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Novel range overlap of three ursids in the Canadian subarctic

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Abstract: We describe for the first time in the peer-reviewed literature observations of American black bear (*Ursus americanus* Pallas, 1780), grizzly bear (*Ursus arctos* Linnaeus, 1758), and polar bear (*Ursus maritimus* Phipps, 1774) at the same locations. Using remote cameras we documented 401 bear-visits of all three species at three camps in Wapusk National Park, Canada, from 2011–2017. These observations add to a growing body of evidence that grizzlies are undergoing a substantial range increase in northern Canada and the timing of our observations suggests denning locally. Polar and grizzly bears are of conservation concern regionally and internationally, so from the literature we assessed the potential effects on conservation efforts from interactions between these three species. In aggregate, those effects are likely to be positive for grizzlies and weakly negative for black and polar bears; further research is needed. Range overlap of these three species in this dynamic ecotonal region should not be viewed as a threat to any of them, but rather as an ecological response to environmental change that needs to be better understood.

Key words: Ursus americanus, *Ursus arctos*, *Ursus maritimus*, Wapusk National Park.

Résumé : Pour la première fois dans la littérature évaluée par les pairs, nous décrivons des observations portant sur l'ours noir (*Ursus americanus* Pallas, 1780), le grizzly (*Ursus arctos* Linnaeus, 1758) et l'ours polaire (*Ursus maritimus* Phipps, 1774) aux mêmes emplacements. Nous avons, à l'aide d'appareils photographiques à déclenchement par télécommande, documenté 401 visites d'ours des trois espèces à trois camps dans le parc national Wapusk au Canada de 2011–2017. Ces observations enrichissent un ensemble croissant de preuves que les grizzlys subissent une augmentation importante de leur aire de distribution géographique dans le nord du Canada et la concordance de nos observations suggère que la mise bas se fait localement. La conservation des ours polaires et des grizzlys est une préoccupation sur le plan régional et international, par conséquent, en nous appuyant sur la documentation, nous avons évalué les effets potentiels que les interactions entre ces trois espèces peuvent avoir sur les efforts de conservation. Dans l'ensemble, ces effets seront probablement positifs pour les grizzlys et faiblement négatifs pour les ours polaires et noirs;

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d'autres recherches s'imposent. Le chevauchement des aires de distribution de ces trois espèces dans cette région dynamique en transition ne devrait pas être perçu comme une menace à aucune d'entre elles, mais comme une réponse écologique au changement environnemental qu'il est nécessaire de mieux comprendre. [Traduit par la Rédaction]

Mots-clés : Ursus americanus, *Ursus arctos*, *Ursus maritimus*, Parc national Wapusk.

Introduction

This paper describes, for the first time, observations of North America's three ursid species — American black bears (*Ursus americanus* Pallas, 1780), grizzly bears (*Ursus arctos* Linnaeus, 1758), and polar bears (*Ursus maritimus* Phipps, 1774) — co-occurring in the same locations. These observations were made during an ongoing study focusing on polar bear–human interactions in Wapusk National Park, MB, Canada. We present them here because of their novelty and implications for species conservation in the park and surrounding region and also because they are consistent with expected ecological responses to the amplified impacts of climate change on high-latitude ecosystems (Humphries et al. 2004).

