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**AN INTEGRATED APPROACH TO COMMUNITY-BASED MONITORING  
OF KILLER WHALES AROUND THE PRIBILOF ISLANDS, ALASKA**

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**An integrated approach to community-based monitoring of killer whales around the Pribilof Islands, Alaska**

**Bruce W. Robson<sup>3</sup>, Karin Holser<sup>1</sup>, Ryan Kingsbery<sup>1</sup>, Amanda M. Merklein<sup>3</sup>, Phillip A. Zavadil<sup>2</sup>, Samantha Zacharof<sup>2</sup> and Desiree Lekanof<sup>1</sup>**

<sup>1</sup>Traditional Council of St. George Island  
Kayumixtax Eco-Office  
101 Zapadni Street  
St. George Island, Alaska, 99591

<sup>2</sup>Aleut Community of St. Paul Island  
Tribal Government  
Ecosystem Conservation Office  
2050 Venia Minor Road  
St. Paul Island, Alaska 99660

<sup>3</sup>Community and Ecology Resources  
2442 NW Market Street, Box 761  
Seattle, Washington 98107

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## TABLE OF CONTENTS

|                                                                                                                                               |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Table of Contents .....                                                                                                                       | iii |
| List of Tables .....                                                                                                                          | iv  |
| List of Figures .....                                                                                                                         | iv  |
| Abstract .....                                                                                                                                | v   |
| Introduction .....                                                                                                                            | 6   |
| Methods .....                                                                                                                                 | 7   |
| Local Fisheries Data Collection Program .....                                                                                                 | 7   |
| Local and Traditional Knowledge Survey .....                                                                                                  | 8   |
| Shore-based Visual Monitoring .....                                                                                                           | 8   |
| Results .....                                                                                                                                 | 9   |
| Fisheries Logbook Program .....                                                                                                               | 9   |
| Shore-based Surveys .....                                                                                                                     | 12  |
| Local and Traditional Knowledge Survey .....                                                                                                  | 14  |
| Predation on Northern Fur Seals .....                                                                                                         | 15  |
| Overall Killer Whale Group Size .....                                                                                                         | 16  |
| Killer Whale Photo-Identification .....                                                                                                       | 16  |
| Discussion .....                                                                                                                              | 21  |
| Group Size .....                                                                                                                              | 21  |
| Predation .....                                                                                                                               | 22  |
| Gear Depredation .....                                                                                                                        | 23  |
| Methodological Considerations .....                                                                                                           | 23  |
| Summary and Conclusions .....                                                                                                                 | 24  |
| Acknowledgements .....                                                                                                                        | 25  |
| References .....                                                                                                                              | 25  |
| Appendices .....                                                                                                                              | 28  |
| Appendix 1. Land-based killer whale surveys conducted on St. Paul and St. George Islands, Alaska from July to October of 2008 .....           | 29  |
| Appendix 2. Sightings of cetacean species during Land-based Surveys conducted on St. George Island, Alaska from July to October of 2008 ..... | 33  |
| Appendix 3. Local and Traditional Knowledge Observations of cetacean Species collected on St. Paul and St. George Islands, Alaska .....       | 35  |
| Appendix 4. Pribilof Community Halibut Longline Fishery Logbook .....                                                                         | 36  |

## LIST OF TABLES

|                                                                                                                                                                                                                                                                                                                                      |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Table 1. Killer whale encounters recorded by Pribilof Island fishing vessels during the 2006 and 2008 halibut fishery. The best estimate of the KW group size is given unless no count (NC) was recorded. ....                                                                                                                       | 10 |
| Table 2. Number of shore-based visual surveys and hours surveyed per week on St. Paul and St. George Island during July-October, 2008. For St. George Island the number of sightings and sightings/hour (in parentheses) are shown for killer whales (KW), fin whales (FW), minke whales (MW) and unidentified whales (UWHALE). .... | 13 |
| Table 3. The number, percent by location, summary group size statistics and time period for killer whale sightings near the Pribilof Islands from 2000-08 as reported during LTK interviews and to the Pribilof Island Sentinel community-based monitoring programs. ....                                                            | 17 |
| Table 4. Summary of killer whale harassment and predation on northern fur seals observed during community-based monitoring activities (fishery logbook and shore-based surveys) and recounted in LTK interviews or reported to the Island Sentinel program. ....                                                                     | 18 |

## LIST OF FIGURES

|                                                                                                                                                                                                                                                                                                                                     |    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Figure 1. The location of shore-based killer whale survey sites on St. George and St. Paul Islands in 2008. Also shown are the locations where Autonomous Recording Units ARUs were deployed during the summer of 2008 by researchers from the University of Alaska, Fairbanks. .                                                   | 9  |
| Figure 2. Map of the Pribilof Archipelago showing the location of killer whale encounters recorded by local fishing vessels during the halibut fishery in 2006 and 2008. The numbers next to the symbols correspond to the encounter numbers listed in Table 1. The inset shows a zoomed in map of St. Paul Island encounters. .... | 11 |
| Figure 3. The overall average group size for killer whale sightings (n = 119) in near-shore waters from 2000-08 as reported in LTK surveys, fisheries logbooks and visual surveys on St. Paul and St. George Islands. ....                                                                                                          | 18 |
| Figure 4. Documentation of a killer whale predation event on September 19, 2003. These photographs were taken by local fisherman Phillip Lestenkof during the halibut fishery off St. Paul Island. ....                                                                                                                             | 19 |
| Figure 5. Killer whale photographed near Dalnoi Point on St. George Island by local fisherman Rodney Lekanof in 2005. This whale was determined to be consistent with the transient ecotype based on visual evaluation of this photograph (John Durban, pers. Comm.). ....                                                          | 19 |
| Figure 6. Two male killer whales previously identified at False Pass on the Alaska Peninsula that were repeatedly observed predating on fur seals on the north side of St. George Island near the village during October and November of 2008. ....                                                                                 | 20 |

**ABSTRACT**

The number of northern fur seal pups born on the Pribilof Islands has decreased by more than 50% since 1975. The reasons for the current decline are poorly understood and the identification of factors that may influence fur seal population dynamics are a high priority for local and regional resource managers. Little is known about the extent of predation on fur seals at Pribilof Island breeding sites. Local observations of killer whale predation on fur seals are not uncommon, however little data exists as to the number of fur seals killed. The objective of this study was to collect baseline information about current and historical trends in the location, numbers and seasonality of killer whales near the islands and the location of predation on fur seals in the near-shore region around the Pribilof Islands. We used a community-based approach that included a logbook program in the local halibut fishery, collection of local and traditional knowledge (LTK) and shore-based visual surveys. To evaluate the effectiveness of our methods we compared our results with concurrent vessel-based surveys and deployment of underwater autonomous recording units in 2008. The patterns that emerge from our study are consistent with the characterization of killer whale ecotypes throughout the eastern North Pacific. Killer whales observed in the near-shore waters of the Pribilof Islands were consistent with the transient ecotype; they were observed in small groups ( $n=119$ , mean=3.2, median = 3.0, IQR = 2.0 – 4.0), were only observed preying upon or harassing marine mammals ( $n=15$  observations) and did not interact with fishing vessels or appear to consume fish. In contrast, killer whales observed by Pribilof fishing vessels near the continental shelf-break were consistent with the resident killer whale ecotype; they occurred in larger groups ( $n=11$ , mean = 13.7, median = 7.0, IQR = 6.0 – 13.5), interacted with fishing vessels and ate fish from halibut longlines. The results of this project demonstrate that with effective training and sufficient effort, an integrated community-based program in a remote location like the Pribilof Islands can collect useful information on killer whales and other ecological phenomena using multiple research methods and platforms.

## INTRODUCTION

Over 50% of the worldwide population of northern fur seals (*Callorhinus ursinus*) breeds on the Pribilof Islands, however the population is currently in decline. The number of pups born on the Pribilof Islands has decreased by more than 50% since 1975 (Towell *et al.* 2006). From 1998 to 2006 pup production has declined by 6.1% per year on St. Paul Island and 3.4% per year on St. George Island (Allen and Angliss 2010) however the St. George population appears to have stabilized since 2008 (NMML unpublished data). Fur seals are currently listed as depleted under the Marine Mammal Protection Act (Allen and Angliss 2010) and there widespread concern about the status of the Pribilof Island population. The reasons for the current decline are poorly understood and the identification of factors that may influence fur seal population dynamics are a high priority for resource managers at both a regional and local level.

A number of factors have been considered to explain the fur seal population declines of recent decades. These include entanglement in marine debris (Fowler 1987; Trites 1992; Fowler 2002), competition with commercial fisheries (York & Hartley 1981; Swartzman & Haar 1983; Trites 1992) and changing environmental conditions (Trites *et al.* 2007). Predation by killer whales (*Orcinus orca*) has been hypothesized as a causal factor in the decline of a suite of North Pacific pinnipeds and sea otters (Springer *et al.* 2003), however this hypothesis has been the subject of considerable debate (DeMaster *et al.* 2006; Trites *et al.* 2007; Wade *et al.* 2007). Existing data are insufficient to fully evaluate this hypothesis as it pertains to the northern fur seal decline. The debate surrounding these questions highlights the importance of evaluating the combined effect of multiple sources of mortality on declining populations of pinnipeds due to the potential for interaction between individual factors (McNamara & Houston 1987; Loughlin & York 2000; DeMaster *et al.* 2006).

Little is known about the extent of predation on fur seals at Pribilof Island breeding sites and throughout their range. The population decline in recent decades has been characterized by variable rates of decline between the two islands. The well documented differences in foraging areas utilized by lactating fur seals from St. Paul and St. George Island during the breeding season (Robson *et al.* 2004; Zeppelin & Ream 2006; Call *et al.* 2008) imply that differences in mortality or birth rates between the two islands may be related to factors in the Bering Sea. At present there is no evidence to suggest different migration routes between breeding sites that could lead to differences in at-sea survival rates between island populations (Ream *et al.* 2005).

Historical evidence indicates that killer whale predation in the Pribilof region is not a new phenomena (e.g. Hanna 1922). However, quantitative estimates of predation rates on free ranging marine mammals are difficult to determine (Barrett-Lennard *et al.* 1995; Estes *et al.* 1998). Gentry and Johnson (1981) estimated that between 3 and 7 percent of the estimated 80,000 fur seal pups born on St. George Island during 1975 may have been killed and eaten by Steller sea lions (*Eumetopias jubatus*). In their study, they cite LTK from St. George residents suggesting that fur seal predation by Steller sea lions was a recent phenomenon on St. George, and did not occur at St. Paul Island. While local observations of killer whale predation on fur seals are not uncommon, little data exists to as to the frequency and extent of fur seals killed on either island.

The objective of this study was to collect baseline information about predation on fur seals in the near-shore region around the Pribilof Islands. We used a community-based approach to assess whether local researchers, fishermen and island residents can provide useful information to improve the understanding of ecological interactions between fur seals and their predators. This approach utilized a logbook program in the local halibut fishery, collection of local and traditional knowledge (LTK) and shore-based visual surveys. Both the LTK survey and fisheries data collection program also focused on collecting specific information on the nature and extent of marine mammal/fisheries interactions in the local halibut fishery. This report summarizes the results of the research that was conducted under two separate grants to the St. George Traditional Council (SGTC), St. George Island Institute (SGII) and Aleut Community of St. Paul Island Tribal Government Ecosystem Conservation Office (ECO) in 2006 and 2008 (University of Alaska Fairbanks Pollock Conservation Cooperative Research Center Grant 06-0036 and Marine Mammal Commission Grant Number E4047740).

## **METHODS**

### *Local Fisheries Data Collection Program*

We used a fishery logbook program to record marine mammal observations in the local subsistence and commercial halibut fishery during 2006 and 2008. Researchers from the Island Sentinel community-based monitoring programs on each island coordinated with the local fishermen's associations to record killer whale sightings made from local fishing vessels. The logbook methodology was designed to be streamlined and simple to increase the probability of successfully gathering useful information in the course of fishing activities. Cooperation and good communication with fishermen was considered an essential part of building an observational network in which local fishermen alerted Island Sentinels and other researchers to the presence and location of killer whales around the islands. Fishermen were contacted regularly during the season to retrieve data and encourage continued participation. Periodic dockside surveys were also conducted to identify and target non-participating fishermen and conduct informal interviews. Training materials were developed and distributed to local fishermen covering standardized methods for killer whale photo identification, pod counts, sex and age determination and documentation of the extent and type of fisheries interactions (e.g. rake marks, damaged catch, and damaged gear). The principle investigator for the 2006 portion of the study, Kate Wynne (UAF), was brought to St. Paul to conduct an initial training and briefing for fishermen and research assistants.

