

**Project #:** 632

**Title:** Distribution, Abundance, and Ecology of Pacific Walrus in the Bering Sea

**Principal Investigator(s), Co-Principal Investigators and Recipient Organization(s):**

Rosa Meehan, Ph.D.	Chadwick V. Jay, Ph.D.	Brenda Konar, Ph.D.
U.S. Fish and Wildlife Service	U.S. Geological Survey	School of Fish. & Ocean Sci.
Marine Mammals	Alaska Science Center	University of Alaska
Management	4230 University Drive	Fairbanks
1011 East Tudor Road	Suite 201	Fairbanks, Alaska
Anchorage, Alaska 99503	Anchorage, Alaska 99508	bkonar@guru.uaf.edu
rosa_meehan@fws.gov	chad_jay@usgs.gov	

**Subaward Period and Amount of Funding:**

August 1, 2006 to October 31, 2009  
\$182,634, \$53,019, \$64,115

**Report Period:** July 1 to December 31, 2008

**Report Submission Date:** March 20, 2009

**Lead Author of Report:** Suzann G. Speckman, USFWS

**PROJECT OVERVIEW**

The Pacific walrus (*Odobenus rosmarus divergens*) is an ice-dependent pinniped. Little information exists to allow prediction or interpretation of the impacts of Arctic warming on Pacific walrus, their sea ice habitats, or their benthic prey. The purpose of this study is to use data collected during a range-wide abundance survey of walrus in the Bering Sea in spring 2006 to examine aspects of walrus ecology under three study components. The first study component involves collaboration with Russian scientists to integrate survey data collected in U.S. and Russian territories, standardize data analysis, and derive a population estimate of the Pacific walrus. The second study component examines relationships between walrus haul-out and movement behaviors and their sea ice environment. The third study component evaluates whether benthic walrus prey composition, abundance, and biomass within an area of the St. Lawrence Polynya have significantly changed in the past 20+ years.

**Part 1: Distribution and Abundance of Pacific Walrus in the Bering Sea**

**Objectives**

1. Analyze digital photographs and thermal images of a sample of thermally detected walrus groups to determine the relationship between thermal signatures and the number of walrus in a group.
2. Estimate the number of walrus hauled out on ice.
3. Use haulout data from tagged walrus to estimate the proportion of time that walrus were in the water and unavailable to be detected by the thermal scanners.
4. Estimate total size of the Pacific walrus population with confidence intervals.

**Part I Project Timeline:**

**Calendar Year 1 (2006)**

1. U.S./Russia research cruise in the Bering Sea to deploy telemetry tags on a representative sample of walrus (completed)
2. U.S./Russian researchers fly aerial surveys for Pacific walrus groups over pack ice in the Bering Sea (completed)
3. Processing of thermal imagery data and digital photographs collected in U.S. and Russian territories

4. Meeting in St. Petersburg, Russia, in September to present preliminary analysis and exchange U.S. and Russian data. Will also provide Russian colleagues with a copy of the software ERDAS Imagine and train them to use this software for digital photograph interpretation and analysis and processing of thermal data.
5. Data analysis. Begin development of an abundance estimate for the Pacific walrus population

#### Calendar Year 2 (2007)

1. Meeting to discuss and coordinate survey data analysis and work together on joint US-Russia manuscripts
2. Complete development of an abundance estimate for the Pacific walrus population
3. Final preparation of manuscripts for peer review and publication (USFWS funded)

### **Part II: Walrus-Sea Ice Relationships in the Bering Sea: Understanding the Importance of Sea Ice as a Foraging Platform**

#### **Objectives:**

1. Assess relations between walrus haul-out state and meteorological variables.
2. Assess relations between walrus movements and sea ice drift.

#### **Part II Project Timeline:**

##### Calendar Year 1 (2006)

1. Compile location and haul-out time series from 2004-2006 tagged walruses
2. Compile meteorological data sets coincident to the 2004-2006 walrus telemetry data
3. Begin derivation of sea ice motion data sets pertinent to 2006 tagged walruses

##### Calendar Year 2 (2007)

1. Complete derivation of sea ice motion data sets pertinent to 2006 tagged walruses
2. Model walrus haul-out status relative to meteorological conditions
3. Model walrus movements relative to sea ice drift vectors
4. Begin preparation of manuscripts

##### Calendar Year 3 (2008)

1. Complete preparation of manuscripts for submission to peer-reviewed journals

### **Part III: Evaluation of Walrus Foraging Grounds in the Bering Sea: a Spatial and Temporal Comparison**

#### **Approach**

The following hypotheses were tested:

- 1) the composition, abundance, and biomass of benthic walrus prey in a portion of the St. Lawrence Polynya has significantly changed over the past 20+ years,
- 2) the species composition, abundance and biomass of prey items found in the stomachs of Pacific walruses has significantly changed over the last 30+ years,
- 3) the species composition, abundance and biomass of prey items found in current Pacific walrus stomachs is positively correlated with current available benthic prey composition, abundance, and biomass in the feeding grounds around the St Lawrence Polynya.

