BELUGA WHALE (*Delphinapterus leucas*) USE OF THE NELSON RIVER ESTUARY, HUDSON BAY

By

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A Thesis

Submitted to the Faculty of Graduate Studies of the University of Manitoba

In partial fulfilment of the requirements of the degree of

MASTER OF SCIENCE

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ABSTRACT

Most beluga whales (*Delphinapterus leucas*) (Pallas 1776) living in areas of seasonal sea ice use estuaries periodically during summer. Beluga estuary-use hypotheses include feeding, calving, moulting, killer whale (*Orcinus orca*) predation, human predation, thermal advantage, and phylogenetic inertia. The hypotheses may not be mutually exclusive and may vary with populations or regions. This study describes aspects of beluga whale summer-ecology by studying the association between inter-annual water levels and beluga habitat selection in the Nelson River estuary. Flow rates from upstream Limestone Dam doubled from the dry years of 2002–2004 to the wet year of 2005. I used radio-tracking data (N=15, 2002–2005) and aerial surveys (2003, 2005) to test the hypothesis (H1) that belugas were farther out in the estuary during the wet year. Model variables included year, day, time, tide and age-sex. Observed location-habitat distances for the radio-tracking and aerial survey data were compared to the random equivalents using a Kolmogorov-Smirnov (KS) test. A cumulative sign test determined the timing of a beluga shift in movement behaviour on August 10th. Pre-August 10th radio-tracking locations provided the spatial-temporal boundary of the Nelson River estuary. General Linear Models (GLM) for both the telemetry and aerial survey data show an association between beluga distance to the river-mouth and year. Study results provide evidence to weigh the main estuary-use hypotheses and contribute to knowledge of beluga ecology and management.

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ACKNOWLEDGMENTS

I thank my major advisor, Steven Ferguson PhD, for his support, advice, and input into the analyses, compilation, and review of this study. I also thank my co-advisor David Walker PhD and my committee members Pierre Richard and Dave Barber PhD. I had the privilege of access to their expertise. Jack Orr provided expert reviews but also served as a guide on my first Arctic field experience. Jack knows how to capture belugas safely and efficiently, and knows how to manage large field operations effectively. I thank the University of Manitoba, Manitoba Hydro, the Nunavut Wildlife Research Trust Fund, ArcticNet and Fisheries and Oceans Canada for providing a functional research environment and for their funding support. Pierre Richard graciously provided the radio-tracking data that made this research possible. Roy Bukowsky has facilitated this research on the part of Manitoba Hydro. I also value greatly the friends I have made in Northern Canada and this chance to learn about First Nations people by spending time with them in the field. This study exists through the hard work of all those involved in the fieldwork as well as those involved in the manuscript review. Thanks to Jeff Higdon of the Orcas of the Canadian Arctic (OCA) research group for providing expertise, review, and numerous links to scarce killer whale references.

DEDICATION

I dedicate this thesis to my partner Meg. Megs support during my long field seasons and her understanding and support of my goals have made this research possible.

CHAPTER I. INTRODUCTION

In ecology, knowledge of a species or population relies upon an understanding of its own species parameters, but also of its interactions with its environment. Thus, habitat studies are necessary precursor to assessing its potential vulnerability to changes to its environment. Animals inhabiting Arctic ecosystems, including beluga whales (*Delphinapterus leucas*) (Pallas 1776), often face seasonally scarce resources and migrate long distances (Draper 1989; Sergeant 1973; Geraci 2005). For this reason, small environmental changes can have substantial affects on health and fecundity of Arctic animals (Gaston *et al.* 2002). Global oceanographic, climate, and general circulation models predict that the most extreme and acute effects of global warming will occur in the Arctic. Predicted effects include more erratic precipitation patterns and increased river outflows (Hinzman 1992; Tynan 1997; Fyfe 1999; Peterson *et al.* 2003). Belugas, like other marine mammals, are vulnerable to these changes for reasons including their strong philopatry to certain sites of seasonal aggregation (Degerbøl and Nielson 1930 in Heide-Jørgensen 2002; O'Corry-Crowe 1997; COSEWIC 2004).

