The data supported the hypothesis that cases of non-habituated wolves seeking out humans are not aberrations involving a small number of wolves in a few locations but are characteristic of the subspecies across its range. The conservation value of this work lies in providing quantitative evidence that the top 82.5% of reported behaviors have the potential to create conflict and might result in wolves being shot when they approach people with little knowledge of their natural behavior. The work

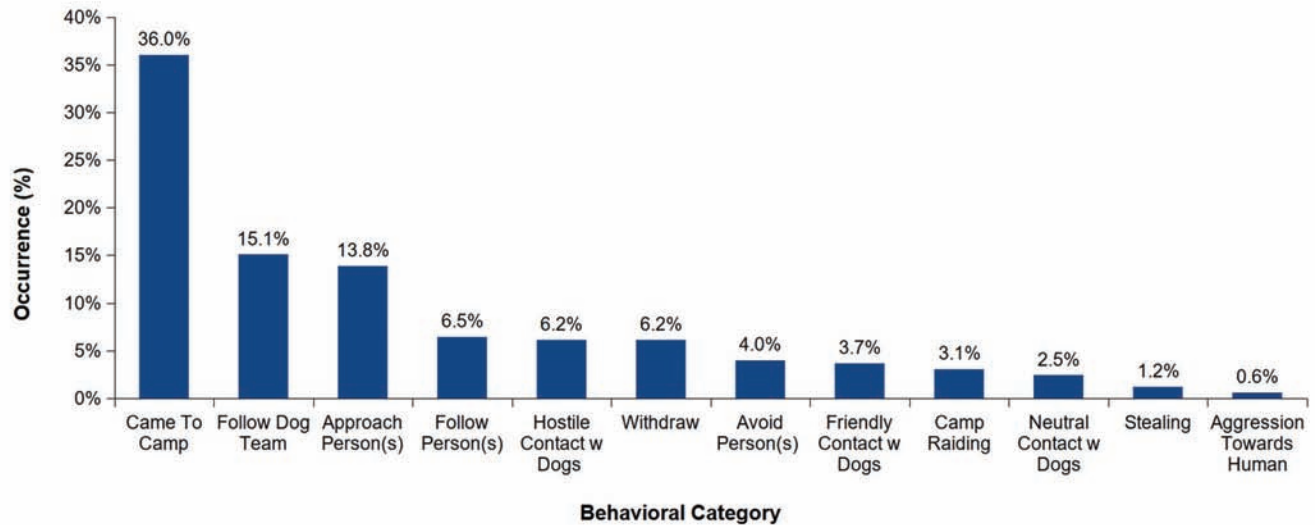


FIG. 2. Occurrence frequency of behavioral categories observed in Arctic wolves in Canada and Greenland in response to humans based on 325 behaviors, 1819–2019. Note that behavior meeting the study definition of aggression towards a human was reported but was exceedingly rare.

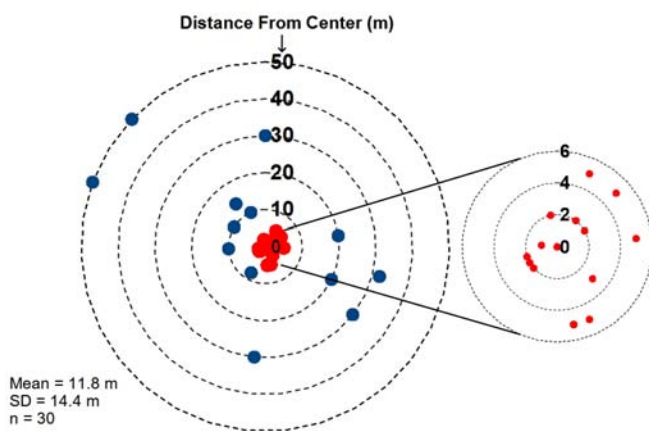


FIG. 3. Net chart of approach behavior of 30 Arctic wolves not known to be diseased or habituated to humans that individually came to within 50 m or less of a person or persons, 1851–2019. Each marker represents the stopping point of the animal; 1 person (or more) was standing in the center. Note that many (70%) of the wolves proceeded to within 10 m or less and some (13%) to within 0 m. The software plotted the data in chronological order, and the figure does not represent each wolf approach direction (an unknown).

also provides a long-term baseline for future evaluation of potential behavioral changes in response to the anticipated increased contact with humans. The high proportion of Arctic wolves seeking out humans contrasted with behaviors reported in lower latitudes, where wolves are persecuted and tend to minimize contact with people, for example, in Spain (Vilà et al., 1995), central Italy (Ciucci et al., 1997), eastern Poland (Theuerkauf et al., 2003b), northwestern Minnesota, USA (Chavez and Gese, 2006), western Alberta, Canada (Shepherd and Whittington, 2006), and in Scandinavia (Karlsson et al., 2007).

