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Source: *Ursus*, 2022(33e4) : 1-8

Published By: International Association for Bear Research and Management

URL: <https://doi.org/10.2192/URSUS-D-20-00024.1>

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## First evidence of a brown bear on Wrangel Island, Russia

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**Abstract:** We report the first photographic and genetic evidence of a brown bear (*Ursus arctos*) on Wrangel Island, Russia, located north of 71° in the Arctic Ocean. The sequenced control region (D-loop) of mitochondrial DNA obtained from hair of a sighted bear was indistinguishable from one of the most widespread haplotypes of the Eurasian brown bear. Molecular genetic analysis indicated that the bear was male. We photographed what may have been a second brown bear on a remote camera trap. It is unknown whether the bear(s) were transients or indicative of a range expansion associated with warming temperatures. Wrangel Island currently supports muskoxen (*Ovibos moschatus*), reindeer (*Rangifer tarandus*), and several top predators including a high density of polar bears (*Ursus maritimus*) during the summer and autumn. Thus, the presence of brown bears could lead to novel interspecies interactions with potentially cascading ecological effects.

**Аннотация:** Мы сообщаем о первой достоверной встрече бурого медведя (*Ursus arctos*) на острове Врангеля, Россия, расположенном севернее 71° СШ в Северном Ледовитом океане, что подтверждают фотоматериалы и результаты генетического анализа. Последовательность контрольного региона (D-петля) мт-ДНК, полученная из образцов шерсти наблюдаемого медведя, неотличима от одного из самых распространённых гаплотипов бурого медведя Евразии. Результаты молекулярно-генетического анализа подтверждают, что наблюдаемая особь – самец. Также при помощи фотоловушки получены снимки бурого медведя - вероятно, другой особи. Неизвестно, являются ли отмеченные заходы следствием расширения ареала в связи с потеплением климата. Остров Врангеля населяют овцебык (*Ovibos moschatus*), северный олень (*Rangifer tarandus*)

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и несколько высших хищников, включая белых медведей (*Ursus maritimus*) с высокой плотностью популяции в летне-осенний период. Таким образом, присутствие бурого медведя на острове может привести к новым межвидовым взаимодействиям с потенциальными многоуровневыми экологическими последствиями.

**Key words:** Arctic, brown bear, Chukotka, climate change, molecular genetic analysis, polar bear, range expansion, *Ursus arctos*, *Ursus maritimus*

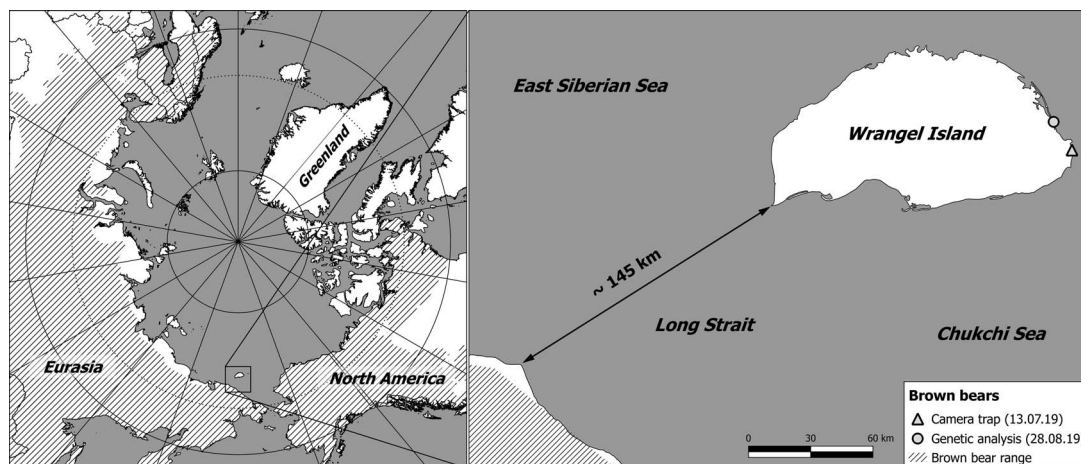
DOI: 10.2192/URSUS-D-20-00024.1

*Ursus* 33:article e4 (2022)

Brown bears (*Ursus arctos*) are the most widely distributed ursid, ranging throughout North America, Europe, and Asia (McLellan et al. 2017). In Russia, they inhabit multiple types of forest, the tundra–forest transition zone, and tundra in the northern part of the Far East, except for Arctic offshore islands (Geptner et al. 1967). On the Chukotka Peninsula, brown bear densities are low in lowland tundra regions because of limited biological productivity. The species is most common in mountain river valleys with thickets of willow (*Salix* spp.) and alder (*Alnus* spp.), preferring river drainages and slopes during the summer and autumn (Chernyavskiy et al. 1993, Chernyavskiy and Krechmar 2001).