Beluga whales are medium sized cetaceans having a primarily panArctic range. In 2002 the beluga population estimate in Canadian waters numbered between 72,000 and 144,000 (DFO 2002), with individual stock populations ranging from zero (Ungava Bay) to 57,000 (Western Hudson Bay). This study focuses on aspects of the summer ecology of the Western Hudson Bay population, considered the largest single beluga whale population on earth (Richard 2005). The goal of this thesis is to understand factors

affecting beluga whale estuary-use. Implications of this research are applicable to management of Western Hudson Bay belugas and their habitat.

Most beluga stocks use estuaries in ice-free regions during summer, but reasons for this behaviour are unknown. Beluga estuary-use hypotheses include feeding (Kleinenberg *et al.* 1969; Seaman and Burns 1981; Seaman *et al.* 1982), calving (Sergeant and Brodie 1969; Sergeant 1973; Fraker *et al.* 1979), moulting (Finley 1982; St. Aubin *et al.* 1990), avoiding killer whales (*Orcinus orca*) (Brodie 1971), avoiding humans (Caron and Smith 1990; Kilabuk 1998), thermal advantage (Sergeant and Brodie 1969; Fraker *et al.* 1978) and phylogenetic inertia (W. Doidge, Makivik Corporation, Montreal, Quebec, pers. comm. 2005). The last hypothesis, Phylogenetic inertia, describes the influence of an ancestor on its descendents; retaining traits unless altered by behavioural mutation (Dembski 2001). Little tested evidence exists for any of the above estuary-use hypotheses and some, including phylogenetic inertia, are not published (Doidge 1990; Caron 1990; W. Doidge, Makivik Corporation, Montreal, Quebec, pers. comm. 2005).

Early research suggested feeding as a main reason for this beluga estuary-use (Comeau 1915; Vladykov 1947; Kleinenberg *et al.* 1969; Seaman and Burns 1981; Seaman *et al.* 1982). Research on stomach contents of belugas in estuaries taken during local harvests however, contradicts this hypothesis. Since many female belugas with calves are observed in estuaries, calving was thought to be the primary behavioural motivation (Sergeant and Brodie 1969; Sergeant 1973; Fraker *et al.* 1979). Research on blubber and skin layers (Doidge, 1990, Boltunov et al 2002) and observations of most females arriving in estuary already with calves contradicts this view. This evidence, along

with observations of warmer water in estuaries led to the hypothesis of thermal advantage to all ages and sex classes in the estuaries (Fraker *et al.*, 1978). However, belugas are adapted to a pack-ice environment with near-zero Celsius waters so evidence does not support this hypothesis (Doidge, 1990). Doidge (1990) notes that belugas and narwhals have equal insulation but only belugas exhibit seasonal occupation of warmer estuarine waters. Moreover, elevated hormone levels were found in belugas in some estuaries, strengthening the moulting hypothesis as a principle reason for beluga estuary-use (Finley 1982; St. Aubin *et al.* 1990). Past studies on belugas in estuaries offer little tested evidence and lack ecological context. Part of the reason for the absence of published research is that belugas, like other marine mammals, especially Arctic species, live most of their lives under water, and often at locations not easily accessible by humans (Martin and Smith 1992; Martin *et al.* 1993, Martin *et al.* 1998; Heide-Jørgensen *et al.* 1998).

For this thesis, I begin **Chapter I** with an overview of beluga whale biology and a brief description of the status and trends of beluga whales in the Canadian Arctic. I then provide a slightly more in-depth description of Hudson Bay, the Nelson River estuary study site, and Western Hudson Bay belugas.

Chapter II examines beluga habitat associations for wet and dry years in the Nelson River estuary, Manitoba, (Port Nelson, 133° 48' W, 55° 41' 45" N). Radio-tracking (n=15) and aerial survey data for belugas collected over the summers of 2002–2005 were used to test the hypothesis (H1) that belugas remained farther offshore during the wet year. Model variables included tide level, depth, year, Julian day, time of day, and age-sex class. First, I use Kolmogorov-Smirnov (K-S) tests to compare the observed data distributions to random-generated data distributions. I then use a distribution-free

cumulative sign test to define the estuary boundary, by measuring day-to-day differences in median distances of the belugas to the river mouth. General Linear Models (GLM) and Tukey's Studentized comparison of means tests are then used to explore the beluga-habitat associations. Finally, results are related to the beluga estuary-use hypotheses.