In each year of the study, logbooks were distributed to local fishermen by research assistants on each island (see Appendix 4, Figures 1-4). Each research assistant was given a field coordinators manual with a protocol for standardizing the data collection methodology in each community and data forms to track the distribution and collection of logbooks and interactions with fishermen. The logbooks were designed with a standardized format for recording the location, date and relevant information for killer whale sightings, predation observations and gear interactions. Fields were included for recording additional details such as vessel activity, target species or catch, bait type and whether photos or video were taken. Also of interest was whether any deterrents were used and whether there was any response to deterrents. Guidance was given on how to look for distinctive markings on species observed (e.g. scars, tags or marine debris)

that may help to document repeated sightings of the same pod or individual animal. Fishermen were also encouraged to record observations of killer whale behavior and any interaction with other species. Space was provided in the logbook to encourage the recording of additional observations of interest. All logbook data were transferred to a computer database for archiving, quality control and subsequent analysis.

#### *Local and Traditional Knowledge Survey*

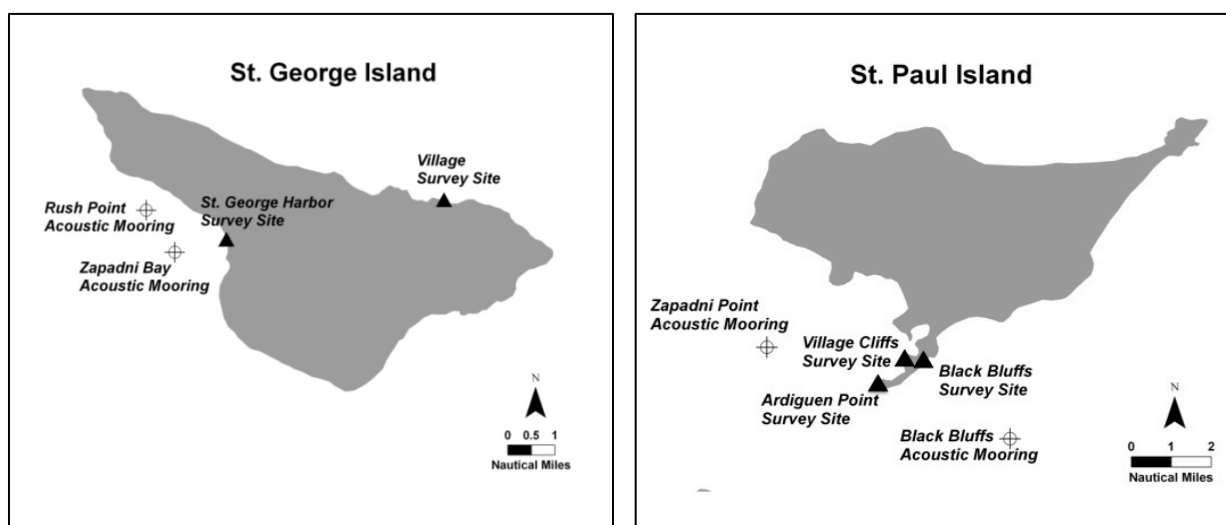
The LTK survey was designed to collect baseline historical information on the spatial and temporal characteristics of killer whales and other fur seal predators in the Pribilof region. We conducted interviews with an array of individuals and groups that had historical data or important insights regarding killer whales. These groups included local fishermen that have participated in the subsistence or commercial halibut fishery, non-resident fishermen who actively fish in the Pribilof region, subsistence hunters and community residents and elders. Local researchers worked with scientific collaborators to develop a standardized survey instrument to gather local and traditional knowledge from study subjects. The survey instrument consisted of detailed manual and a set of four integrated forms. The forms were used to record data during interviews or from notes and recordings following interviews. Scientific collaborators were present on-island during the early stages of the LTK survey to assist local researchers. Interviews were designed to target information on the spatial and temporal occurrence of killer whales and direct observations of predation events. We were also interested in the extent and type of fisheries interactions (e.g. rake marks, damaged catch, or damaged gear) and existence of photographic documentation of these behaviors. Spatial data collected during interviews was geo-referenced and incorporated into a GIS database designed by scientific collaborators and jointly maintained by the Island Sentinel programs.

#### *Shore-based Visual Monitoring*

In the summer and fall of 2008 we conducted shore-based visual surveys for killer whales at sites adjacent to fur seal rookeries on St. George and St. Paul Islands. Observations were made from predetermined observation sites using tripod-mounted adjustable magnification (25x or 40x) Big-Eye binoculars (Victoria B.C. Canada). Sites were chosen to maximize offshore views near fur seal rookeries. Two forms of observation were conducted. First, a consistent set of fixed-time observations was attempted on a regular schedule coinciding with hours when increased killer whale vocal activity was reported on St. Paul Island (Newman and Springer 2007) and when light levels still allowed surveys. Second, opportunistic observations were made when killer whales were observed or reported by community members. For each observation we recorded number of killer whales present, behavioral activities, signs of predation, behavior and distance to nearest fur seals, and general location. Observation locations were also coordinated with the deployment of “Pop Up” Autonomous Recording Units (ARU) by researchers from the University of Alaska Fairbanks UAF so that archived acoustic records could be evaluated in conjunction with visual observations. We also coordinated shore-based survey efforts with researchers from the National Marine Mammal Laboratory (NMML) and North Gulf Oceanic Society (NGOS) that were conducting vessel-based killer whale research during July and August 2008.



Our goal was to conduct surveys for 4 hours per day in two hour blocks allocated during the morning (0800-1200), mid-afternoon (1500-1700) and evening (2000-2400). These time periods were based on the peak sighting periods during previous vessel-based observations (John Durban NMML pers. comm.) and examination of the diurnal pattern of killer whale vocal frequency observed by Newman and Springer (2007) using ARUs in 2006. It was expected that these observation periods would be weather dependent and likely would be skewed toward the afternoon and evening periods due to the frequent presence of dense fog during the morning hours at this time of year in the Pribilof Islands. The shore-based surveys and the fishery logbook programs were coordinated with killer whale vessel-based surveys and acoustic monitoring in 2008 in part to evaluate the effectiveness of the community-based monitoring methods.



**Figure 1.** The location of shore-based killer whale survey sites on St. George and St. Paul Islands in 2008. Also shown are the locations where Autonomous Recording Units ARUs were deployed during the summer of 2008 by researchers from the University of Alaska, Fairbanks.

## RESULTS

### *Fisheries Logbook Program*

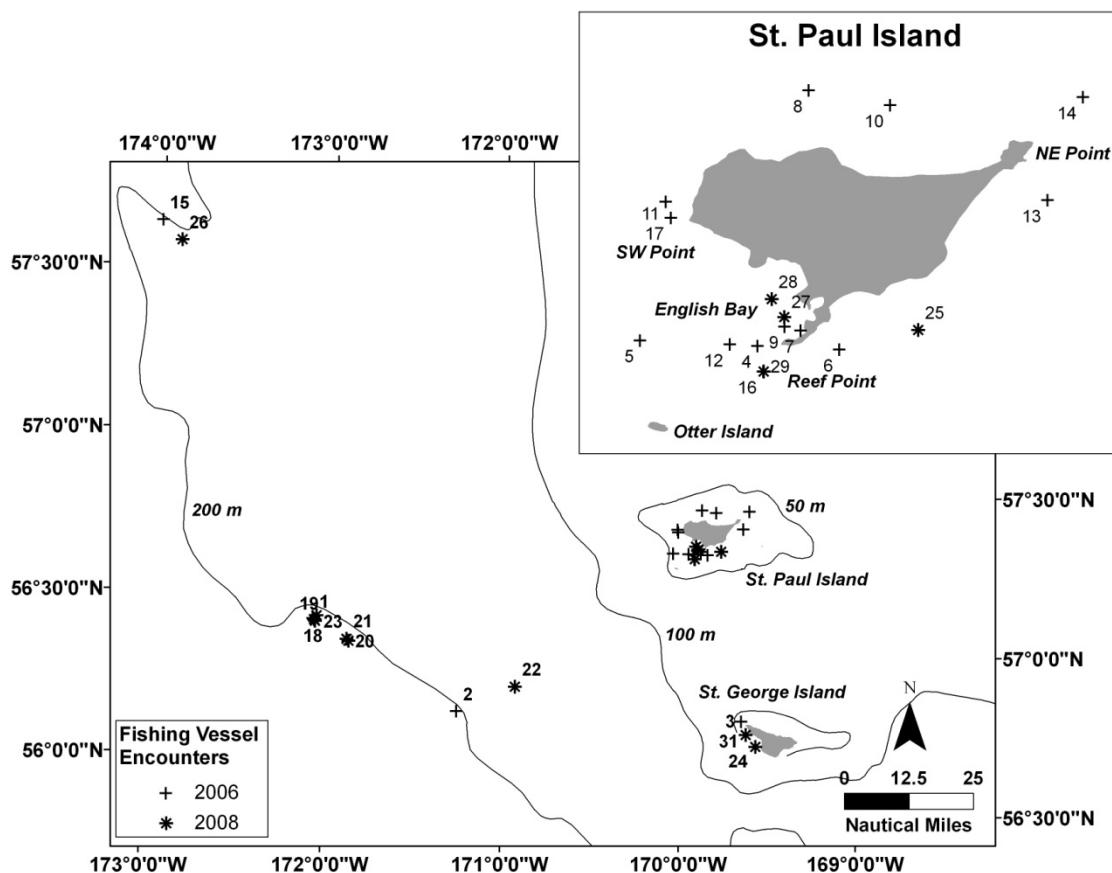
During the 2006 and 2008 commercial halibut fisheries, up to 15 boats from St. Paul and 4 boats from St. George, participated in the logbook program, representing nearly complete coverage of the local fleet. From mid-June through late-September of 2006 fishermen from ten boats recorded 17 sightings of killer whales and in 2008 fishermen from seven boats reported 14 sightings (Table 1). Encounters with killer whales occurred in both the near-shore waters around the Islands and at the continental shelf break (Figure 1). The time at which the whales were sighted was recorded for 24 sightings. The majority ( $n=13$ ) of sightings occurred between the hours 1800-2359 (54%), while 6 sightings (25%) occurred between 0600-1159 and 5 (21%) between 1200-1759. During the study period (June-August), all of these sightings would have occurred during daylight hours.

Killer whales were reported in groups estimated to range in size from 1 to 40 whales. The average group size for all sightings combined in 2006 was 3.7 whales per encounter (median = 4,

**Table 1. Killer whale encounters recorded by Pribilof Island fishing vessels during the 2006 and 2008 halibut fishery. The best estimate of the KW group size is given unless no count (NC) was recorded.**