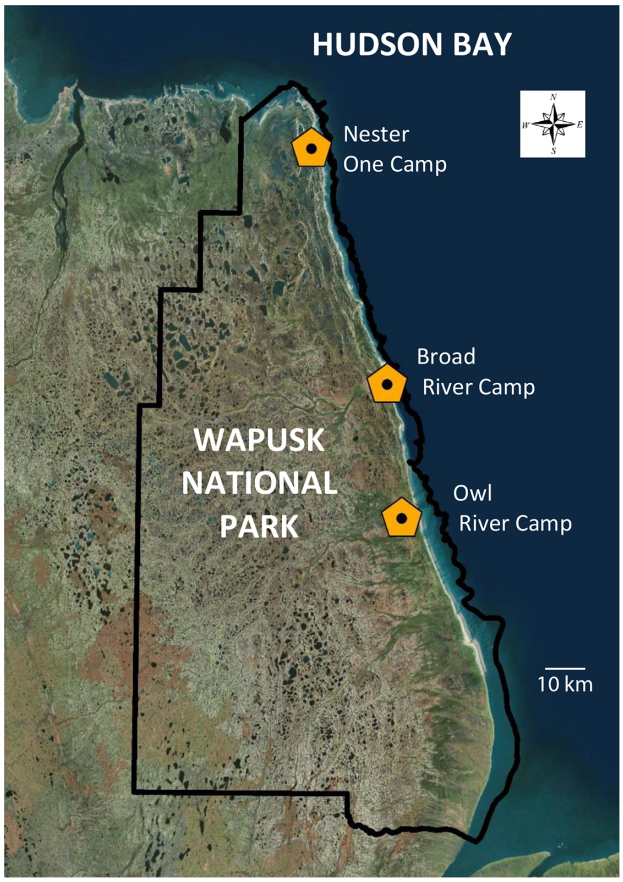
The subarctic is experiencing rapid climate warming with accelerating biophysical, ecological, and social impacts (Callaghan et al. 2010). Responses to climate change by ursids may include changes in distribution, with the potential to result in overlap in habitat use among species and an increase in interspecific interactions (Laidre et al. 2008; Miller et al. 2015). It has been long-postulated that these three species co-occur in the Mackenzie Delta, NT, but not in our study area (Banfield 1977). Black bears are at or near the northern edge of their range in Wapusk, in what Scheick and McCown (2014) consider secondary habitat (defined as lower quality habitat with no or only isolated breeding). Wapusk is at the southeastern edge of an apparent recent range expansion by grizzly bears in the Canadian Arctic and subarctic since the 1990s (Clark 2000; Doupé et al. 2007; Rockwell et al. 2008; Clark and Slocombe 2011; COSEWIC 2012), which may not have been the Arctic's first (Harington et al. 1962) but appears novel for Manitoba. The source population for grizzlies in Wapusk is not known but is likely to have been from established populations in Nunavut as there are no known grizzly populations to the south or west (Clark 2000). A large, but varying, proportion of polar bears from the Western Hudson Bay subpopulation spend summer and autumn (typically July–November) ashore in Wapusk due to complete annual melting of the sea ice (Stirling et al. 1977, 2004). On shore those bears segregate by age and sex classes, with most bears remaining on the coast and pregnant females traveling inland to a maternity denning area where they will overwinter and give birth (Clark et al. 1997; Clark and Stirling 1998). The conservation status of these three species varies. Internationally, both polar and grizzly bears are listed under Appendix II of the *Convention on the International Trade in Endangered Species*. Black bears are not considered at-risk anywhere in Canada. Grizzlies are considered a Species of Special Concern in Canada (COSEWIC 2012) and remain listed as extirpated under the province's *Endangered Species and Ecosystems Act* as there is no evidence of an established breeding population (W. Watkins, personal communication, 2016). Polar bears are also provincially listed as threatened and are highly vulnerable to a warming Arctic climate, although the Western Hudson Bay subpopulation is considered temporarily stable (Lunn et al. 2016).

Materials and methods

Study area

Wapusk National Park is situated along the western coast of Hudson Bay (Fig. 1) and is located within the Hudson Bay Lowlands, encompassing a transition from boreal forest to Arctic tundra ecosystems (Brook and Kenkel 2002). We collected data at three remote field

Fig. 1. Map of the Greater Wapusk Ecosystem with base map derived from LANDSAT imagery (Map data: Google, DigitalGlobe, 2018) showing camp locations and the Wapusk National Park boundary.