Wrangel Island is located approximately 145 km north of mainland Chukotka, where the East Siberian and Chukchi seas meet (Fig. 1). The island is outside the traditional range of brown bears (McLellan et al. 2017). To our knowledge, there are no reports of brown bears on Wrangel from researchers or early explorers (Gorodkov et al. 1987, Stishov 2004, Gruzdev et al. 2014). In this article, we present the first photographic and genetic evidence that ≥1 brown bear was on Wrangel Island in summer 2019.

The Arctic has warmed twice as fast as the rest of the world in recent decades (AMAP 2017, IPCC 2019). This has led to widespread physical and ecological changes in terrestrial and marine habitats (Post et al. 2019) affecting the phenology, distribution, composition, and dynamics of Arctic species and communities (Root et al. 2003, Lovejoy and Hannah 2005, Nielsen et al. 2013, Tedesco et al. 2019, Bjørkman et al. 2020). Since the 1990s, an increasing number of brown bears have been observed north of their traditional range, although most



**Fig. 1.** Wrangel Island is situated north of Chukotka, Russia, outside of the typical range of brown bears (*Ursus arctos*; left panel). Confirmed (circle) and apparent (triangle) observations of brown bears occurred on the eastern coast of Wrangel Island in 2019 (right panel).

observations have been in the Canadian Arctic Archipelago where interisland distances are relatively short (Struzik 2003, Doupé et al. 2007, Olohaktomiut HTC 2013, Pongracz et al. 2017). It is currently unknown whether our first-ever observations of brown bear(s) on Wrangel Island represent transient animals or are indicative of a range expansion associated with changes in habitat and food availability.

## Study area

The entire 794,520-ha area of Wrangel Island is a ‘zapovednik’ (i.e., state nature reserve) with the highest level of environmental protection in the Russian Federation (Fig. 1). The island is characterized by mountainous terrain in the interior with tundra lowlands and numerous lakes, marshes, and meandering river valleys in the south and the north. Mountains up to 1,096 m in elevation cover about 70% of the land area and support a wide range of biotopes (Gruzdev et al. 2014). Weather and climate vary across the island, with polar conditions along the coast and milder, semicontinental conditions in the central area (Svatkov 1970).

Wrangel Island lies in the Arctic tundra subzone. In the central part of the island vegetation is characteristic of northern tundra, whereas the cool and foggy north-eastern and southwestern coasts exhibit southern variants of the polar desert zone (Kholod 2013). Rush, grass, and cryptogam tundra dominate in the north; graminoid, prostrate dwarf shrub, forb, and herb tundra in the central

and southern parts; and carbonate mountain complexes at higher altitudes (Walker et al. 2005).

Biodiversity on Wrangel Island is high for an Arctic island (Gorodkov et al. 1987, Pulyaev 1988). There are 382 species and subspecies of vascular plants (Gruzdev et al. 2019). Sixty-two species of birds are known to breed on the island, among which 18 are common (Stishov 2004). The terrestrial mammalian fauna consists of 8 species, 4 of which are long-time residents: brown (*Lemmus sibiricus portenkoi*) and collared (*Dicrostonyx vinogradovi*) lemmings, arctic foxes (*Vulpes lagopus*), and polar bears (*Ursus maritimus*). Red foxes (*Vulpes vulpes*) have been observed occasionally. Reindeer (*Rangifer tarandus*) were introduced to the island around 1950 (Gruzdev and Sipko 2007b) and muskox (*Ovibos moschatus*) were introduced in 1975 (Gruzdev and Sipko 2007a).

Following the establishment of ungulates, the island was colonized by wolverines (*Gulo gulo*) and wolves (*Canis lupus*; Stishov 2004). These species moved onto the island over sea ice in 1970s but were extirpated by humans in 1982–1983. After several winters with ice-crust formation and rain-on-snow events, the population of reindeer decreased from 8,500 in 2002 to 450–500 in 2007 (Gruzdev and Sipko 2007b, Kazmin and Kholod 2014). Following this die-off, wolves and wolverines recolonized the island. By 2016 the number of reindeer had stabilized at approximately 200–300 individuals, with predation considered the main factor preventing population increase (Mizin et al. 2018).