#### **Objectives:**

1. Analyze benthic samples for species composition, abundance, and biomass.
2. Compare the data obtained in this study to historical benthic data.
3. Analyze stomach contents of harvested Pacific walrus
4. Compare stomach data obtained in this study to historical stomach data.
5. Compare benthic and stomach data obtained in this study.

### **Part III Project Timeline:**

#### Calendar Year 1 (2006)

1. Sample walrus foraging areas
2. Work up benthic samples (sort, identify, count and weigh; fall and winter)
3. Merrill to attend Primer Workshop (fall)
4. Begin data analysis

#### Calendar Year 2 (2007)

1. Stomach collections (spring)
2. Work up stomach samples (sort, identify, count and weigh; summer)
3. Complete data analysis (fall)

#### Calendar Year 3 (2008)

1. Thesis defense (spring)
2. Manuscript preparation (spring)
3. Complete final report (spring)

### **PROGRESS SUMMARY**

On December 27, 2007, NPRB granted project #632 a no-cost extension to December 31, 2008. On February 26, 2009, NPRB granted project #632 an additional no-cost extension to October 31, 2009. Parts II and III of this project have been completed.

#### **Part 1: Distribution and Abundance of Pacific Walruses in the Bering Sea**

A walrus survey meeting of Russian and U.S. collaborators was held concurrently with the Marine Mammals of the Holarctic V International Conference in Odessa, Ukraine, 14 to 18 October 2008. At this meeting, the on-ice numbers were discussed and the reporting process was outlined, including the review process and the intricacies of writing and producing parallel manuscripts in two languages.

In October, the U.S. team submitted a manuscript entitled, “An improved procedure for detection and enumeration of walrus signatures in airborne thermal imagery” for publication to the International Journal of Applied Earth Observation and Geoinformation. This manuscript describes the technical methods used by the U.S. team to detect walrus groups in thermal imagery, and will be translated into Russian upon its acceptance, so it will be available to our Russian colleagues and other interested specialists.

A second major milestone for this part of the project also has been completed. The report entitled, “Range-wide survey of Pacific walruses in 2006: estimated number of walruses on sea ice” provides an estimate of the number of walruses on Bering Sea ice within the surveyed areas in both Russia and the U.S. during the time of the survey. The report has been finalized in English and a Russian-language version is in the last stages of editing.

We are currently focused on applying the haulout model (Part II) to the walrus survey data to estimate the number of walruses in the water at the time of the survey and unavailable for counting with thermal imagery.

#### **Part II: Walrus-Sea Ice Relationships in the Bering Sea: Understanding the Importance of Sea Ice as a Foraging Platform**

Two reports were completed, within 60 days of the project extension date, addressing each of the two objectives. Since the last reporting period, further refinements to a walrus haul-out model were made and Objective 1 was completed. Further analyses were conducted for Objective 2 and the objective was completed. Both reports are currently being prepared for journal publication.

### **Part III: Evaluation of Walrus Foraging Grounds in the Bering Sea: a Spatial and Temporal Comparison**

Tracie Merrill completed her thesis and graduated from the University of Alaska Fairbanks in December 2008. Her thesis project met the five objectives defined for this study. The thesis is comprised of two chapters, entitled, “A temporal comparison of benthic community structure southwest of St. Lawrence Island between 2006 and 1970-1974” and “A comparison of Pacific walrus stomach contents between 2006 and the 1980s around St. Lawrence Island.” Both chapters are currently being prepared for journal publication.

#### **Preliminary Results:**

##### **Part 1: Distribution and Abundance of Pacific Walruses in the Bering Sea**

In spring of 2006, a range-wide survey of the Pacific walrus (*Odobenus rosmarus divergens*) was conducted as a collaboration among the U. S. Fish and Wildlife Service, U.S. Geological Survey, and the Russian institutes Giprorybflot and ChukotTinro. The goal of the survey was to estimate the size of the Pacific walrus population across its spring range, the ice-covered continental shelf of the Bering Sea. U.S. and Russian scientific crews coordinated aerial survey efforts on their respective sides of the international border. The Bering Sea was partitioned into survey blocks, and a systematic sample of transects within a subset of the blocks was surveyed with airborne thermal scanners using standard strip-transect survey methodology. An independent sample of scanned walrus groups was aerially photographed with digital cameras. Counts of walruses in photographed groups were used to model the relation between the thermal signature and the number of walruses in a group and to estimate the probability of thermally detecting a walrus group as a function of its size.