| No.             | Date      | Time  | Group Size | Location         | Vessel | Vessel Activity     | KW Behavior            |
|-----------------|-----------|-------|------------|------------------|--------|---------------------|------------------------|
| 1               | 21-Jun-06 | 13:00 | 7          | Shelf-Break      | SG-2   | Retrieving          | Gear Depredation       |
| 2               | 22-Jun-06 | n/a   | 7          | Shelf-Break      | SG-2   | Retrieving          | Gear Depredation       |
| 3               | 24-Jun-06 | n/a   | 4          | SG Nearshore, NW | SG-1   | Setting, Retrieving | Following Vessel       |
| 4               | 06-Jul-06 | 21:30 | 2          | SP Nearshore, SW | SG-2   | Traveling           | Traveling, Feeding     |
| 5               | 07-Jul-06 | 18:05 | 7          | SP Nearshore, SW | SG-2   | Traveling           | n/a                    |
| 6               | 07-Jul-06 | n/a   | 3          | SP Nearshore, SW | SP-2   | Retrieving          | Traveling              |
| 7               | 07-Jul-06 | 20:39 | 4          | SP Nearshore, SW | SP-5   | Traveling           | n/a                    |
| 8               | 08-Jul-06 | 10:45 | 1          | SP Nearshore, N  | SP-3   | Retrieving          | Traveling              |
| 9               | 09-Jul-06 | 18:00 | 2          | SP Nearshore, SW | SP-5   | Traveling           | n/a                    |
| 10              | 13-Jul-06 | 20:30 | 1          | SP Nearshore, N  | SP-5   | Retrieving          | n/a                    |
| 11              | 14-Jul-06 | 20:30 | 1          | SP Nearshore, W  | SP-3   | Traveling           | Traveling              |
| 12              | 19-Jul-06 | 20:00 | 4          | SP Nearshore, SW | SP-5   | Traveling           | n/a                    |
| 13              | Jul-06    | n/a   | 4          | SP Nearshore, NE | SP-1   | Traveling           | Traveling              |
| 14              | Jul-06    | n/a   | 4          | SP Nearshore, NE | SP-1   | Traveling           | Patrolling, Travelling |
| 15              | 17-Aug-06 | 11:30 | 6          | Zhemchug Canyon  | SG-2   | Retrieving          | Gear Depredation       |
| 16              | 23-Sep-06 | n/a   | 3          | SP Nearshore, SW | SP-1   | Traveling           | Traveling              |
| 17              | 25-Sep-06 | n/a   | 3          | SP Nearshore, W  | SP-4   | Traveling           | Traveling              |
|                 |           |       |            |                  |        |                     |                        |
| 18              | 8-Jun-08  | 23:30 | 20         | Shelf Break      | SP-6   | n/a                 | n/a                    |
| 19              | 19-Jun-08 | 21:30 | 6          | Shelf Break      | SP-6   | Setting             | n/a                    |
| 20              | 20-Jun-08 | 08:30 | NC         | Shelf Break      | SP-6   | Retrieving          | Gear Depredation       |
| 21              | 20-Jun-08 | 12:30 | NC         | Shelf Break      | SP-6   | Retrieving          | Gear Depredation       |
| 22              | 20-Jun-08 | 12:50 | NC         | Shelf Break      | SP-6   | Retrieving          | Gear Depredation       |
| 23              | 20-Jun-08 | 19:00 | 40         | Shelf Break      | SP-6   | Retrieving          | Gear Depredation       |
| 24              | 7-Jul-08  | 10:30 | 5          | SG Nearshore SW  | SG-3   | Setting             | Traveling              |
| 25 <sup>1</sup> | 10-Jul-08 | 17:15 | 5          | SP Nearshore SE  | SP-5   | n/a                 | n/a                    |
| 26              | 10-Jul-08 | 20:45 | 1          | Zhemchug Canyon  | SP-6   | n/a                 | n/a                    |
| 27 <sup>2</sup> | 18-Jul-08 | 20:50 | 2          | SP Nearshore SW  | SP-1   | Traveling           | Traveling              |
| 28              | 25-Jul-08 | 20:25 | 3          | SP Nearshore SW  | SP-2   | Traveling           | Traveling              |
| 29              | 27-Jul-08 | 22:00 | 6          | SP Nearshore SW  | SP-2   | Traveling           | Feeding                |
| 30 <sup>3</sup> | 28-Jul-08 | 14:00 | 3          | SP Nearshore SW  | SP-6   | Traveling           | Possibly Feeding       |
| 31              | 3-Aug-08  | 12:00 | 1          | SG Nearshore SW  | SG-3   | Traveling           | Traveling              |

<sup>1</sup>Reported to the RV Dora which estimated a group size of 6 killer whales.<sup>2</sup>Reported to the RV Dora which estimated a group size of 3 killer whales.<sup>3</sup>A group of 7 killer whales was reported to the RV Dora which by another fishing vessel 7 hours after this sighting.



**Figure 2.** Map of the Pribilof Archipelago showing the location of killer whale encounters recorded by local fishing vessels during the halibut fishery in 2006 and 2008. The numbers next to the symbols correspond to the encounter numbers listed in Table 1. The inset shows a zoomed in map of St. Paul Island encounters.

IQR<sup>1</sup> = 2 -4) and in 2008 the average group size was 8.4 whales per encounter (median = 5, IQR = 2.5 – 6.0). The largest groups reported were all encountered at the continental shelf break in both 2006 (median = 7, IQR = 6.5 - 7) and 2008 (median = 13, IQR = 4.8 – 25.0). The seven shelf-break sightings for which numbers were estimated were the largest groups of whales reported by Pribilof vessels (Table 1). In general, smaller groups were observed near the islands in both 2006 (median = 3, IQR = 2 – 4) and 2008 (median = 3, IQR = 2.5 – 5.0).

Killer whales were encountered during both setting and retrieval of fishing gear and while traveling to and from the fishing grounds. The majority of the sightings (71%) reported in near-shore waters (n=21) occurred while vessels were traveling (n=15). The rest were recorded during setting and retrieval of fishing gear. In both years of the logbook program, gear depredation by killer whales was only reported by vessels fishing farther away from the islands, usually near the continental shelf break or in the shelf-break canyons. There was no gear depredation reported by vessels fishing close to the islands in either 2006 or 2008. All such interactions (n=7) occurred during gear retrieval. Fishermen reported that the killer whales were following vessels and responding to the sounds generated by the retrieval of fishing gear. In several cases fishermen reported substantial damage to or loss of their catch. Gear depredation usually resulted in vessels having to leave the fishing grounds temporarily. No fishermen that participated in the logbook program reported using deterrence methods.

Observations of other species were also reported by local vessels, including; fin whales (*Balaenoptera physalus*), minke whales (*Balaenoptera acutorostrata*), unidentified large whales, Steller sea lions, northern fur seals, and Laysan albatross (*Phoebastria immutabilis*), ancient murrelets (*Synthliboramphus antiquus*), and coho salmon (*Oncorhynchus kisutch*). Both fin and minke whales were repeatedly sighted by vessels fishing near Dalnoi Point and other areas south and west of St. George Island. One fin whale with a distinctive “notched” dorsal fin was photographed that had been previously observed in this area.

#### *Shore-based Surveys*

Shore-based visual surveys began on St. George Island on 6 July and were conducted until 28 October 2008. There was a break in effort between 11 August and 1 September in order to allocate more survey effort in the fall when northern fur seal pups spend increasing time in the water (Appendix 1; Table 1). A total of 78 surveys were conducted on 58 days from the St. George harbor and Village survey sites (Figure 1). The average survey duration on St. George Island was 104 minutes (SD = 27.3; Range 39 – 165 minutes). On St. Paul Island surveys began on 15 July and were conducted until 7 October 2008 with a similar break in effort between 13 August and 15 September (Appendix 1 Table 2). A total of 27 surveys were conducted on 20 days. The average survey duration on St. Paul Island was 65 minutes (SD = 39.3; Range 1 – 133 minutes).

Three cetacean species were identified during shore-based surveys; killer whales, fin whales and minke whales (Table 2 and Appendix 2; Table 1). Observers on St. George Island recorded sightings of killer whales during surveys on 5 occasions; three times during the first week of

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<sup>1</sup> The inter-quartile range (IQR) is defined as the distance between the first quartile (25<sup>th</sup> percentile) and the third quartile (75<sup>th</sup> percentile).

**Table 2. Number of shore-based visual surveys and hours surveyed per week on St. Paul and St. George Island during July-October, 2008. For St. George Island the number of sightings and sightings/hour (in parentheses) are shown for killer whales (KW), fin whales (FW), minke whales (MW) and unidentified whales (UWHALE).**

|                   | St. Paul Island |       | St. George Island |       |          |          |          |           |           |
|-------------------|-----------------|-------|-------------------|-------|----------|----------|----------|-----------|-----------|
| Week <sup>1</sup> | Surveys         | Hours | Surveys           | Hours | KW       | FW       | MW       | UWHALE    | Total     |
| 28                | 0               | 0     | 12                | 21.5  | 3 (0.14) | 0        | 0        | 0         | 3 (0.14)  |
| 29                | 5               | 2.3   | 3                 | 4.8   | 0        | 0        | 0        | 0         | 0         |
| 30                | 5               | 3.6   | 10                | 18.5  | 0        | 1 (0.05) | 0        | 0         | 1 (0.05)  |
| 31                | 6               | 9.8   | 9                 | 17.7  | 0        | 0        | 1 (0.06) | 1 (0.06)  | 2 (0.11)  |
| 32                | 2               | 2.6   | 7                 | 13.8  | 0        | 1 (0.07) | 0        | 2 (0.15)  | 3 (0.22)  |
| 33                | 2               | 1.6   | 1                 | 2.0   | 0        | 0        | 0        | 0         | 0         |
| 34                | 0               | 0     | 0                 | 0     | --       | --       | --       | --        | --        |
| 35                | 0               | 0     | 0                 | 0     | --       | --       | --       | --        | --        |
| 36                | 0               | 0     | 7                 | 13.2  | 0        | 1 (0.08) | 0        | 1 0.08)   | 2 (0.15)  |
| 37                | 0               | 0     | 1                 | 0.7   | 0        | 1 (1.54) | 0        | 0         | 1 (1.54)  |
| 38                | 5               | 7.2   | 3                 | 4.3   | 0        | 2 (0.46) | 1 (0.23) | 0         | 3 (0.69)  |
| 39                | 0               | 0     | 5                 | 7.1   | 0        | 2 (0.28) | 3 (0.42) | 8 (1.13)  | 13 (1.84) |
| 40                | 0               | 0     | 7                 | 10.8  | 0        | 2 (0.19) | 3 (0.28) | 2 (0.19)  | 7 (0.65)  |
| 41                | 2               | 2.6   | 6                 | 8.5   | 1 (0.12) | 5 (0.59) | 2 (0.24) | 1 (0.12)  | 9 (1.06)  |
| 42                | 0               | 0     | 4                 | 7.3   | 1 (0.14) | 0        | 1 (0.14) | 1 (0.14)  | 3 (0.41)  |
| 43                | 0               | 0     | 2                 | 3.5   | 0        | 1 (0.29) | 0        | 0         | 4 (1.14)  |
| 44                | 0               | 0     | 1                 | 2.0   | 0        | 0        | 0        | 0         | 3 (1.50)  |
|                   |                 |       |                   |       |          | 16       | 11       |           | 54        |
| Total             | 27              | 29.5  | 78                | 135.4 | 5 (0.04) | (0.12)   | (0.08)   | 16 (0.12) | (0.40)    |

<sup>1</sup>Weeks are calculated from Sunday to Sunday and week 28 began on Sunday July 6, 2008.

surveys (week 28) and one time each during weeks 41 and 42 in late-October. No killer whales were observed during shore-based visual surveys on St. Paul Island during 2008. The average group size of killer whales observed during St. George Island Surveys was 3.2 whales per sighting (median = 3, IQR = 2.0 – 4.0). During the three weeks when killer whales were sighted during surveys on St. George the rate of sightings per hour ranged from 0.12 to 0.14 (Table 2). Fin whales and minke whales were sighted with greater frequency during the later months of the survey season (Table 2).

To assess the effectiveness of shore-based surveys we cross-referenced the survey times for both islands to observations of killer whales recorded by research vessel surveys, fishery logbooks, LTK surveys and with preliminary data for the ARUs. This comparison was complicated somewhat by differences in both vessel and shore-based survey effort between islands and the placement of ARUs only on the south side of St. George although shore-based surveys were conducted on both the north and south sides. Vessel-based killer whale surveys by NMML and NGOS researchers aboard the RV Dora began on 5 July and continued until 13 August 2008. A total of 14 encounters with killer whales were recorded near St. Paul Island (where the majority of vessel survey effort occurred) and one brief sighting occurred while transiting between the islands. All but three of the St. Paul Island encounters occurred before 21 July 2008 and no encounters were recorded in August despite good weather conditions for most of the survey

period. The RV Dora did not have any encounters with killer whales near St. George Island on either of two separate days in late-July when they circumnavigated the island. Data for all killer whale encounters by the RV Dora were provided for this analysis (John Durban and Craig Matkin pers. comm.). Archival ARUs were deployed on 6 June near Zapadni Point and Black Bluffs off St. Paul Island and 3 July near Rush Point and in Zapadni Bay off of St. George Island (Figure 1). The ARUs were operational for 60 days at St Paul Island and 38 days at St. George Island. Due to the volume of data collected by ARUs and proprietary concerns, ARU data were provided primarily for times when shore-based surveys were conducted.

All of the St. George Island sightings of killer whales ( $n=3$ ) and baleen whales ( $n=2$ ) were cross-referenced with ARU data for the period while the units were deployed. Killer whale sounds were recorded by either one or both of the ARUs during 2 of the 3 of the killer whale sightings recorded in the first week of shore-based surveys (6-13 July). On one occasion (8 July 10:30-10:40) killer whales were sighted during the survey period (10:15-12:20) but were not detected in the initial analysis of ARU data. Killer whale sounds were also recorded by ARUs outside of the survey period on 2 days (7 and 9 July) and on one day (11 July) when there was no survey conducted on the south side of St. George Island. The only time killer whale sounds were recorded during a shore-based survey but not sighted by observers was on 23 July. No whales were observed during the entire 2-hour survey period, however the visibility was poor due to fog and mist. The recordings were made by the Rush Point ARU, the more distant of the acoustic moorings. Neither of the 2 baleen whale sightings that occurred during the time when ARUs were deployed matched with recordings of baleen whale sounds, however baleen whales were detected on other dates.

