The Influence of Ice Conditions on Terrestrial Haulouts of the Pacific Walrus *Odobenus rosmarus divergens* Illiger, 1815 in the Gulf of Anadyr, Bering Sea

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Abstract—The boundaries of the area of appropriate depths for feeding by the Pacific walrus were determined. Based on the ice maps for the period of 1997–2011, the long-term dynamics of ice breakup and formation in the Gulf of Anadyr (Bering Sea) were analyzed. There was a tendency towards a reduction in the ice-cover period in the Gulf of Anadyr, especially during 2007–2011. In 2008, the number and duration of stay of walruses at terrestrial haulout sites on Meeskyn Spit Island and on Retkyn Spit continued to decrease. Walruses also used other haulouts located in the Gulf of Anadyr at Cape Gek and Cape Retkyn. The age and sex structure of the walrus herd changed: the proportions of adult males and young animals decreased, while the proportion of females with calves increased.

Keywords: Pacific walrus, pinnipeds, Bering Sea, Gulf of Anadyr, ice, dynamics of abundance, age and sex structure

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INTRODUCTION

According to Tsekhanskaya’s data [6], the first information on terrestrial haulouts of the walrus *Odobenus rosmarus divergens* Illiger, 1815 in the Gulf of Anadyr dates back to the middle of the 17th century. Since the early 20th century a vast quantity of data has been collected on the abundance and functioning of haulouts of these marine mammals on Retkyn Spit (Rudder Bay) and on Meeskyn Spit Island [1–5, 10–12, 15, 16].

A significant decrease in the numbers and duration of stay of walruses in the Gulf of Anadyr was observed in the 2000s [10, 16]. Ice cover and water depth are known to be very important for walruses [7, 17]; however, the effects of these factors on the intraspecific structure, dynamics of terrestrial haulout use, and other issues of the biology of the species have been inadequately studied. The goal of the present work is to analyze long-term changes in the ice conditions of the Gulf of Anadyr (periods of ice breakup and formation of new ice cover) and estimate their effect on the functioning of coastal haulouts of the walrus *O. rosmarus divergens* (period of formation, duration of functioning, dynamics of abundance, as well as the age and sex structure) on Meeskyn Spit Island and Retkyn Spit.

MATERIALS AND METHODS

All observations were carried out in 2008 at the coastal walrus haulouts in the Gulf of Anadyr (Fig. 1): from July 26 to September 3 (40 days) on Meeskyn Spit Island and from July 11 to September 12 (64 days) on Retkyn Spit. The walruses were counted daily, one or two times a day, from elevated points. Additionally, observation were conducted in the villages of Uel’kal’ (July 22–25 and September 4–18) and Enmelen, as well as during hiking and boat tours over total distances of 650 and 290 km, respectively. The census of walruses was carried out using methods that were developed by the Chukchi Branch of the TINRO Center [9]. The age and sex of walruses were determined according to a method based on sexual dimorphism and the external morphology of different age groups [18].

The ice cover dynamics were followed using data from the US National Ice Center website (http://www.natice.noaa.gov) during the period of 1997–2011 (updated every 3 to 4 days). The water depths in the Gulf of Anadyr and distances from the shoreline were determined by Google Earth maps.
RESULTS AND DISCUSSION

Hydrology in the Walrus Habitat

Walruses are typical benthic feeders and can dive to depths of more than 200 m [19], but the optimal depths for feeding are 50 to 60 m [7, 13]. The area with such depths stretches along the coastline of the Gulf of Anadyr and has a width of 60 km on average; near Retkyn Spit, Meeskyn Spit Island, and the outer end of the Anadyr estuary its width extends to 80–140 km (Fig. 1). Therefore, the terrestrial haulout sites of walruses are located close to feeding region with a considerable area of optimal depths.

Aggregations of walruses on Retkyn Spit and Meeskyn Spit Island usually begin to form as soon as the ice breaks up over the entire territory of the Gulf of Anadyr [3, 4]. To estimate the dynamics of ice-cover changes, data on the complete ice breakups in the gulf for the last 15 years were analyzed from the National Ice Center. The earliest ice breakup took place in 2007 (June 29) and 2011 (June 30) and normally ice breakups happened around July 15 (Fig. 2).

In 2008 in the Gulf of Anadyr ice broke up completely on July 7, i.e., a week before the long-term average annual date. The melting and breaking of the ice edge starts from the deep-sea open area of the Bering Sea and proceeds in northern and northwestern directions. Pack ice remains for the longest time in the most sheltered and shallow-water areas (Kresta Bay and Anadyr estuary; in 1997 near Retkyn Spit, too). It is well known that walruses prefer to rest on ice rather than on dry land [14] and when they start to congregate for haulouts, they first of all come to the pack ice that still remains in a region.

The duration of the ice-free period may also affect walrus abundance dynamics when the animals stay at terrestrial haulouts. If walruses use the same haulout for an extended period of time, the local food reserves may become depleted, forcing the animals to move to another foraging region. These regions are often located at a great distance and walruses do not have an opportunity to take a rest on a hard substrate [8].

According to the data from the National Ice Center website, the duration of the ice-free period from the time of marginal ice melting (including that in all the bays and the Anadyr estuary) until freeze-up (Fig. 3) of the Gulf of Anadyr for the last 15 years was 96 days on average and 116 days maximum (in 2011). The ice-free period in 2008 was slightly longer than the average, i.e., 98 days. Ice cover in the Gulf of Anadyr forms starting from the shore, first of all in closed brackish-water recesses, for example the Anadyr estuary or

Fig. 1. The region where observations were conducted of the terrestrial haulouts of the Pacific walrus *Odobenus rosmarus divergens* in the Gulf of Anadyr in 2008.