These models were then used to estimate the number of walruses in groups that were not photographed but were detected by the thermal scanner, and to estimate the number of walruses in groups that were not detected by the scanner. Thermal imagery is capable only of detecting walruses that are hauled out on the pack ice. Adjustment of the on-ice estimate to account for walruses in the water and unavailable for detection will be addressed in a later publication. During the course of the survey, the size of the study area, i.e., the area of Bering Sea pack ice over waters less than 200 m deep, ranged from about 576,000 km<sup>2</sup> to 742,000 km<sup>2</sup> and averaged about 660,000 km<sup>2</sup>. Transects covering a total of 96,423 km<sup>2</sup> of sea ice were surveyed, representing 9-45% of the area in each of 26 survey blocks. The total number of Pacific walruses hauled out on sea ice within the surveyed area was estimated to be about 22,000 individuals, with a 95% confidence interval of 8,453 to 45,439 individuals. Estimation of the total population size for the Pacific walrus will require additional analysis, including estimation of the number of walruses in the water.

##### **Part II: Walrus-Sea Ice Relationships in the Bering Sea: Understanding the Importance of Sea Ice as a Foraging Platform**

Our predictive model of walrus haul-out behavior in sea ice habitat indicated that the tagged walruses averaged only about 17% of their time hauled out on sea ice. Probability of being hauled out decreased with wind speed and increased with temperature. These probabilities also followed a diurnal cycle with highest values in the evening, though the relations to these variables were weaker than relations to wind speed. Our model can be used to estimate the proportion of the population that was in the water and therefore unavailable for detection in an aerial infrared survey of the Pacific walrus population conducted jointly by the United States and Russia in spring of 2006. In addition to its survey application, the model also provides an important step in understanding relations of environmental factors to haul-out behavior of Pacific walruses on sea ice.

Our study of the movements of walruses and their associated ice floes in northern Bering Sea indicated that walruses were not homing to specific ice floes when hauling out. Angles and displacements between

walrus and their previously associated ice floes increased with observation duration, proportion of time the walrus spent in the water, and varied among regions (regional mean angles ranged 38° to 77° and mean displacements ranged 14 km to 33 km). We suggest that these substantially divergent movements of walrus and sea ice are due, in part, to the walrus' effort to maintain or gain new access to areas of abundant prey.

### **Part III: Evaluation of Walrus Foraging Grounds in the Bering Sea: a Spatial and Temporal Comparison**

Invertebrate biomass and abundance may be changing in Bering Sea benthic infaunal communities. This study compared benthic invertebrate biomass, abundance, and infaunal community composition between 1970-1974 and 2006 at stations in an area southwest of St. Lawrence Island. Invertebrate biomass and abundance were significantly greater in 2006 than in 1970-1974 primarily due to high nuculid (*Bivalvia*) biomass and abundance that contributed 13.15 % (biomass) and 8.54 % (abundance) to differences in community structure. Nuculids may have increased between 1970-1974 and 2006 due to enhanced settling of silt within the overall St. Lawrence Island Polynya region since the late 1980s. Results suggest that bivalve biomass and abundance may be higher, or be more patchily distributed, than previously thought. Patchiness in bivalve biomass and abundance, spatial scale, selective predation, a strong recruitment event and/or sampling design may account for the differences between this study and previous studies.

Alterations in walrus behavior and foraging habitat (benthic communities), caused by climate change over the last 20+ years, may be correlated with reduced food for Pacific walrus (*Odobenus rosmarus divergens*). Since dietary changes can indicate altered food availability, this project compared stomach contents from walrus harvested near St. Lawrence Island in 2007 to those harvested in the 1980s. No significant differences were detected in counts, weights, frequencies, and species composition of prey items between time periods. A significantly lower proportion of walrus had food in their stomachs in 2007, perhaps because a larger proportion of 2007 samples were from fasting postpartum females. Although the non-significant results may be attributed to a small sample size in 2007, they suggest that a large change is unlikely to have occurred in the prey base. A dietary change, though, may not be evident if the Pacific walrus population has undergone a redistribution and/or decline.

#### **Project Progress Concerns:**

No problems have been encountered during this reporting period. Parts II and III of this project have been completed. Part I is moving forward and is expected to be completed by late 2009.

#### **Education and Outreach:**

There are no education and outreach activities to report for this period. We will present our findings in future meetings with Alaska Native villages and the Eskimo Walrus Commission. We will also present results on the USGS walrus research website (<http://alaska.usgs.gov/science/biology/walrus/index.html>).

#### **PROJECT STATUS**

We move slowly but inexorably towards completion of the population estimate for the Pacific walrus. We are in the process of devising a final timeline and associated deadlines for completion of this work. All partners are working well together, and we remain confident that our final product will be useful for managers and researchers interested in walrus.