The local fishing fleet coordinated with researchers aboard the RV Dora and three of the St. Paul Island killer whale encounters were first reported to the RV Dora by St. Paul fishermen (Table 1). However, none of the whales encountered by the RV Dora, reported by local fishermen or detected by the acoustic moorings were sighted during shore-based surveys. The first seven killer whale encounters by the RV Dora took place prior to the first shore-based survey on St. Paul Island on July 15, 2008. Only one of the seven subsequent encounters by the RV Dora occurred during the course of a shore-based survey conducted at Ardiguen Point, however the whale encounter occurred over 5 miles away at Southwest Point and would not likely have been visible from the survey site. The other 6 encounters by the RV Dora all occurred more than 4 hours after the end of the survey conducted that day, three of which were also near Southwest Point. Despite the lack of temporal overlap between the surveys and killer whale encounters, nine of the 14 RV Dora encounters during 2008 were in or near the Reef Point and Harbor areas and should have been easily visible from the survey site, had a survey been in progress and visibility been good. ARU data were checked for all survey periods during July and August when the ARUs were operating. Killer whale sounds were detected by both ARUs shortly before and after the survey on 18 July, however the weather was foggy and the survey was abandoned after 4 minutes. Baleen whales were detected by both St. Paul moorings on 22 July shortly before the beginning of a survey but none were observed during the survey.

#### *Local and Traditional Knowledge Survey*

Forty-eight LTK interviews were conducted during course of the project; 32 on St. Paul Island and 16 on St. George Island. The earliest reported observations of killer whales were made in

1976; however most of the interview records were from 2000 or later. There were 27 sightings of killer whales reported between May and November of 2006 and 19 during the same period in 2008 for the two islands combined. Observations recorded by the Island Sentinel community-based monitoring program on each island (including incidental observations recorded by SGII researchers) contributed an additional 41 sightings of killer whales to the LTK database (St. George  $n=20$ ; St. Paul  $n=21$ ) for a combined total of 104 LTK observations. Observations of other species were also recorded during LTK interviews including fin whales, minke whales, gray whales (*Eschrichtius robustus*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), unidentified large whales, dall's porpoise (*Phocoenoides dalli*), and unidentified sharks.

LTK observations of killer whales were concentrated in areas frequently visited by community members, hunters and fishermen and the highest percentage of observations on each island occurred in the near-shore area close to each village (Table 3). On St. George Island, 64.7% of the sightings were made from the village ( $n=22$ ) and on St. Paul Island, 42.4% of the sightings ( $n=25$ ) occurred in the Reef Point, Village and East Landing areas near the village. Sightings were also common at both Southwest Point (16.9%) and Northeast Point (22%) on St. Paul Island. The majority (63%) of killer whale observations were made during the summer months, followed by fall/winter (34%) and spring (8%). In 97 of the LTK sightings reported, observers estimated the number of the killer whales that were present (Table 3). The average group size reported from 2000 to 2008 for near-shore sightings was 3.0 on St. George Island ( $n=34$ , median = 3.0, IQR = 2.0 – 4.0) and 3.3 on St. Paul Island ( $n=59$ , median = 3.0, IQR = 2.5 – 4.0). The overall mean group size of near-shore sightings for the two islands combined was 3.2 ( $n=93$ , median = 3.0, IQR = 2.0 – 4.0). Killer whales encountered in offshore waters had an average group size of 16.0 ( $n = 4$ , median = 6.5, IQR = 4.8 – 17.8), however there were relatively few sightings reported independent of the fishery logbook program.

#### *Predation on Northern Fur Seals*

Killer whale predation on northern fur seals was reported in LTK surveys or Island Sentinel observations spanning the period from 1981 to 2008 and detailed information was recorded for 11 likely harassment or predation events during this period. These events are summarized in Table 4 with an additional 4 predation events recorded during shore-based surveys or in fishery logbooks. The most recent killer whale predation on northern fur seals observed by local fishermen was reported by vessel SNP-2 from St. Paul Island on July 27, 2008 (Tables 1 & 4). The crew observed killer whales herding seals and jumping out of water and they saw 2 northern fur seals killed in the course of this predation event. The following day another vessel (SNG-6) observed killer whales in the same general area and reported that they were possibly feeding. There were no predation events on northern fur seals reported by fishermen from either island during the 2006 halibut fishery. Fishermen attributed this to the prevalence of foggy conditions during the 2006 season. Prior to this a predation event was reported to the Island Sentinel program by a St. Paul fishing vessel on September 19, 2003. This kill was documented with video and still photography and fur seal remains were photographed in the water following the

event (Figure 4). No predation by killer whales on Steller sea lions or any species other than fur seals was reported during this study<sup>2</sup>.

Two of the shore-based survey killer whale sightings recorded on St. George Island in early July involved harassment or predation on fur seals. Following the end of dedicated survey effort in October, two additional killer whale harassment or predation events on northern fur seals were observed and reported to the Island Sentinel program by SGII researchers. The same group of killer whales was observed on a regular basis in the vicinity of the village and North rookery and was assumed to be feeding on fur seal pups.

Steller sea lion predation on northern fur seal pups was also reported during LTK interviews on St. George Island (n=7 events). Two observations of Steller sea lions feeding on fur seal pups in 2006 were also reported to the island sentinel program. Sea lions predating on fur seals were usually judged to be lone individuals and in all cases were only observed preying on pups. No observations of Steller sea lions predating on fur seals were reported on St. Paul Island.

#### *Overall Killer Whale Group Size*

To further evaluate the group size of killer whales observed near the Pribilof Islands we pooled estimates from all three sources (fishery logbooks, shore-based surveys and LTK observations) from 2000 to 2008. The average group size for near-shore sightings ranged from a minimum of 2.4 in 2004 to a maximum of 4.4 in 2001 and did not show any discernable trend by year for the two islands combined (Figure 3). The average group size of killer whales reported using community-based monitoring techniques was 3.2 whales per observation (n = 119, median = 3.0, IQR = 2.0 – 4.0).

#### *Killer Whale Photo-Identification*

Several killer whale observations and one predation event were documented with photographs that have been used for photo-identification of individual killer whales in the Pribilof region (e.g. Figures 4 -6). The male killer whale shown in Figure 5 was photographed near Dalnoi Point on St. George Island. This whale had not been previously photographed near the Pribilofs and was determined to be consistent with the transient ecotype based on visual examination of the photograph (John Durban pers. comm.). During the fall of 2008 a group of 3 killer whales previously identified at False Pass on the Alaska Peninsula as WT137, WT138 and WT141 was repeatedly observed predating on fur seals on the north side of St. George Island near the village (Figure 5). The predation event shown in Figure 4 photographed by a St. Paul fishing vessel on September 19, 2003 involved two of the same individuals, indicating that these killer whales are regular fall visitors to the Pribilof Islands.

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<sup>2</sup> Following the completion of this study a predation attempt on Steller sea lions near Kitasilox haulout on the northeast side of St. George Island on 19 February 2009 at 10:00 AM was reported to the Island Sentinel program. No sea lion mortality was observed at this time. Preliminary evaluation of photos taken during the sighting indicated that these were the same killer whales that were repeatedly present at St. George during October-November, 2008.



**Table 3. The number, percent by location, summary group size statistics and time period for killer whale sightings near the Pribilof Islands from 2000-08 as reported during LTK interviews and to the Pribilof Island Sentinel community-based monitoring programs.**

| Location                 | N (%)     | Killer Whale Group Size |        |      |      |                  | Sighting Year |        |
|--------------------------|-----------|-------------------------|--------|------|------|------------------|---------------|--------|
|                          |           | Mean                    | Median | Min. | Max. | IQR <sup>1</sup> | Earliest      | Latest |
| <u>St. George Island</u> |           |                         |        |      |      |                  |               |        |
| Cascade Pinnacle         | 1 (2.9)   | --                      | --     | 4    | --   | --               | 2007          | --     |
| Rush Pt.                 | 1 (2.9)   | --                      | --     | 2    | --   | --               | 2003          | --     |
| Zapadni Bay              | 2 (5.9)   | --                      | --     | 1    | 1    | --               | 2005          | 2006   |
| Staraya Artil            | 3 (8.8)   | 3.7                     | 4.0    | 3    | 4    | 3.5-4.0          | 2004          | 2008   |
| Dalnoi Pt.               | 5 (14.7)  | 3.6                     | 4.0    | 1    | 5    | 4.0-4.0          | 2005          | 2006   |
| Village                  | 22 (64.7) | 3.0                     | 4.0    | 1    | 4    | 2.5-4.0          | 2004          | 2008   |
| <b>Total</b>             | 34        | 3.0                     | 3.0    | 1    | 5    | 2.3-4.0          | 2003          | 2008   |
| <u>St. Paul Island</u>   |           |                         |        |      |      |                  |               |        |
| High Bluffs              | 1 (1.7)   | --                      | --     | 8    |      | --               | 2006          | --     |
| Village                  | 2 (3.4)   | --                      | --     | 4    | 5    | --               | 2005          | 2006   |
| Lukanin                  | 3 (5.1)   | 3.3                     | 3.0    | 3    | 4    | 3.0-3.5          | 2001          | 2005   |
| Ridgewall                | 3 (5.1)   | 4.0                     | 3.0    | 1    | 8    | 2.0-5.5          | 2001          | 2006   |
| Zapadni Pt.              | 4 (6.8)   | 3.8                     | 3.5    | 3    | 5    | 3.0-4.3          | 2002          | 2006   |
| East Landing             | 6 (10.2)  | 3.0                     | 3.5    | 1    | 5    | 1.5-4.0          | 2000          | 2006   |
| Southwest Pt.            | 10 (16.9) | 3.5                     | 4.0    | 1    | 5    | 3.0-4.0          | 2001          | 2006   |
| NE Point                 | 13 (22.0) | 3.0                     | 3.0    | 1    | 5    | 2.0-4.0          | 2001          | 2007   |
| Reef Point               | 17 (28.8) | 3.0                     | 3.0    | 1    | 5    | 1.0-4.0          | 2000          | 2008   |
| <b>Total</b>             | 59        | 3.3                     | 3.0    | 1    | 8    | 2.5-4.0          | 2000          | 2008   |
| Offshore                 | 4         | 16.0                    | 6.5    | 1    | 50   | 4.8-17.8         | 2005          | 2006   |

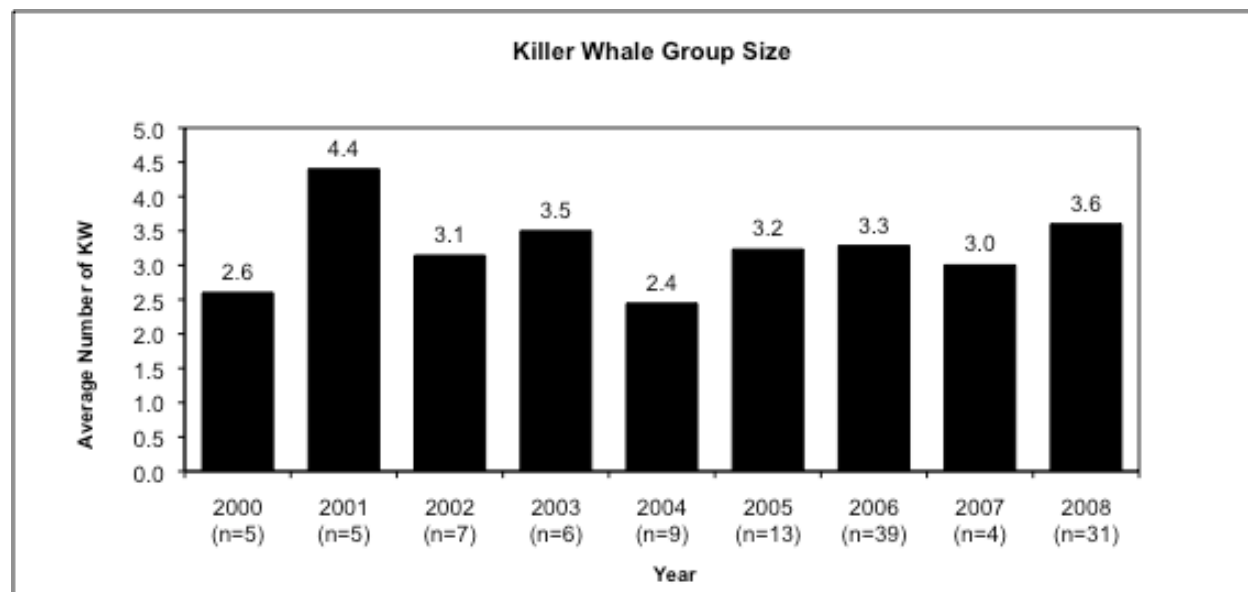
<sup>1</sup> The inter-quartile range (IQR) is defined as the distance between the first quartile (25<sup>th</sup> percentile) and the third quartile (75<sup>th</sup> percentile).