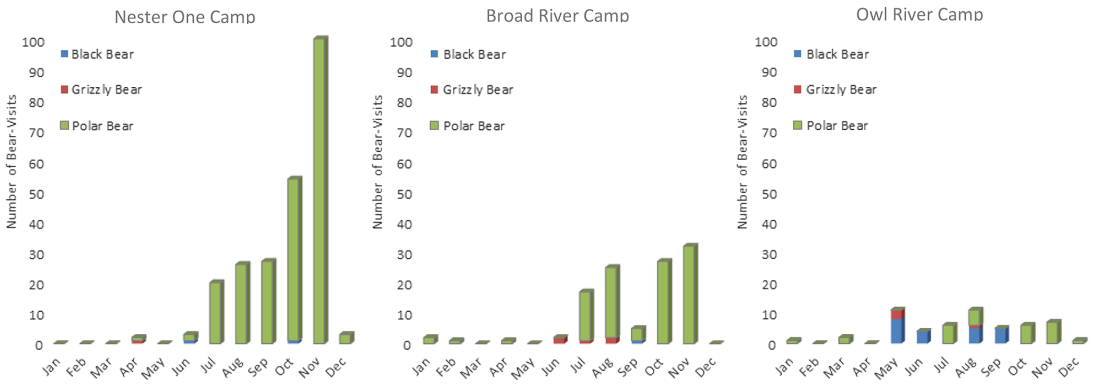


camps in the park, located at varying distances from the coast (Nester One = 2.3 km, Broad River = 4 km, Owl River = 6 km). Nester One is located on open tundra, whereas the Broad and Owl River camps are located on riverbanks at the interface between tundra and forest–tundra (Brook and Kenkel 2002). These camps all have hard-sided buildings surrounded by permanent 3 m high pagewire fences with rectangular perimeters approximately 22 m × 57 m. Access is by aircraft or snow machine only and the camps are largely used in winter, spring, and early summer by park staff, researchers, and university field courses. Potential bear attractants are tightly controlled and camp users' garbage is typically removed or burned on-site.

Remote camera layout and data collection

We deployed an average of five Reconyx PC-900 remote cameras at each of three remote field camps from July 2011 to April 2017 at Nester One and Broad River, and July 2012 to April 2017 at Owl River (Laforge et al. 2017). These cameras are motion-triggered and operated year-round, whether people were in the camps or not. Memory cards and batteries were replaced and images collected annually. Cameras were protected by a Reconyx Heavy-Duty Security Enclosure, fastened with tamper-proof bolts (to avoid tooth damage to curious bears from padlock hasps), and attached 85 cm above ground to the camps' fence

Fig. 2. Bear visits by month shown by camp.



posts using lag bolts, facing outwards in each cardinal direction. Cameras were left on factory default settings with a 46° field of view and 30 m nominal detection range. At each activation the cameras recorded three images one second apart, followed by a 10 s delay. All cameras had an infrared flash to avoid affecting the behaviour of animals photographed at night (Gibeau and McTavish 2009). No bait or supplemental lighting was used. As it is not always possible to visually differentiate individual bears we count bear-visits: defined as unique observations (often on >1 camera) of distinguishable individual bears or family groups (a female with dependent young) within a 1 h period. We then identified the species and summarized data by species, month, and camp. Species identifications were made from images with sufficient quality to see the anatomical features that distinguish grizzly bears from black bears (Herrero 2018).

Compliance with ethical standards

This research was authorized by Parks Canada research permits WAP-2011-8336, WAP-2012-11956, WAP-2013-13933, and WAP-2017-25782; and by the University of Saskatchewan Animal Research Ethics Board, protocol number 20110076.

Results

We recorded a total of 401 bear-visits at all camps up to the latest complete month of data retrieval for all camps, April 2017: 25 by black bears (6.2%), 10 by grizzlies (2.5%), and 366 by polar bears (91.3%) (Figs. 2, 3, Supplementary Table).[1]

Black bears

88% of black bear visits took place at the Owl River camp ($n = 22$), and were almost as numerous as polar bear visits there ($n = 28$). Across all camps black bears were detected most commonly in May–June and August–September: generally the months when polar bears were on shore but least-commonly observed on camera (Fig. 2). We observed both black and cinnamon colour phases of black bear at Owl River, as well as an intermediate blonde-highlighted black bear. Many of these observations involved bears circling the camp or exhibiting similar exploratory behaviours. None had dependent young but photos show a sequence we interpret as black- and cinnamon-phase black bears mating on 23 June 2013 (Supplemental Figures).[1] This latter determination was based on the close but apparently

[1]Supplementary data are available with the article through the journal Web site at http://nrcresearchpress.com/doi/suppl/10.1139/as-2018-0013.