**Fig. 2. A confirmed brown bear (*Ursus arctos*) on Bruch Spit, Wrangel Island, Russia, on 28 August 2019. © Babiy Ulyana**

Most adult females in the Chukotka–Alaska polar bear population (also referred to as the “Chukchi Sea subpopulation,” with different boundaries; Durner et al. [2018]) build their maternal dens on Wrangel Island (Belikov 1977, Rode et al. 2018). Each year, a substantial proportion of the approximately 3,000 bears in the population (Regehr et al. 2018) spend the summer and autumn on Wrangel, waiting for the sea ice to reform (Kochnev 2002, Ovsyanikov and Menyushina 2010, Rode et al. 2015). Climate change has led to declines in the extent and thickness of Arctic sea ice (MacDonald 2010, AMAP 2017), which has negatively affected some of the world’s 19 polar bear subpopulations (Durner et al. 2018) and is expected to affect nearly all polar bears in the longer term (Atwood et al. 2016, Regehr et al. 2016). As polar bears are forced to spend longer periods on land (Stirling and Derocher 2012, Wilson et al. 2017), opportunities for contact with brown bears will likely increase where the ranges of the species overlap.

## Methods

We routinely perform ground-based observational surveys for multiple wildlife species on Wrangel Island during the summer and autumn. On 28 August 2019 during a survey on Bruch Spit, located on the east coast of the island (approx. N71.34° W177.79°), we sighted a running bear that had been resting in a daybed prior to being disturbed by the sound of our vehicles (Fig. 2). The bear had features characteristic of brown bears including a dark coat, distinctive hump, and shortened face (Geptner et al. 1967). The bear appeared healthy and in good body condition. We gathered approximately 10 hairs for genetic



**Fig. 3. An apparent brown bear (*Ursus arctos*) photographed by a remote camera trap on Cape Waring, Wrangel Island, Russia, on 13 July 2019.**

analysis (see below) from the daybed where the bear had been resting.

We later learned that on 13 July 2019, an apparent brown bear (Fig. 3) was photographed by a remote camera trap near Cape Waring on the eastern end of the island (approx. N71.23° W177.50°), roughly 30 km southeast of where the confirmed brown bear was observed on 28 August. This animal appeared smaller and thinner than the other bear, with a lighter coat. Without genetic evidence, however, we cannot confirm that this sighting represented a second individual.

We isolated total DNA from the hairs collected on 28 August using QIAamp® DNA Investigator Kit (QIAGEN®, Germany) following the protocol “Isolation of Total DNA from Nail Clippings and Hair” (www.qiagen.com). For species identification, the most variable fragment of mitochondrial DNA (mtDNA), the control region (D-loop), was used as a molecular marker. A fragment of the mtDNA control region was amplified using primers BED1 (forward) 5'-AGCAACAGCTCCACTACCAG-3' and D4 (reverse) 5'-AGGCATTTTCAGTGCCTTGCTTTG-3' (Matsuhashi et al. 1999) and the polymerase chain reaction (PCR) kit MasterMixX5 (Dialat, Russia). We performed PCR under the following conditions: preliminary DNA denaturation (94°C for 3 min), 40 amplification cycles (94°C for 1 min, 60°C for 30 sec, 72°C for 2 min), and final chain elongation (72°C for 10 min). We determined the nucleotide sequences on an automated sequencer ABI PRISM 3500 (Applied Biosystems®, United States) using the BigDye Terminator v.3.1. kit (Applied Biosystems) with the same forward and reverse primers used in PCR. We carried out sequence alignment and editing manually in the program Bioedit (Hall 1999).

We determined sex using PCR with primers SE47 (5'-CAGCCAAAACCTCCCTCTGC-3') and SE48 (5'-CCCGCTTGGTCTTGTCTGTTGC-3') for the amelogenin locus (Ennis and Gallagher 1994), under the following amplification conditions: preliminary DNA denaturation (94°C for 9 min), 40 amplification cycles (94°C for 30 sec, 66°C for 30 sec, 72°C for 1 min 30 sec), and final extension (72°C for 10 min). We analyzed PCR products by gel electrophoresis on 2.5% Tris/Borate/ethylenediaminetetraacetic acid buffer agarose gels stained with ethidium bromide and visualized in ultraviolet light. Visualization of the gel after electrophoresis reveals the presence of 2 bands in males and 1 in females.

## Results

We sent the sequence of the control region (D-loop) of mtDNA (697 base-pair length) to the Genbank (ncbi; #MT152317) where it was compared with homologous mtDNA sequences using the BLAST program (Basic Local Alignment Search Tool). The sequence was indistinguishable from one of the most widespread haplotypes of the brown bear mtDNA control region, EA1 (Korsten et al. 2013), described in different parts of the Eurasian range including Finland (Anijalg et al. 2018), Estonia, the European part of Russia, the Urals, Siberia, and the North of the Far East. Genetic analyses further indicated that the hairs belonged to a male brown bear.