This study relied on historical data collected by non-scientists. The use of community gathered data is gaining wider acceptance, and this method has previously been used in research on this subspecies (e.g., Miller, 1993;

Miller and Reintjes, 1995; Marquard-Petersen, 2021). But that use should be undertaken with due regard for the risk of introducing possible bias in the data set. In this study, a principal potential bias involved accurate species identification, but that risk was minimized by excluding reports of wolf tracks and other reports that did not involve an actual sighting of an Arctic wolf.

There did not appear to be any comparable reports of free-living, non-habituated canids that exhibit similar, human-seeking behaviors on a large spatiotemporal scale. An absence of fear of humans has been reported in some wolves in Alaska and Canada, but habituation and food-conditioning were involved, or it was uncertain how much contact the animals had previously had with people, for example, because they inhabited national parks with a high number of visitors (see McNay, 2002). There were occasional, cursory reports that some canids elsewhere may approach humans, for example, golden jackals (*Canis aureus*) in Dalmatia, Croatia (Radović and Kovačić, 2010), but these animals live in proximity to humans. In the Arctic wolf, the wide variety of human-seeking behaviors across its range therefore appears to be unique among contemporary canids and likely represents the fact that wolves in many areas this far north have not been exploited.

Wolves coming to camp was the most frequently reported behavior in both Canada and Greenland, likely reflecting the lack of contact most wolves this far north have had with humans (Fig. 4). Seeking out people in this way increases the risk to wolves from potential harm inflicted by people who are alarmed by this behavior and react defensively by killing the animal, but that outcome was rare in this dataset. A typical scenario involved people being in camp when one or more wolves arrived, followed by one wolf approaching a tent to sniff and investigate, while other pack members stayed in the background, until the animals continued their travels. If people were asleep, a typical scenario involved



FIG. 4. One of the most distinguishing behavioral characteristics of wolves in the High Arctic involves seeking out people and their camps. Here a wolf in Greenland paid me a visit. Most Arctic wolves will not come this close, but some will. I concluded (based on body language) that this young animal (perfect teeth) was not a threat and allowed it to walk around freely, sniffing and investigating, while I stood back and kept an eye on the visitor. It departed on its own after having satisfied its curiosity.

more bold wolf behavior, including playing with hiking boots left outside or attempts at gaining access to food items or equipment (Fig. 4). This activity as a rule woke up tent occupants. Although this paper focuses on the behavior of the wolves, not the related attitudes of people, it is worth noting that coming to camp is the one Arctic wolf behavior most appreciated by some visitors who have experienced it (Grace, 1976; Ericson and Elander, 1984; Gray, 1995). It was not unusual in the descriptions of these events to see an expression of hope that it would happen again, once people had recovered from the initial shock of being approached so closely by a wild predator with a fearsome reputation and had realized what an extraordinary event they had witnessed. Visiting wolves occasionally caused damage to tents if an animal was given too much freedom to investigate what was inside, so people should be prepared to implement appropriate countermeasures, for example, let out a shout or physically advance towards the animal; see additional information about wolves and wolf encounters provided by the Government of Northwest Territories (GNWT, 2018).

Wolves that followed traveling dog teams were observed more frequently in Greenland than in Canada, likely because many Canadian Inuit travel using snowmobiles. In the Greenland wolf range, however, both Greenlanders and the Danish military, the latter responsible for sovereignty patrols, still travel extensively by dog team. Cases of wolves following dog teams may end badly for wolves in both Greenland and the Canadian High Arctic, and the behavior therefore has conservation implications. In Greenland, long-distance following behavior is typically exhibited by single wolves that quickly learn food scraps and dog scat (with incomplete processing of nutrients) are available for consumption. Once that learning process takes hold, deterrence becomes near impossible, according to Danish military personnel that I interviewed. Fights with dogs over food scraps, mating rights, or dominance tend to follow,

and when a wolf repeatedly causes injuries to tethered sled dogs, the episode usually ends with the wolf being shot (Marquard-Petersen, 2008, 2021).