Fig. 3. (A) polar bear, (B) black-phase American black bear, (C) grizzly bear, and (D) cinnamon-phase American black bear at Owl River camp, Wapusk National Park.

non-aggressive interaction between those two individuals and the known timing of the black bear mating season (Tsubota et al. 1997).

Grizzly bears

Six of 10 grizzly bear observations (60%) occurred in spring: all involved single bears and they generally travelled past the camps without stopping to investigate them further. Springtime grizzly observations at Owl River were highly synchronous: 21 May in both 2014 and 2015, and 22 May in 2016. The 2014 and 2015 images all appear to be of a mature male (broad head, high body mass to leg length ratio, absence of vulva hairs) traveling east towards the coast and so may be of the same bear (Supplemental Material).[1] A grizzly bear was observed at Owl River on 22 May in 2016 but the entire bear wasn't visible, so although the timing is suggestive of the same individual as in previous years, that cannot be determined with certainty. The 2016 observations at Broad River between 15 June and 1 August and at Owl River 9 August are of smaller-framed animals than the one in earlier observations, and may be the same individual because those camps are only approximately 30 km apart, well within known movement parameters in similar habitat (McLoughlin et al. 1999).

Polar bears

Polar bears were the most common bear species at all three camps. Occasional visits occurred in winter as most polar bears are actively foraging on sea ice at this time, and bears were increasingly observed in early summer as melting sea ice forced them ashore

each year (Fig. 2). In late autumn visits became markedly more frequent, especially at Nester One. Adult males dominated at Nester One, whereas at Broad and Owl River visits by females with young were frequent in summer and late autumn, as these family groups travel to and from the inland denning area (Laforge et al. 2017). Visits varied widely in duration and apparent intent, with some bears simply passing by and others circling the camp and evidently investigating it (Laforge et al. 2017). Twice, we observed female polar bears with cubs-of-the-year at Owl River (27 March 2013, and 14 March 2017), apparently recently emerged from a maternity den and moving towards the sea ice (Ramsay and Andriashek 1986).

Discussion

These observations represent the first time in peer-reviewed literature that all three North American bear species have been documented in precisely the same locations, although not at the same time. Wapusk National Park has long been known as important seasonal polar bear habitat so it is unsurprising they were commonly observed all three camps, or that their observed camp visitation pattern is consistent with previous studies of their terrestrial distribution on the west coast of Hudson Bay (Stirling et al. 1977; Latour 1981; Derocher and Stirling 1990; Clark and Stirling 1998; Towns et al. 2010). However the distribution and ecology of the other two species in Wapusk — particularly grizzlies — are far less well understood. Although these species appeared to differ in their behavioural responses to the camps, they are unlikely to have been sampled at different intensities as our cameras were fixed and had a constant detection radius (Laforge et al. 2017). However, we do not know how bears may have behaved towards the camps outside that detection radius.

