Vol. 378: 247–261, 2009
doi: 10.3354/meps07823

MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser

Published January 27

Deep into the ice: over-wintering and habitat selection in male Atlantic walruses

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ABSTRACT: New technological developments in animal-borne satellite-tracking devices in conjunction with increased access to satellite-based environmental data are creating new possibilities for studying movement patterns and habitat selection by animals in remote, logistically challenging environments. In the present study, we report the first year-round data on movement patterns of walruses in the High Arctic, including at-sea positions. Using first-passage times (FPT) to study habitat use and quantifying habitat selection using mixed-effects Cox proportional hazards models, we disputed the conventional perception that seasonal movement patterns of Atlantic walruses are simply a result of flaws following the retraction and expansion of annually formed sea ice. Walruses in this study (n = 17 males) actively moved into areas of high ice concentration (>90%) during winter, travelling far into the ice pack, as far as 600 km from ice-free water. Additionally, high inter-annual, seasonal site fidelity was documented. Seasonal differences in habitat use patterns were also observed. In summer, when walruses feed intensively, FPTs were affected by water depth and distance to the coast (R^2 = 0.371), but these variables had no effect on walrus habitat use in winter. Sea ice concentration was the most important environmental condition during the winter season (R^2 = 0.562), though there are clearly other factors influencing where individuals occur in winter that are currently unaccounted for in these analyses. The male walruses in this study did not do much benthic diving during winter, suggesting that they did not feed often during the time that they are known to breed. Instead, they remained in areas with high ice coverage, far from their coastal summering areas, spending much of their time hauled out or in surface waters.

KEY WORDS: Cox proportional hazards models · First-passage time · Odobenus rosmarus rosmarus · Random-effects models · Satellite telemetry · Site fidelity

INTRODUCTION

The study of movement patterns and habitat selection has been a fundamental component of animal ecology for many decades (e.g. Manly et al. 2002, Fortin & Dale 2005). But, in marine mammal research, this field has progressed slowly compared to terrestrial studies because of the technological problems encountered in attempting to track animals at sea (Cowles et al. 2004). New tag technology (e.g. Fedak et al. 2002, McConnell et al. 2004, Robinson et al. 2006), in combination with greater access to satellite-based and other environmental data, as well as new statistical approaches to the study of animal movements in relation to environmental correlates (e.g. Aarts et al. 2008, Freitas et al. 2008b), are opening up new possibilities for studying animals even in remote, very logistically challenging environments. Extensive sea ice, harsh weather and sea conditions, in addition to 24 h winter darkness has limited our ability to work with large,

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