**Table 4. Summary of killer whale harassment and predation on northern fur seals observed during community-based monitoring activities (fishery logbook and shore-based surveys) and recounted in LTK interviews or reported to the Island Sentinel program.**

| Date/Time                  | Island | Location    | KW Group Size | Interaction         | Evidence                  |
|----------------------------|--------|-------------|---------------|---------------------|---------------------------|
| 8/30/03 18:00              | STP    | Kitovi      | UNK           | Feeding?            | N/A                       |
| 9/19/03                    | STP    | NE Point    | 4             | Kill                | Seal pieces in water      |
| June, 2004                 | STP    | Reef Point  | 1             | Harassment          | Pursuit, harassment       |
| 10/1/04 10:58              | STP    | Reef Point  | 1             | Feeding             | Pursuing pups?            |
| 11/4/06 8:30               | STP    | Reef Point  | 3             | Harassment, Feeding | Pursuit,                  |
| 11/6/06 13:12              | STP    | NE Point    | 1             | Feeding?            | N/A                       |
| 11/20/07 13:24             | STP    | Reef Point  | 2             | Feeding?            | N/A                       |
| 11/27/07 13:52             | STP    | NE Point    | 2             | Feeding?            | N/A                       |
| 7/8/08 10:15 <sup>1</sup>  | STG    | Zapadni Bay | 2             | Feeding?            | Flipper or tail slapping  |
| 7/10/08 8:50 <sup>1</sup>  | STG    | Zapadni Bay | 5             | Harassment, Kill?   | Pursuit                   |
| 7/27/08 22:00 <sup>2</sup> | STP    | Reef Point  | 6             | Kill, Feeding       | 2 seals killed            |
| 7/28/08 14:00 <sup>2</sup> | STP    | Reef Point  | 3             | Feeding?            | N/A                       |
| 10/23/08 17:30             | STG    | Village     | 3             | Feeding             | Tail slapping, porpoising |
| 11/7/08 10:44              | STP    | Reef Point  | 3             | Feeding?            | N/A                       |
| 11/12/08 11:30             | STG    | Village     | 2             | Kill                | Pursuit, slick on water   |

<sup>1</sup>Recorded during shore-based surveys.

<sup>2</sup>Recorded by local fishing vessels near St. Paul Island.



**Figure 3. The overall average group size for killer whale sightings (n = 119) in near-shore waters from 2000-08 as reported in LTK surveys, fisheries logbooks and visual surveys on St. Paul and St. George Islands.**



**Figure 4. Documentation of a killer whale predation event on September 19, 2003. These photographs were taken by local fisherman Phillip Lestenkof during the halibut fishery off St. Paul Island.**



**Figure 5. Killer whale photographed near Dalnoi Point on St. George Island by local fisherman Rodney Lekanof in 2005. This whale was determined to be consistent with the transient ecotype based on visual evaluation of this photograph (John Durban, pers. Comm.).**



**Figure 6. Two male killer whales previously identified at False Pass on the Alaska Peninsula that were repeatedly observed predating on fur seals on the north side of St. George Island near the village during October and November of 2008.**

## DISCUSSION

The results of this project demonstrate that an integrated community-based program in a remote location like the Pribilof Islands can collect valuable information on killer whales and species using multiple research methods and platforms. The LTK interviews and fishery logbook program provided information on the spatial distribution, group size and ecological interactions among killer whales and other marine mammals around the Pribilof Islands. The shore-based survey and Island Sentinel monitoring programs further demonstrated that if there is adequate training and survey effort, a community-based monitoring program can provide accurate data and photo-documentation on the presence of ephemeral species like killer whales throughout the year that complements the research conducted by management agencies and academic institutions.

The patterns that emerge from our study are consistent with the characterization of killer whale ecotypes in the eastern North Pacific (Barrett-Lennard *et al.* 1996; Matkin *et al.* 1999; Barrett-Lennard 2000) and more recently in the eastern Aleutian (Matkin *et al.* 2007) and Pribilof Islands (Durban *et al.* In Prep.) Killer whales observed in the near-shore waters of the Pribilof Islands were consistent with the transient ecotype; they were observed in small groups, preyed exclusively on marine mammals and did not interact with fishing vessels or appear to consume fish. In contrast, killer whales observed by Pribilof fishing vessels near the continental shelf-break were consistent with the resident killer whale ecotype; they occurred in larger groups, interacted with fishing vessels and ate fish from halibut longlines. Although we cannot conclusively classify the killer whales into either ecotype based on these data alone (Matkin *et al.* 2007), the results of the logbook program, shore-based surveys, LTK interviews and Island Sentinel observations provide valuable information on several specific aspects of killer whale behavior and ecology in the Pribilof region.

### *Group Size*

The logbook program, LTK interviews and shore-side surveys consistently indicate that killer whales near the islands were most frequently observed in smaller groups of approximately 3-4 individuals. In contrast, killer whale groups observed near the continental shelf break typically ranged from 6-50 killer whales. These observations are consistent with published data for the Pribilof Islands and southeastern Bering Sea. Barreta and Hunt (1994) observed killer whales in varying group sizes up to twelve. However their survey data is presented as whales/100 km, so it is difficult to compare directly with the results of this study. Barreta and Hunt (1994) did observe fewer whales per 100 km surveyed in near-shore and continental shelf waters than at the shelf-break, which is consistent with our results. Waite *et al.* (2002) calculated average killer whale group sizes of 5.0 and 4.5 for transect surveys conducted in 1999 and 2000 respectively. Their surveys were conducted in conjunction with hydro-acoustic trawl surveys conducted in June of each year. Most of their sightings occurred near the Alaska Peninsula and the Pribilof Islands, however they did not calculate separate group size estimates for near-shore and offshore sightings. The most recent information on killer whale group size for the Pribilof region is that summarized by Durban *et al.* (in prep.) In their study transients typically occurred in smaller groups (median = 4, IQR = 3 - 5) than residents (median 11, IQR = 7 - 20) when encountered during surveys in proximity to the Pribilof Islands.

The data collected by fishermen and reported by community members may slightly underestimate of the true killer whale group size near the islands. In the studies by Barreta and Hunt (1994) and Waite et al. (2002) cited above, group size estimates were made from transect surveys that summarized killer whale sightings from near-shore and more distant waters. This may have resulted in higher average group sizes if larger resident killer whale groups near the shelf-break were included in the group size calculations. Transect surveys can also overestimate the true group size in an area if smaller groups are more likely to be missed (Waite et al. 2002). The Pribilof near-shore sightings from our study were usually made from a distance, without closer approach to obtain a more accurate estimate of numbers. Zerbini et al. (2007) have shown that initial group size (IGS) estimates such as this tend to underestimate the true size of the group. Post-encounter group size estimates (PEGS), where extra time is taken at closer range to better determine the number of individual whales present, usually result in larger group size estimates (Zerbini et al. 2007). In our study two sightings of killer whales reported in fishery logbook program were also reported to the RV Dora at the time of the sighting. In both cases, the IGS recorded by fishermen was 1 killer whale less than the PEGS reported by researchers on the RV Dora. Lastly, many of the sightings in this study were made by a wide range of Pribilof community members with varying experience at counting wildlife. Due to these considerations our estimates are best considered as a minimum estimate of the true killer whale group size.

### *Predation*

Observations of killer whale predation events on small cetaceans and pinnipeds are relatively rare, sometimes even during directed survey efforts. Heise et al. (2003) used a mariners survey to gather information similar to that in our LTK survey. They found that “Mariners spent an average of 8100 hours on the water for each observation of a killer whale/sea lion interaction and 125 000 hours for each observation of a fatal attack on a sea lion” (Heise et al. 2003). Matkin et al. (2007) logged 22,491 miles in 421 days of surveys in the False Pass-Unimak Island and Eastern Aleutian Islands regions in 2001-04 in a study of killer whale predation. They encountered transient killer whales on 61 occasions and observed 26 successful kills. The majority of these events were kills of gray whale calves (n=18 kills) or other large cetaceans (n=3) in the False Pass region, a predation hotspot for gray whales. Only 4 fur seal predation events and 1 Steller sea lion predation event were observed during their surveys, even though fur seals were the most frequently encountered pinniped. Researchers aboard the RV Dora in 2008 were able to document 22 predation and harassment events during 14 encounters with killer whales near St. Paul, most of which occurred in the Reef Point area which they defined as a predation hotspot (Durban et al. In Prep.).

In the context of these studies, the predation events reported by local fishermen and the LTK information collected in this study may be a useful guide for future research efforts. In the nearshore areas surrounding St. Paul Island, the Northeast Point area ranked second only to Reef Point in the number of killer whale sightings recorded (n=13) and predation and harassment events observed (n=3). Northeast Point is the location of some of the largest fur seal rookeries on St. Paul Island and may be the location of an additional predation hotspot. Similarly, the LTK observations and shore-based surveys on the north side of St. George Island indicate that future efforts should be targeted at this area, where the majority of the St. George fur seal population is located. The community-based monitoring program was able to add data on numbers of killer

whales and photo identifications of recurring individuals around St. George Island that may not have been recorded using ARUs and vessel-based surveys. These data indicate that killer whales probably visit the island throughout the year and may prey on other species when fur seals are not present. Further comparison of these concurrent data sets may provide valuable insight into patterns of killer whale predatory behavior near the Pribilof Islands and the likelihood of detecting killer whales using different methods.

### *Gear Depredation*

Killer whale depredation on longline catches has been documented in the Bering Sea and Aleutian Islands since the mid 1960's (Yano & Dahlheim 1995). Photographic, acoustic and genetic data suggest that killer whales of the resident ecotype are primarily involved in fishery interactions (Matkin et al. 2007). In our study, the only reported gear depredations between killer whales and halibut longline vessels occurred in distant waters near the continental shelf-break. Fishermen described killer whales removing or damaging large amounts of halibut during gear retrieval. One interviewee speculated that the whales relied on the rapidity with which the lines were retrieved to stun or weaken the halibut on ascent, making them easier to remove from the longline. In the near-shore fishery, no gear depredation was reported by vessels fishing close to the islands. Near-shore fishermen stated that the whales left their catch alone. Our results for group size and feeding behavior are consistent with available data that suggest that resident pods of killer whales are primarily responsible for longline gear depredation, and that these whales are primarily found in deeper waters near the shelf-break. Due to declining catches in recent years, some Pribilof fishing vessels have begun fishing farther from the islands in search of productive fishing grounds and killer whale depredation on longline catches may present a serious problem for this sector of the local fleet as they expand their range.

### *Methodological Considerations*

Our analysis of the combined data from vessel surveys, ARUs and shore-based surveys on St. George Island provides some useful insights into implementing a successful community-based survey program. First, although it is likely that shore-based surveys cannot detect every occurrence of killer whales, in combination with additional community-based monitoring data they are likely to accurately characterize the presence of killer whales near the island. This is provided that the observations take place in areas that killer whales are likely to hunt (i.e. predation hotspots). It is important in this regard to determine the location of hotspots and other areas of frequent killer whale occurrence using dedicated vessel surveys and other methods such as LTK information or vessel logbooks. Second, the lack of killer whale sightings on St. Paul during shore-based surveys when other methods documented their presence indicates that additional training and increased survey effort may be required for a community-based killer whale survey effort to be successful there. In retrospect, if the St. Paul surveys had been begun early in July when killer whale sightings and predation events were both common, the St. Paul staff could have better developed the survey skills and "search image" necessary to effectively conduct shore-based surveys. These issues are not difficult to anticipate and resolve and are important to consider when implementing a community-based monitoring program in an isolated rural setting like the Pribilof Islands.

### *Summary and Conclusions*

In summary, the information collected during this study, demonstrates that relevant ecological information on killer whales in the Pribilof region can be collected through community-based research. While there are limitations to the type of data that can be collected at present, appropriately designed local research can aid in the design and implementation of more focused studies to increase our understanding of killer whale behavior and interactions with other marine mammals and people in the Pribilof region. Given the enthusiastic participation of Pribilof fishermen and local residents, with sufficient support and training local researchers and fishermen can to continue to collect opportunistic killer whale sighting and photo-identification information such as that demonstrated by this study. In addition to periodic focused studies by outside research institutions, consistent community-based research efforts can provide a low cost means to collect long-term data on the local killer whale population and its ecological interactions with other local species. The local Island Sentinel program can provide a centralized structure for fishermen and community members to report their sightings and ensure their transmission to other community members and appropriate research institutions.