Our observations demonstrate occupancy over multiple years by >1 bear, but do not extend the geographic range of grizzly bear observations in Wapusk (Rockwell et al. 2008). Subadult grizzlies disperse widely in tundra habitat (Gau et al. 2004) so the observation of at least one mature bear signifies that some bears observed may be resident rather than transient. Edwards et al. (2009) observed that space use by Arctic grizzlies varied annually, so in that context the spring observations across years at Owl River suggests that this area is ecologically significant. Denning is a possibility, as that delta contains the largest exposed alluvial deposits in the park (Dredge and Nixon 1992), a substrate which is the preferred denning habitat for Arctic grizzlies (McLoughlin et al. 2002). Evans et al. (2016) found that timing of den emergence in European brown bears varies among individuals but is driven by physiological mechanisms rather than environmental cues. If so, the synchrony of these observations could be explained by recent emergence of the same individual and, by inference, correspondingly lower likelihood that it denned farther away. The dates of these observations are more than three weeks later than emergence dates documented farther north in tundra habitat (McLoughlin et al. 2002), so denning habitat may be at best only a partial explanation of why grizzlies are present there. However, the delta is distant from concentrated terrestrial food sources such as snow goose (*Chen caerulescens*) colonies (Iles et al. 2013) and forage plants are sparse at that time of year. Alternatively, that bear may simply have been traveling through, possibly towards the still-frozen bay for either feeding or mating opportunities (Taylor 1995; Pongracz et al. 2017). Better understanding of grizzly bear ecology in this region should be a high scientific and conservation priority.

Taken together, these observations demonstrate clear potential for interactions to occur between these three species, raising questions about how interspecific interactions might affect conservation efforts for them in the region. We examined literature on interactions between these three species to assess what implications, if any, such interspecific

Table 1. Potential effects on species conservation efforts from interspecific interactions in our study area: positive (+), negative (−), or neutral (0). Also denoted are species not involved (n/i).

Type of interaction, species involved, and citations	black bear	grizzly bear	polar bear
spatial and temporal niche partitioning by grizzly and black bears, grizzlies dominant (Aune 1994; MacHutchon et al. 1998; Schwartz et al. 2010)	−	+	n/i
competitive exclusion of female and subadult grizzly bears from habitat dominated by black bears (Mattson et al. 2005)	+	−	n/i
predation by grizzlies on black bears (Mattson et al. 1992)	−	+	n/i
predation by grizzlies on polar bears (Taylor 1995)	n/i	+	−
competition between grizzly and polar bears for terrestrial food sources, grizzlies dominant (Miller et al. 2015)	n/i	+	−
non-aggressive sharing of terrestrial food sources by polar and black bears (Lemelin et al. 2010)	0	n/i	0
polar bear–grizzly bear hybridization (Pongracz et al. 2017)	n/i	0	0

interactions may have for their conservation (Table 1). To be clear, we did not observe any such interactions but discuss them here because of their potential significance for conservation and management. Interactions between each species have been documented across multiple ecosystems elsewhere, but these may not represent the full range of ecological possibilities in Wapusk.

Under current ecological conditions, the most benefits from these specific interactions would likeliest accrue to grizzlies, with neutral to negative outcomes for polar and black bears (Table 1). Some potential interactions clearly warrant further investigation. As interspecific avoidance between any of these three species cannot be quantitatively demonstrated from our present data, we recommend research into this phenomenon in Wapusk, testing hypotheses formulated from the overview in Table 1. Specific foci for such research include competitive exclusion of female or subadult grizzly bears by male black bears (Mattson et al. 2005), which may functionally limit how far south breeding populations of grizzly bears will establish in the Hudson Bay Lowlands. Conversely, grizzlies could functionally block any northward range expansion by black bears there too, and the geographic overlap of these species is likely to continue changing spatially and temporally. Black bears appear most commonly at Owl River in the months of the on-shore season when polar bears visit least, suggesting the possibility of avoidance (Fig. 1). Such behaviour could go either way, though, or even be mutual given the predominance of female polar bears with cubs who would likely avoid situations where cub predation might be a risk. Hybridization between polar and grizzly bears is possible in and offshore from Wapusk National Park due to the range overlap there. Very little is known about the ecology or behaviour of such hybrid individuals (Pongracz et al. 2017) so close study of any hybrid individuals' ecology would be important. Consequently, we recommend that range overlap of these three ursid species in Wapusk National Park not be viewed as a threat to any of them, but rather as an ecological response to environmental change that needs to be further examined through a holistic, dynamic, and non-equilibrium ecological perspective.

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