Chapter III uses a 'weight of evidence' approach to review existing beluga estuary-use hypotheses, including **Chapter I** results. **Chapter IV**, includes major findings and a general discussion of beluga estuary-use including a discussion on any anthropogenic effects caused by the artificial alteration of riverine systems. I conclude with recommendations for future research on the beluga estuary hypotheses. The appendix contains additional information and figures related to this study. Movement maps for each of the 14 Nelson River radio-tracked belugas are also located in the appendix.

I.2 BELUGA WHALE BIOLOGY

I.2.1 Description

The beluga whale is a medium-sized odontocete. Size varies between populations with Hudson Bay belugas being among the smallest (Kleinenberg 1964). Generally, adult male belugas measure 2.6–6.7 meters in length and weigh 450–1000 kilograms, while adult females measure 3–4 meters in length and weigh 250–700 kilograms (Kleinenberg 1969; Brodie 1971; Stewart and Stewart 1989). Neonates measure approximately 1.6 meters in length and are born grey-cream or pink in colour, and then turn dark brown or blue-grey (Brodie 1971; DFO 2002). Belugas reach maturity, which is typically

associated with a change in coloration to white at 12–18 years, and can live up to 92 years (Harwood 2002), assuming one growth layer group (GLG) per year (Stewart *et al.* 2006). However, reports exist of grey ones giving birth (S. Ferguson pers. Comm., Department of Fisheries and Oceans, Canada. Winnipeg, pers. comm. 2007). The white coloration of adults may be an adaptation to their environment. It is the source of their name, originating from *Belukha*, which is Russian for white. The scientific name '*Delphinapterus leucas*' translates as "the white dolphin without a wing"(DFO 2002). Belugas are also commonly referred to as white whales likely to differentiate them from the white (or beluga) sturgeon (*Huso huso*).

I.2.2 Ontogeny and Reproduction

The bulk of knowledge regarding the development or course of development of an individual beluga (Ontogeny) exists through in-situ observation and necropsies. The majority of beluga mating occurs during spring and timing varies geographically (Brodie, 1971). Doan and Douglas (1953) suggested that some mating in Western Hudson Bay may continue into September. Little evidence exists regarding beluga mating, although males have exhibited polygamy (Stewart and Stewart 1989). Gestation lasts approximately 14 months and births occur from June to August, followed by a nursing period of approximately 18 months. These reproductive parameters mean that females can produce young only every three years. Peak calving times also vary geographically from late march to early august (Stewart and Stewart 1989). Western Hudson Bay belugas generally give birth at the end of June, coinciding with the break up of the sea ice (Sergeant 1986). Rapid growth in neonates is due to the fat-rich milk of the mother.

Newborn calves grow from 40 percent of their mother's length to 65 percent in the first year and measure approximately 70 percent of adult length when weaned at the end of the second year (Stewart and Stewart 1989).

I.2.3 Diet

Belugas have one of the most varied diets of any cetacean. Seasonal availability of prey items results in a generalist diet consisting of capelin, Arctic cod, herring, shrimp, squid, and marine worms (Kleinenberg 1969; Seaman *et al* 1982; DFO 2002). Some unique adaptations of belugas, possibly related to feeding, include the lack of a dorsal fin and un-fused cervical vertebrae, allowing lateral flexibility of the head and neck, presumably to aid in benthic and sub-sea ice foraging (Vladykov 1949)

I.2.4 Distribution

Belugas have a primarily panArctic distribution throughout seasonally ice-covered Arctic and sub Arctic waters of the Northern Hemisphere (Gurevich 1980, Stewart 1989). Most beluga stocks congregate in shallow estuaries during summer months. During winter, belugas are closely associated with open leads and polynyas in ice-covered regions (Doidge and Finley, 1993; Richard 1990; Richard *et al.* 1993; Richard 2002). Depending on season and region, they may occur in both offshore and coastal waters. Sea-ice, tide, temperature, human action, and access to prey affect seasonal distribution (Lowry 1985). Annual migrations may cover thousands of kilometers (Reeves 1990). During spring, most belugas migrate to warmer coastal estuaries, bays, and rivers. Reasons for this behaviour are unknown and are the subject of