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## APPENDICES

|                                                                                                                                              |    |
|----------------------------------------------------------------------------------------------------------------------------------------------|----|
| Appendix 1. Land-based killer whale surveys conducted on St. Paul and St. George Islands, Alaska from July to October of 2008.....           | 29 |
| Appendix 2. Sightings of cetacean species during Land-based Surveys conducted on St. George Island, Alaska from July to October of 2008..... | 33 |
| Appendix 3. Local and Traditional Knowledge Observations of cetacean Species collected on St. Paul and St. George Islands, Alaska.....       | 35 |
| Appendix 4. Pribilof Community Halibut Longline Fishery Logbook .....                                                                        | 36 |

# APPENDIX 1. LAND-BASED KILLER WHALE SURVEYS CONDUCTED ON ST. PAUL AND ST. GEORGE ISLANDS, ALASKA FROM JULY TO OCTOBER OF 2008.

**Appendix 1. Table 1. Land-based killer whale surveys conducted on St. George Island, Alaska from July to October of 2008.**

| Survey Number       | Survey Location | Start Date/Time | Duration (min) | Weather                  | Wave Ht.    | Wind     | Wind Dir. | Temp. Deg. F | Tide |
|---------------------|-----------------|-----------------|----------------|--------------------------|-------------|----------|-----------|--------------|------|
| SNG-1               | Village         | 7/6/08 14:25    | 55             | clear                    | 10ft-12ft   | 4-7mph   | NW        | 49           | Mid  |
| SNG-2               | Village         | 7/6/08 15:26    | 60             | clear                    | 10ft-12ft   | 4-7mph   | NW        | 49           | Mid  |
| SNG-3 <sup>1</sup>  | Zapadni Bay     | 7/6/08 20:35    | 120            | clear, glare,            | 1/2ft-2ft   | 4-7mph   | NW        | 48           | Mid  |
| SNG-4               | Village         | 7/7/08 8:15     | 120            | clear                    | 4ft-6ft     | 1-3mph   | W         | 48           | Low  |
| SNG-5 <sup>2</sup>  | Zapadni Bay     | 7/7/08 16:15    | 120            | sunny                    | 2ft-4ft     | 1-3mph   | W         | 58           | Low  |
| SNG-6               | Zapadni Bay     | 7/8/08 10:15    | 125            | overcast                 | 1/2ft-2ft   | 4-7mph   | SW        | 45           | High |
| SNG-7               | Village         | 7/8/08 20:30    | 90             | overcast, rain, fog/mist | 4ft-6ft     | 25-31mph | SSW       | 40           | High |
| SNG-8 <sup>3</sup>  | Zapadni Bay     | 7/9/08 17:10    | 120            | pt.cloudy, fog/mist,     | 6ft-10ft    | 4-7mph   | SW        | 50           | High |
| SNG-9 <sup>4</sup>  | Zapadni Bay     | 7/10/08 8:50    | 120            | overcast, fog/mist,      | 2ft-4ft     | 1-3mph   | S         | 45           | Mid  |
| SNG-10              | Village         | 7/10/08 22:10   | 120            | pt.cloudy                | 2ft-4ft     | 13-18mph | SSW       | n/a          | Low  |
| SNG-11              | Village         | 7/11/08 8:00    | 120            | overcast                 | 1/4ft-1/2ft | 13-18mph | SSE       | 6            | Low  |
| SNG-12              | Zapadni Bay     | 7/12/08 16:20   | 120            | overcast                 | 4ft-6ft     | 19-24mph | WNW       | 47           | High |
| SNG-13              | Village         | 7/15/08 12:30   | 60             | overcast, fog/mist,      | 1/4ft-1/2ft | 4-7mph   | NW        | 47           | Low  |
| SNG-14              | Zapadni Bay     | 7/16/08 9:30    | 120            | overcast, fog/mist,      | 2ft-4ft     | 8-12mph  | NW        | 47           | n/a  |
| SNG-15              | Village         | 7/17/08 8:45    | 110            | overcast                 | 4ft-6ft     | 8-12mph  | SW        | 42           | Mid  |
| SNG-16              | Village         | 7/20/08 11:10   | 60             | overcast, fog/mist, rain | 4ft-6ft     | 8-12mph  | WSW       | 45           | Low  |
| SNG-17              | Zapadni Bay     | 7/21/08 19:10   | 120            | overcast                 | 1/2ft-2ft   | 1-3mph   | SW        | 54           | Low  |
| SNG-18              | Village         | 7/22/08 20:40   | 110            | pt.cloudy                | 2ft-4ft     | 1-3mph   | W         | 48           | Low  |
| SNG-19 <sup>5</sup> | Zapadni Bay     | 7/23/08 8:45    | 120            | overcast, fog/mist,      | n/a         | <1mph    | n/a       | 45           | n/a  |
| SNG-20              | Zapadni Bay     | 7/23/08 22:05   | 119            | clear, glare,            | n/a         | n/a      | NW        | 53           | n/a  |
| SNG-21              | Village         | 7/24/08 8:05    | 120            | clear                    | 2ft-4ft     | <1mph    | n/a       | 40           | Low  |
| SNG-22              | Zapadni Bay     | 7/24/08 18:30   | 138            | sunny, clear, glare      | 1/2ft-2ft   | 8-12mph  | WNW       | n/a          | n/a  |
| SNG-23              | Village         | 7/25/08 12:30   | 125            | overcast                 | 1/4ft-1/2ft | 4-7mph   | SW        | n/a          | n/a  |
| SNG-24              | Village         | 7/25/08 21:30   | 70             | overcast                 | <1/4ft      | 4-7mph   | SSW       | 47           | Low  |
| SNG-25              | Village         | 7/26/08 21:25   | 125            | overcast                 | 4ft-6ft     | 13-18mph | N         | 42           | n/a  |
| SNG-26              | Village         | 7/27/08 23:30   | 55             | overcast                 | n/a         | 1-3mph   | N         | 45           | High |
| SNG-27              | Village         | 7/28/08 4:15    | 144            | overcast                 | n/a         | 8-12mph  | E         | 41           | Mid  |
| SNG-28              | Village         | 7/28/08 21:10   | 125            | overcast                 | 1/2ft-2ft   | 4-7mph   | NE        | 46           | n/a  |
| SNG-29              | Village         | 7/29/08 17:30   | 130            | overcast                 | <1/4ft      | 1-3mph   | SSE       | 50           | Mid  |
| SNG-30              | Village         | 7/30/08 15:00   | 140            | overcast                 | 1/2ft-2ft   | 1-3mph   | NE        | 53           | n/a  |
| SNG-31              | Village         | 7/31/08 12:30   | 120            | overcast                 | <1/4ft      | 1-3mph   | N         | 50           | n/a  |
| SNG-32              | Village         | 8/1/08 15:40    | 125            | fog/mist                 | <1/4ft      | <1mph    | NE        | 50           | n/a  |
| SNG-33              | Zapadni Bay     | 8/2/08 10:35    | 120            | overcast                 | <1/4ft      | <1mph    | Variable  | 49           | Low  |

| Survey Number | Survey Location | Start Date/Time | Duration (min) | Weather                              | Wave Ht.    | Wind     | Wind Dir. | Temp. Deg. F | Tide |
|---------------|-----------------|-----------------|----------------|--------------------------------------|-------------|----------|-----------|--------------|------|
| SNG-34        | Village         | 8/2/08 20:20    | 100            | overcast                             | <1/4ft      | <1mph    | Variable  | 48           | High |
| SNG-35        | Zapadni Bay     | 8/5/08 7:40     | 120            | overcast                             | <1/4ft      | <1mph    | Variable  | 45           | Mid  |
| SNG-36        | Village         | 8/5/08 22:05    | 100            | overcast                             | <1/4ft      | <1mph    | Variable  | 46           | Mid  |
| SNG-37        | Village         | 8/6/08 7:45     | 120            | overcast                             | <1/4ft      | <1mph    | Variable  | 43           | Mid  |
| SNG-38        | Zapadni Bay     | 8/6/08 21:40    | 120            | overcast                             | 1/2ft-2ft   | 8-12mph  | NW        | 40           | Mid  |
| SNG-39        | Zapadni Bay     | 8/7/08 7:40     | 95             | overcast                             | <1/4ft      | 1-3mph   | NE        | 46           | Low  |
| SNG-40        | Zapadni Bay     | 8/8/08 18:00    | 165            | overcast, glare, overcast            | 1/2ft-2ft   | 4-7mph   | N         | 42           | n/a  |
| SNG-41        | Village         | 8/9/08 21:50    | 105            | overcast                             | <1/4ft      | <1mph    | Variable  | 44           | High |
| SNG-42        | Village         | 8/11/08 21:00   | 120            | overcast                             | 1/4ft-1/2ft | 1-3mph   | NE        | 50           | High |
| SNG-43        | Zapadni Bay     | 9/1/08 20:00    | 120            | overcast, drizzle,                   | 2ft-4ft     | 13-18mph | NNW       | 45           | High |
| SNG-44        | Village         | 9/3/08 20:15    | 81             | overcast                             | 2ft-4ft     | 4-7mph   | NW        | 46           | High |
| SNG-45        | Village         | 9/4/08 10:00    | 120            | overcast                             | 2ft-4ft     | 4-7mph   | N         | 45           | Mid  |
| SNG-46        | Zapadni Bay     | 9/4/08 14:30    | 110            | overcast                             | <1/4ft      | 4-7mph   | N         | 47           | n/a  |
| SNG-47        | Zapadni Bay     | 9/5/08 11:25    | 120            | overcast                             | <1/4ft      | 1-3mph   | Variable  | 45           | n/a  |
| SNG-48        | Zapadni Bay     | 9/6/08 8:30     | 120            | overcast, partly sunny,              | 2ft-4ft     | 8-12mph  | NW        | 46           | n/a  |
| SNG-49        | Village         | 9/6/08 16:15    | 120            | overcast, fog/mist,                  | 1/2ft-2ft   | 4-7mph   | N         | 46           | High |
| SNG-50        | Village         | 9/10/08 16:08   | 39             | overcast                             | 1/2ft-2ft   | <1mph    | Variable  | 45           | High |
| SNG-51        | Village         | 9/16/08 20:50   | 70             | clear                                | n/a         | 4-7mph   | SW        | n/a          | n/a  |
| SNG-52        | Village         | 9/16/08 20:50   | 70             | overcast                             | n/a         | 1-3mph   | SW        | 43           | n/a  |
| SNG-53        | Village         | 9/17/08 20:50   | 120            | overcast                             | <1/4ft      | 1-3mph   | W         | 43           | n/a  |
| SNG-54        | Zapadni Bay     | 9/21/08 11:00   | 90             | fog/mist                             | 4ft-6ft     | 4-7mph   | W         | 47           | High |
| SNG-55        | Village         | 9/24/08 20:10   | 80             | overcast                             | 4ft-6ft     | 8-12mph  | N         | 42           | Mid  |
| SNG-56        | Village         | 9/26/08 10:00   | 120            | pt.cloudy, drizzle, clear            | 4ft-6ft     | 13-18mph | E         | 43           | Low  |
| SNG-57        | Zapadni Bay     | 9/26/08 16:50   | 60             | clear, sunny, glare                  | 2ft-4ft     | 8-12mph  | NNW       | 50           | High |
| SNG-58        | Village         | 9/27/08 19:30   | 75             | overcast                             | 2ft-4ft     | <1mph    | Variable  | 45           | Low  |
| SNG-59        | Zapadni Bay     | 9/29/08 10:25   | 60             | fog/mist                             | 4ft-6ft     | 4-7mph   | SW        | 46           | High |
| SNG-60        | Village         | 9/29/08 17:30   | 120            | overcast                             | 6ft-10ft    | <1mph    | SSW       | 48           | High |
| SNG-61        | Village         | 9/30/08 17:30   | 120            | pt.cloudy, clear,                    | 2ft-4ft     | 4-7mph   | WSW       | 48           | Mid  |
| SNG-62        | Zapadni Bay     | 10/1/08 17:30   | 45             | pt.cloudy, sunny, glare              | n/a         | 4-7mph   | NW        | n/a          | n/a  |
| SNG-63        | Zapadni Bay     | 10/2/08 9:45    | 120            | pt.cloudy                            | 2ft-4ft     | 4-7mph   | N         | 40           | High |
| SNG-64        | Village         | 10/2/08 17:00   | 60             | pt.cloudy                            | 2ft-4ft     | 13-18mph | NNE       | 40           | Mid  |
| SNG-65        | Village         | 10/3/08 10:10   | 120            | pt.cloudy, heat wave on water,       | 4ft-6ft     | 13-18mph | NNW       | 39           | High |
| SNG-66        | Village         | 10/5/08 19:45   | 60             | pt.cloudy, rain, sleet               | 2ft-4ft     | 32-38mph | NW        | 35           | High |
| SNG-67        | Zapadni Bay     | 10/6/08 11:20   | 120            | pt.cloudy, heat wave on water, sunny | 1/2ft-2ft   | 8-12mph  | WNW       | 42           | High |
| SNG-68        | Village         | 10/6/08 17:30   | 90             | pt.cloudy, heat wave on water,       | 4ft-6ft     | 13-18mph | NNW       | 38           | Mid  |
| SNG-69        | Village         | 10/7/08 10:00   | 90             | pt.cloudy, rain,                     | 1/2ft-2ft   | <1mph    | Variable  | 35           | Low  |
| SNG-70        | Village         | 10/7/08 19:30   | 60             | clear, sunny,                        | 2ft-4ft     | 8-12mph  | E         | 38           | Low  |