## Discussion

At least one brown bear was present on Wrangel Island in summer 2019. We hypothesize that the bear(s) reached the island by walking from mainland Chukotka prior to sea-ice breakup, which occurred approximately on 13 July 2019 based on visual assessment of remote sensing sea-ice imagery (Cavaliere et al. 1996, updated yearly). Brown bears in northern regions of the Russian Far East emerge from winter dens in late April and early May (Chernyavskiy and Krechmar 2001). This currently provides sufficient time for them to access the sea ice north of Chukotka before it recedes in late July and early August (Rode et al. 2015), although progressively earlier sea-ice breakup due to climate warming (e.g., Molnar et al. 2020) could eventually limit on-ice dispersal opportunities for brown bears unless den emergence also occurs earlier (Delgado et al. 2018). The brown bear observed on 28 August was in good body condition, suggesting it may have been feeding while on the island. The potentially different individual photographed by a

remote camera trap on 13 July appeared smaller and thinner.

There are several potential food sources on Wrangel Island that brown bears could exploit. Although there are no berries, there is vegetation such as sedges (*Carex* spp.; Chernyavskiy and Krechmar 2001) as well as rodents and multiple bird species and their young, including molting snow geese (*Anser caerulescens*). Furthermore, an unusually large number of pink salmon (*Oncorhynchus gorbuscha*) were observed in large rivers on Wrangel in 2019 (Gruzdev et al. 2020). Brown bears can be effective predators on reindeer (Olohaktomiut HTC 2013) and muskoxen (Arthur and Del Vecchio 2017, Cuyler et al. 2019), the latter of which are abundant on Wrangel and calve earlier than most other ungulates (Lent 1999). Reynolds et al. (2002) reported that individual brown bears can prey successfully on muskoxen despite their group-defensive behavior, and that  $\geq 2$  muskoxen were killed from the same group at the same time in 61% of documented predation events in northeastern Alaska. Thus, muskoxen could represent an important nutritional resource for brown bears on Wrangel, especially in spring when most other food sources are not available. Although brown bears are omnivorous throughout most of their range, some studies have found a greater proportion of ungulate meat in their diets at higher latitudes, resulting from both scavenging and active predation (Krechmar 1995, Persson et al. 2001, Niedzialkowska et al. 2018). Like polar bears on Wrangel Island, brown bears might also feed on the beach-cast carcasses of walrus (*Odobenus rosmarus*) and whales (*Eschrichtius robustus*, *Balaena mysticetus*, *Delphinapterus leucas*; Miller et al. 2015, Laidre et al. 2018).

The arrival of a new apex predator on Wrangel Island has potential ramifications for other species and broader ecosystem dynamics, particularly considering the brown bear's great mobility and flexible feeding and habitat requirements (Schwartz et al. 2003). Direct competition for food and space could occur with wolves (Koene et al. 2002, Lewis and Lafferty 2014), wolverines (Krebs et al. 2009), and polar bears (Miller et al. 2015, Clark et al. 2018). Interactions with polar bears are particularly interesting because the two species have large body sizes, high energetic requirements (Cahill et al. 2013, Gormezano and Rockwell 2015), and are capable of hybridization (Pongracz et al. 2017). Although direct competition has rarely been documented, Miller et al. (2015) found that feeding polar bears were more likely to be displaced by brown bears than by conspecifics. This could lead to density-dependent regulation given the importance of beach-cast marine mammal carcasses to polar bears on

Wrangel (Kochnev 2002, Laidre et al. 2018). It also is possible that brown bears could attack polar bears, especially cubs (Taylor 1995).

It is still a question whether the brown bear(s) on Wrangel Island in 2019 were transient or indicative of a range expansion, possibly in response to milder and more favorable environmental conditions as has happened with wolves and wolverines (Manteyfel 1948, Geptner et al. 1967, Stishov 2004). Evidence that the bear observed on 28 August was male is consistent with sex-biased dispersal in the species (Støen et al. 2006). Additional research is required to determine whether the individual(s) observed in 2019 remained on Wrangel Island and survived the winter, and how brown bears might alter the ecological dynamics of the island in the future.

## Acknowledgments

Genetic analyses were conducted in the Molecular Diagnostic Center of the A.N. Severtsov Institute of Ecology & Evolution RAS (IEE RAS), which is a part of the Joint Usage Center “Instrumental Methods in Ecology” of IEE RAS. We thank the Associate Editor and reviewers for their comments, which substantially improved the manuscript.

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*Received: August 5, 2020*

*Accepted: January 17, 2021*

*Associate Editor: R. Shideler*