Some Arctic wolves clearly are willing to closely approach humans, and they do so in a manner and to within a distance that many people initially will find alarming. Visitors who have experienced close approaches have stated that a wolf was threatening to attack or that it felt like “being stalked like prey” (Trépanier, 2020). Accordingly, some people have killed an Arctic wolf in perceived self-defense (Miller, 1978; Gray, 1995; Marquard-Petersen, 2008). Regrettably, there were also examples of wolves being coaxed to come closer by wildlife biologists who offered food to promote the interaction or to develop good relations during a research study (see Miller, 1978; Mech, 1988; Turner and Dennis, 1989). Intentional feeding of any canid is almost universally a bad idea, because the animal may 1) begin to associate humans with food, 2) become habituated to people, 3) lose its natural fear of people, 4) become aggressive, and 5) eventually may have to be shot (see review in Schmidt and Timm, 2007). In the Canadian High Arctic, intentional feeding of prescribed wildlife, including wolves, such as feeding by hand or throwing food, has been prohibited by law since at least 1995, and this prohibition has been communicated to visitors (Gray, 1995). No similar recognition of the problem has emerged in Greenland although a call to action was recently issued (Marquard-Petersen, 2021). In lower latitudes, habituated canids are a primary source of conflict, for example, dingoes (*C. l. dingo*; Burns and Howard, 2003), coyotes (*Canis latrans*; Bonnell and Breck, 2017), and red fox (*Vulpes vulpes*; Bridge and Harris, 2020).

While it is clear from the data that approach behavior in this subspecies is almost never a sign of aggression, it is important to recognize the reality that it could be, as demonstrated by the case of the Arctic wolf that attacked a man and his canoe on Victoria Island. The behavior documented on the video was unusual and extreme for Arctic wolves and was consistent with rabies (see Rausch, 1958; McNay, 2002), particularly as the animal could not be deterred through defensive action by the canoeist but kept attacking repeatedly and even pursued him into the water. Rabies has also been found in a wolf at Canadian Forces Station Alert on northern Ellesmere Island that was involved in unprovoked attacks on base personnel (Gray, 1995). Accordingly, good field practice during approach behavior by an unfamiliar wolf is to closely observe the animal to look for signs that it might be diseased or is exhibiting especially erratic or unusual behavior, such as the animal standing its ground or being aggressive (Rausch, 1958). Visitors to the High Arctic are far more likely, however, to contract rabies from an Arctic fox (*Vulpes lagopus*)—considered the main reservoir for the virus (Hueffer and Murphy, 2018)—than from wolves that are believed to die relatively quickly once infected (Chapman, 1978; Weiler et al., 1995).

Hostile contact with dogs was the predominant type of wolf-dog interactions and took on a variety of forms: 1) wolves preying on domestic dogs (Miller, 1978), 2) dogs chasing wolves away from an area (Miller, 1978) and, possibly the most intriguing 3) wolves appearing to attempt to entice dogs away from human protection to kill them (Devold, 1940; Pedersen, 1963; Miller, 1978). Packs of 2 or more wolves were more engaged in hostile contact than singletons, suggesting the involvement of a territorial defense element. This category included wolf behavior indicative of strategic thinking, such as a wolf retreating in front of a pursuing dog or dogs to a place where the rest of the pack was lying in ambush and would attack as one (Miller, 1978). Or wolves giving the impression they were retreating, until the fastest dog pursuing them was ahead of other dogs, alone and vulnerable, then the wolves swung around and attacked the dog (Friis, 1925). In lower latitudes, hostile interactions have also been reported; conflicts are not always rooted in territorial disputes because some wolves in both the Arctic and elsewhere clearly perceive dogs as prey (Manniche, 1910; Fritts and Paul, 1989; Kojola et al., 2004). Therefore, anyone bringing a dog into the Arctic wolf range, for example, as a bear alarm, should be aware that the dog will be at risk of wolf attack. But the wolf-dog relationship is complex as is evident in the data presented here, involving both friendly and neutral contact with dogs. Similar complexity was reported in lower latitudes (Lescureux and Linnell, 2014).

Camp raiding and stealing were low-frequency events but large-impact problem behaviors and could take on greater importance if their frequency increases with greater human activity. An otherwise favorable perception of the animal is adversely affected if people return to their campsite after a temporary absence and discover it has been destroyed by wolves. Food stored in tents was a frequent cause of such raids, but on an expedition to the High Arctic, people rarely have viable food storage alternatives. There are no trees into which provisions can be hoisted for protection from wildlife and few facilities for storage capable of keeping animals out. Losing vital food stores in a region where there is little, if any, opportunity to re-supply can have expedition-ending consequences. One useful strategy is to avoid leaving a camp unattended and to limit the risk of stealing behavior by not keeping items lying on the ground. Another is to act in a discouraging manner if a wolf visits and shows an obvious interest in an item. Fladry lines and electrical fences are other possible deterrence options. Pack mates steal food from each other (Mech, 1999), so when an Arctic wolf steals an item from a human visitor (Fig. 5), it may be a reflection of what is a normal and accepted practice among conspecifics.