| Survey Number | Survey Location | Start Date/Time | Duration (min) | Weather                              | Wave Ht.  | Wind     | Wind Dir. | Temp. Deg. F | Tide |
|---------------|-----------------|-----------------|----------------|--------------------------------------|-----------|----------|-----------|--------------|------|
| SNG-71        | Village         | 10/11/08 10:30  | 90             | pt.cloudy, sunny, heat wave on water | 6ft-10ft  | 19-24mph | NW        | 33           | Low  |
| SNG-72        | Village         | 10/12/08 11:00  | 120            | overcast                             | 1/2ft-2ft | 13-18mph | E         | 33           | Low  |
| SNG-73        | Village         | 10/14/08 19:20  | 60             | overcast                             | 1/2ft-2ft | 1-3mph   | Variable  | 40           | Low  |
| SNG-74        | Village         | 10/15/08 18:50  | 120            | sunny, heat wave on water,           | 2ft-4ft   | 4-7mph   | NE        | 30           | Mid  |
| SNG-75        | Village         | 10/16/08 18:00  | 135            | overcast                             | 1/2ft-2ft | 13-18mph | ENE       | 34           | Low  |
| SNG-76        | Zapadni Bay     | 10/22/08 14:15  | 90             | overcast, partly sunny,              | 4ft-6ft   | 47-54mph | NE        | 36           | n/a  |
| SNG-77        | Village         | 10/23/08 11:15  | 120            | sunny                                | 6ft-10ft  | 19-24mph | W         | 34           | Low  |
| SNG-78        | Village         | 10/28/08 11:00  | 120            | overcast                             | n/a       | 25-31mph | SW        | 40           | n/a  |

<sup>1</sup>Killer whale sounds were recorded on 6 July by the ARU near Rush Point at 0540, between 11:00-12:20 and again at 13:10.

<sup>2</sup>A sighting of 5 KW was reported by FV SNG-3 on 7 July at 10:30am while setting gear on the southwest side of St. George Island. Killer whale sounds were also recorded by the ARU ½ mile outside St. George harbor.

<sup>3</sup>Killer whale sounds were recorded on 9 July by the ARU outside the St. George harbor at 14:50. Baleen whales were also detected at this time.

<sup>4</sup>Killer whale sounds were recorded on 10 July by the ARU near Rush Point at 0940 and later by the ARU outside the St. George harbor at 14:40, 16:10, and 22:10.

<sup>5</sup>Killer whale sounds were recorded on 23 July by the ARU near Rush Point at 09:10, 09:30, 09:40, 09:50, 10:00, 10:40, and again at 13:30.

**Appendix 1 Table 2. Land-based killer whale surveys conducted on St. Paul Island, Alaska from July to October of 2008.**

| Survey Number       | Survey Location | Start Date/Time | Duration (min) | Weather                  | Wave Ht.  | Wind     | Wind Dir. | Temp. Deg. F | Tide |
|---------------------|-----------------|-----------------|----------------|--------------------------|-----------|----------|-----------|--------------|------|
| SNP-1               | Village Cliffs  | 7/15/08 16:35   | 17             | overcast, pt.cloudy,     | 2ft-4ft   | 1-3mph   | S         | 51.6         | High |
| SNP-2 <sup>1</sup>  | Village Cliffs  | 7/16/08 13:43   | 111            | overcast                 | 4ft-6ft   | 13-18mph | SW        | 44.6         | Mid  |
| SNP-3               | Village Cliffs  | 7/17/08 16:10   | 4              | fog/mist                 | 4ft-6ft   | 8-12mph  | WSW       | 43.4         | Mid  |
| SNP-4 <sup>2</sup>  | Village Cliffs  | 7/18/08 16:05   | 4              | fog/mist                 | 4ft-6ft   | 8-12mph  | WNW       | 43           | Low  |
| SNP-5               | Village Cliffs  | 7/19/08 16:20   | 1              | fog/mist                 | 2ft-4ft   | 4-7mph   | WNW       | 43.2         | Low  |
| SNP-6 <sup>3</sup>  | Village Cliffs  | 7/21/08 16:00   | 1              | fog/mist                 | 4ft-6ft   | 4-7mph   | SW        | 46           | Mid  |
| SNP-7               | Village Cliffs  | 7/22/08 16:00   | 5              | fog/mist                 | 2ft-4ft   | 4-7mph   | WSW       | 46.1         | Low  |
| SNP-8 <sup>4</sup>  | Village Cliffs  | 7/22/08 17:53   | 72             | overcast                 | 2ft-4ft   | 8-12mph  | SW        | 49.5         | Low  |
| SNP-9               | Village Cliffs  | 7/22/08 19:05   | 51             | overcast                 | 2ft-4ft   | 8-12mph  | SW        | 49.5         | Low  |
| SNP-10              | Ardiguen Point  | 7/23/08 20:44   | 89             | partly sunny, clear,     | 1/2ft-2ft | 4-7mph   | NW        | 53           | Low  |
| SNP-11              | Ardiguen Point  | 7/28/08 9:27    | 112            | overcast                 | 2ft-4ft   | 4-7mph   | NW        | 46.4         | Low  |
| SNP-12 <sup>5</sup> | Ardiguen Point  | 7/28/08 14:24   | 108            | overcast                 | 4ft-6ft   | 4-7mph   | NE        | 46.1         | Mid  |
| SNP-13              | Ardiguen Point  | 7/29/08 9:31    | 100            | overcast                 | 4ft-6ft   | 4-7mph   | E         | 42.2         | Low  |
| SNP-14 <sup>6</sup> | Ardiguen Point  | 7/29/08 13:30   | 104            | overcast                 | 4ft-6ft   | 4-7mph   | E         | 46.6         | Mid  |
| SNP-15              | Ardiguen Point  | 7/30/08 13:56   | 101            | overcast, pt.cloudy,     | 2ft-4ft   | 4-7mph   | NW        | 48.5         | Low  |
| SNP-16              | Ardiguen Point  | 8/1/08 13:33    | 61             | pt.cloudy, partly sunny, | 2ft-4ft   | 1-3mph   | Variable  | 49.5         | Low  |
| SNP-17              | Ardiguen Point  | 8/4/08 15:42    | 79             | overcast                 | 2ft-4ft   | 1-3mph   | NE        | 44.6         | Low  |
| SNP-18              | Ardiguen Point  | 8/6/08 21:36    | 74             | overcast                 | 1/2ft-2ft | 1-3mph   | Variable  | 43.9         | Mid  |
| SNP-19              | Ardiguen Point  | 8/11/08 15:48   | 73             | overcast                 | 4ft-6ft   | 1-3mph   | NW        | 51.1         | Mid  |
| SNP-20              | Ardiguen Point  | 8/13/08 17:40   | 21             | fog/mist                 | 4ft-6ft   | 1-3mph   | NE        | 42.6         | Mid  |
| SNP-21              | Black Bluffs    | 9/15/08 13:40   | 133            | pt.cloudy                | 4ft-6ft   | 8-12mph  | NNW       | 40.6         | Low  |
| SNP-22              | Ardiguen Point  | 9/17/08 13:40   | 81             | pt.cloudy                | 4ft-6ft   | 13-18mph | NW        | 40.3         | Low  |
| SNP-23              | Black Bluffs    | 9/17/08 15:40   | 70             | pt.cloudy                | 2ft-4ft   | 13-18mph | NW        | 40.2         | High |
| SNP-24              | Black Bluffs    | 9/18/08 18:20   | 68             | pt.cloudy                | 4ft-6ft   | 13-18mph | WNW       | 40.2         | High |
| SNP-25              | Ardiguen Point  | 9/18/08 19:40   | 77             | pt.cloudy                | 4ft-6ft   | 13-18mph | WNW       | 40.5         | High |
| SNP-26              | Black Bluffs    | 10/7/08 18:08   | 81             | fog/mist                 | 6ft-10ft  | 13-18mph | NNE       | 37.8         | High |
| SNP-27              | Ardiguen Point  | 10/7/08 19:45   | 73             | fog/mist                 | n/a       | 13-18mph | NNE       | n/a          | High |

<sup>1</sup>A group of 15 KW was recorded by NMML/NGOS researchers on the RV Dora at Southwest Point between 18:30 and 21:40.

<sup>2</sup>Two separate KW encounters were recorded by the RV Dora on this date: the first from 19:48 – 20:43 (5 whales) and the second from 21:28 – 21:55 (3 whales). Both KW and possible baleen whales were also detected by the ARUs at Zapadni Point and Black Bluffs on St. Paul Island on this date.

<sup>3</sup>The RV Dora recorded an encounter with 4 KW from 20:30 -21:31.

<sup>4</sup>Baleen whales were detected by the ARU at Zapadni Point at 17:40, shortly before the beginning of the survey.

<sup>5</sup>The RV Dora recorded an encounter with 7 KW at Southwest Point from 21:00-22:52. The initial KW sighting was reported to the RV Dora by the FV Cameo.

<sup>6</sup>The RV Dora recorded an encounter with 8 KW from 11:52-13:39 and a second encounter with 7 KW from 20:57-21:57.



## APPENDIX 2. SIGHTINGS OF CETACEAN SPECIES DURING LAND-BASED SURVEYS CONDUCTED ON ST. GEORGE ISLAND, ALASKA FROM JULY TO OCTOBER OF 2008.

**Appendix 2 Table 1. Sightings of killer whales (KW), fin whales (FW), minke whales (MW) and unidentified whales (UWHALE) recorded during shore-based surveys on St. George Island during July-October, 2008.**