A high proportion of the observed behaviors could potentially cause conflicts with humans, highlighting the possibility that wolves could be destroyed by people who feel threatened by some of these behaviors. This outcome takes on increased importance due to the small population size. Unfortunately, there are no reliable estimates of Arctic



FIG. 5. Any object can become a target of Arctic wolf stealing behavior but there are response options. Here, a wolf in Greenland carries off my hat dropped in the few seconds I had to get ready (camera) to receive a pack of six wolves running towards me. A foot chase and some yelling recovered the hat without resistance by the animal, which appeared to accept the owner was reclaiming his property.

wolf numbers in Canada. In the mid-1990s, about 200 were believed to inhabit the Queen Elizabeth Islands in the northernmost part of the range, but much uncertainty exists about population size on the southern islands (Miller, 1995). In Greenland, the population crashed at the end of the 20th century and has not recovered (Marquard-Petersen, 2021). Based on the number of known, core distributional areas in North Greenland, I consider it unlikely that more than 30–40 wolves currently inhabit Greenland during most years; in unfavorable years, the population may be less than half that number.

Because of the small metapopulation size, the use of deadly force to stop an approaching wolf can have important conservation consequences. The impact of a killing is exacerbated because much of the Arctic wolf range consists of polar desert or semidesert—wolf habitat so depauperate that it can support only a few wolves (Miller, 1995; Marquard-Petersen, 2011b). These animals live as singletons or in pairs across vast areas (Riewe, 1975; Miller and Reintjes, 1995; Marquard-Petersen, 2009). Thus, one bullet can eliminate the only wolf in an area and might also end the possibility of reproduction where a mated pair is active, if one wolf is killed by people who misinterpret close-approach behavior for aggression. Unlike in lower latitudes, immigration cannot be expected to quickly make up for a loss because of extraordinarily low wolf densities (Riewe, 1975; Miller, 1993; Marquard-Petersen, 2009).

The high frequency of behaviors in this study that brings Arctic wolves into direct contact with people was evidence that anyone traveling into their range could be confronted by these behaviors when encountering wolves. Expecting these encounters and planning appropriate countermeasures are important in ensuring peaceful coexistence with this animal. As the case of Munthe and Hutchinson (1978) demonstrated, there will be occasional incidents where

people may feel a need to fend off particularly disturbing approaches. Means of non-lethal deterrence have been limited, but recent efforts during environmental restoration on Prince Patrick Island in the western Canadian Arctic Archipelago in 2019 have reportedly been successful. Wolves there visited several work sites but, according to the contractor, were effectively deterred from the work zones through the use of hazing techniques involving screamers, bear bangers, rubber bullets, pellets, and bean bags (Golder Associates Ltd., 2019). To my knowledge, those claims have not been independently verified, and the implications of using those deterrence methods on Arctic wolves, especially rubber bullets, have not been studied. The concept of humane hazing is a recent perspective, however, and the use of projectiles is not universally accepted as qualifying for that category because of the risk of injuring the animal (Sampson and Van Patter, 2020). Nonetheless, people traveling into the Arctic wolf range on expeditions or for work might want to consider looking into whether non-lethal deterrence devices would be practicable in their situation, especially because the Arctic wolf range is also polar bear country, and effective deterrence methods therefore should be carried in the field anyway. Pyrotechnics, such as screamers and bear bangers, are generally banned from commercial flights, and the logistics of arranging for such devices to be available are therefore complex. Pepper spray has, to my knowledge, not been tested on Arctic wolves but would likely deter a wolf from coming uncomfortably close, although the method is subject to the same transportation difficulties as pyrotechnics

and, in addition, performs poorly at low temperatures and suffers from limitations in effectiveness associated with wind direction as there is also a risk of blowback onto the operator (see Ross et al., n.d. with reference to pepper spray use against polar bears).

Although the methods of this study were backward-looking, the aim was future-oriented. On that premise, educational outreach to stakeholders (tourists, government workers, and industry personnel) and engagement with Inuit and other northern residents on what constitutes normal Arctic wolf behavior and deterrence options could mitigate risks of conflicts and likely save the lives of several wolves in coming decades while decreasing concerns of visitors who encounter this rare animal in its natural environment. Education, tolerance by visitors of Arctic wolf behaviors, and restraint in the use of hazing techniques could also help preserve the natural behavior of these animals as our gift to future generations of humans, many of whom undoubtedly would be excited to know they have a possibility of experiencing a visit similar to that shown in Figure 4.

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