| Date                   | Primary Observer | Start Time | End Time | Species | Visibility | ID Confidence | Best Ct. | Location             | Sighting Direction. | Min. Dist. (mi) | Max. Dist. (mi) |
|------------------------|------------------|------------|----------|---------|------------|---------------|----------|----------------------|---------------------|-----------------|-----------------|
| 06-Jul-08 <sup>1</sup> | RK               | 20:35      | 20:45    | KW      | good       | sure          | 2        | Zapadni Bay Offshore | W                   | 1               | 2               |
| 08-Jul-08 <sup>2</sup> | RK               | 10:30      | 10:40    | KW      | excellent  | sure          | 2        | Zapadni Bay          | W                   | 0.5             | 2               |
| 10-Jul-08 <sup>3</sup> | KH               | 9:20       | 10:52    | KW      | excellent  | sure          | 5        | Zapadni Bay Offshore | WNW                 | 2               | 4               |
| 07-Oct-08              | RK               | 10:30      | 10:40    | KW      | excellent  | sure          | 4        | Village-nearshore    | NNW                 | 0.25            | 0.5             |
| 16-Oct-08              | RK               | 18:20      | 18:30    | KW      | excellent  | sure          | 3        | Village-nearshore    | NE                  |                 | 0.25            |
| 22-Jul-08              | RK               | 20:40      | 20:50    | FW      | excellent  | likely        | 1        | Village-offshore     | N                   | 3               | 5               |
| 08-Aug-08 <sup>4</sup> | MM               | 18:00      | 20:45    | FW      | excellent  | likely        | 2        | Zapadni Bay Offshore | SW                  | 6               | 10              |
| 06-Sep-08              | KH               | 9:16       | 9:16     | FW      | excellent  | sure          | 2        | Zapadni Bay Offshore | W                   | 5               | 10              |
| 10-Sep-08              | KH               | 16:47      | 16:47    | FW      | good       | sure          | 1        | Village-offshore     | E                   | 3               | 5               |
| 16-Sep-08              | RK               | 21:10      | 21:10    | FW      | excellent  | sure          | 1        | Village-offshore     | NE                  | 2               | 4               |
| 17-Sep-08              | RK               | 21:15      | 22:05    | FW      | excellent  | sure          | 1        | Village-offshore     | NE                  | 3               | 5               |
| 26-Sep-08              | RK               | 11:05      | 11:05    | FW      | excellent  | not sure      | 1        | Village-offshore     | NW                  | 0.5             | 0.75            |
| 27-Sep-08              | RK               | 20:15      | 20:15    | FW      | excellent  | likely        | 1        | Village-offshore     | NNE                 | 3               | 4               |
| 30-Sep-08              | RK               | 18:10      | 18:10    | FW      | excellent  | likely        | 1        | Village-offshore     | NNE                 | 3               | 5               |
| 30-Sep-08              | RK               | 17:45      | 17:45    | FW      | excellent  | sure          | 1        | Village-offshore     | ENE                 | 1               | 2               |
| 05-Oct-08              | RK               | 20:05      | 20:05    | FW      | excellent  | sure          | 2        | Village-offshore     | NNW                 | 5               |                 |
| 06-Oct-08              | RK               | 18:20      | 18:20    | FW      | excellent  | sure          | 1        | Village-offshore     | NW                  | 6               | 7               |
| 07-Oct-08              | RK               | 11:00      | 11:00    | FW      | excellent  | sure          | 3        | Village-offshore     | WNW                 | 5               | 6               |
| 07-Oct-08              | RK               | 19:32      | 19:32    | FW      | excellent  | sure          | 3        | Village-nearshore    | W                   | 0.5             | 1               |
| 07-Oct-08              | RK               | 19:30      | 19:30    | FW      | excellent  | sure          | 1        | Village-nearshore    | W                   | 0.25            | 0.5             |
| 01-Aug-08 <sup>5</sup> | MM               | 17:05      | 17:05    | MW      | fair       | sure          | 2        | Village-offshore     | NE                  | 3               | 5               |
| 17-Sep-08              | RK               | 21:15      | 21:30    | MW      | excellent  | sure          | 2        | Village-offshore     | NNW                 | 2               | 4               |
| 24-Sep-08              | RK               | 20:15      | 20:15    | MW      | dark       | likely        | 1        | Village-offshore     | N                   | 2               | 3               |
| 26-Sep-08              | RK               | 11:50      | 11:50    | MW      | excellent  | likely        | 1        | Village-offshore     | WNW                 | 0.25            | 0.5             |
| 26-Sep-08              | RK               | 10:40      | 10:40    | MW      | excellent  | likely        | 3        | Village-offshore     | NW                  | 1               | 2               |
| 30-Sep-08              | RK               | 19:17      | 19:17    | MW      | excellent  | likely        | 3        | Village-offshore     | NE                  | 1               | 3               |
| 30-Sep-08              | RK               | 17:40      | 17:40    | MW      | excellent  | likely        | 2        | Village-offshore     | NNE                 | 3               | 5               |
| 02-Oct-08              | RK               | 17:15      | 17:15    | MW      | excellent  | likely        | 1        | Village-offshore     | N                   | 3               | 4               |
| 06-Oct-08              | RK               | 17:45      | 17:45    | MW      | excellent  | sure          | 2        | Village-offshore     | WNW                 | 1               | 2               |
| 07-Oct-08              | RK               | 19:43      | 19:43    | MW      | excellent  | sure          | 2        | Village-nearshore    | NNE                 | 0.5             | 1               |
| 12-Oct-08              | RK               | 11:05      | 11:05    | MW      | excellent  | likely        | 2        | Village-offshore     | NW                  | 3               | 4               |
| 02-Aug-08              | KH               | 12:35      | 12:35    | UWHALE  | good       | not sure      | 1        | Zapadni Bay Offshore | SSW                 |                 |                 |

| Date      | Primary Observer | Start Time | End Time | Species | Visibility | ID Confidence | Best Ct. | Location             | Sighting Direction. | Min. Dist. (mi) | Max. Dist. (mi) |
|-----------|------------------|------------|----------|---------|------------|---------------|----------|----------------------|---------------------|-----------------|-----------------|
| 08-Aug-08 | MM               | 18:10      | 20:45    | UWHALE  | excellent  | not sure      | 5        | Zapadni Bay Offshore | SW                  | 5               | 10              |
| 09-Aug-08 | KH               | 22:03      | 22:03    | UWHALE  | fair       | not sure      | 1        | Village-offshore     | NW                  |                 |                 |
| 04-Sep-08 | KH               | 14:30      | 14:30    | UWHALE  | excellent  | sure          | 3        | Zapadni Bay          | SSE                 |                 |                 |
| 24-Sep-08 | RK               | 20:18      | 20:30    | UWHALE  | dark       | sure          | 1        | Village-offshore     | N                   | 3               | 4               |
| 26-Sep-08 | RK               | 11:00      | 11:00    | UWHALE  | good       | sure          | 1        | Village-offshore     | N                   | 3               | 4               |
| 26-Sep-08 | RK               | 11:30      | 11:30    | UWHALE  | excellent  | sure          | 1        | Village-offshore     | NNW                 | 0.25            | 0.5             |
| 26-Sep-08 | RK               | 12:00      | 12:00    | UWHALE  | excellent  | sure          | 1        | Village-offshore     | ENE                 | 1               | 2               |
| 26-Sep-08 | RK               | 16:55      | 16:55    | UWHALE  | excellent  | sure          | 2        | Zapadni Bay Offshore | W                   | 1               | 2               |
| 26-Sep-08 | RK               | 17:45      | 17:45    | UWHALE  | excellent  | sure          | 1        | Zapadni Bay Offshore | W                   | 3               | 4               |
| 27-Sep-08 | RK               | 19:30      | 19:30    | UWHALE  | good       | sure          | 2        | Village-offshore     | NW                  | 4               | 6               |
| 27-Sep-08 | RK               | 19:40      | 19:40    | UWHALE  | excellent  | sure          | 3        | Village-offshore     | N                   | 3               | 4               |
| 01-Oct-08 | RK               | 17:37      | 17:37    | UWHALE  | excellent  | sure          | 2        | Zapadni Rookery      | W                   | 6               | 7               |
| 02-Oct-08 | RK               | 17:35      | 17:35    | UWHALE  | excellent  | sure          | 1        | Village-offshore     | WNW                 | 6               | 7               |
| 06-Oct-08 | RK               | 18:25      | 18:25    | UWHALE  | excellent  | sure          | 1        | Village-offshore     | NW                  | 4               | 5               |
| 12-Oct-08 | RK               | 11:35      | 11:35    | UWHALE  | excellent  | sure          | 1        | Village-offshore     | N                   | 4               | 5               |

<sup>1</sup>Killer whale sounds were recorded on 6 July by the ARU near Rush Point at 0540, between 11:00-12:20 and again at 13:10.

<sup>2</sup> Killer whale sounds were not detected on 8 July during the initial analysis of ARU data.

<sup>3</sup> Killer whale sounds were detected on 10 July, by the ARU near Rush Point at 0940 and later by the ARU outside the St. George harbor at 14:40, 16:10, and 22:10.

<sup>4</sup>No baleen whale sounds were detected on 8 August at the time of this sighting.

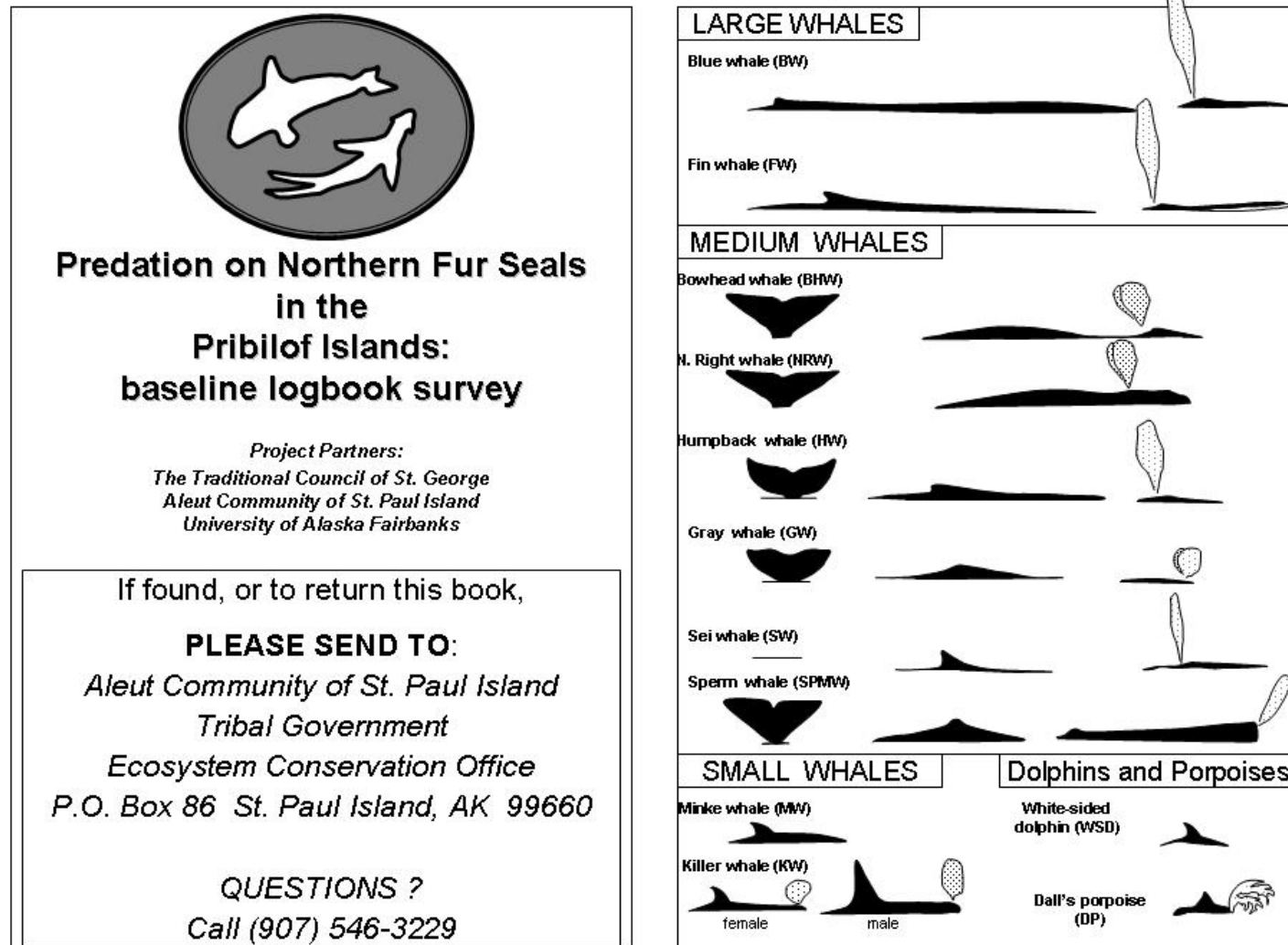
<sup>5</sup>No baleen whale sounds were detected on 1 August at the time of this sighting.

### APPENDIX 3. LOCAL AND TRADITIONAL KNOWLEDGE OBSERVATIONS OF CETACEAN SPECIES COLLECTED ON ST. PAUL AND ST. GEORGE ISLANDS, ALASKA.

**Appendix 3 Table 1. LTK observations of killer whales (KW), fin whales (FW), gray whales (GW) and unidentified whales (UWHALE) recorded by community members and island sentinels on St. Paul and St. George Islands during 2006-2008.**

| Date      | Time  | Sighting Direction. | Visiblity | Species | Location                 | Best Count | Min. Ct. | Max. Ct. |
|-----------|-------|---------------------|-----------|---------|--------------------------|------------|----------|----------|
| 31-May-06 | 12:00 | E                   | excellent | GW      | SP-Lukanin Bay           | 1          | --       | --       |
| 6-Nov-06  | 14:16 | NE                  | good      | KW      | SP-Vostochni West        | 1          | --       | --       |
| 21-Mar-07 | 0:00  | n/a                 | n/a       | UWHALE  | SG-East Rookery Offshore | 4          | --       | --       |
| 16-Apr-07 | 8:30  | E                   | good      | GW      | SP-Schnag                | 4          | --       | --       |
| 25-Jul-07 | 15:53 | S                   | excellent | FW      | SG-Cascade Pinnacle      | 2          | --       | --       |
| 26-Jul-07 | 16:00 | W                   | excellent | KW      | SG-Cascade Pinnacle      | 4          | --       | --       |
| 31-Aug-07 | 15:55 | E                   | good      | KW      | SG-East Landing          | 4          | --       | --       |
| 6-Nov-07  | 15:30 | n/a                 | n/a       | UWHALE  | South Rookery offshore   | 4          | 4        | 6        |
| 7-Nov-07  | 14:00 | S                   | n/a       | FW      | South Rookery offshore   | 1          | --       | --       |
| 11-Nov-07 | 15:00 | n/a                 | n/a       | UWHALE  | South Hill offshore      | 3          | 3        | 6        |
| 20-Nov-07 | 13:39 | WSW                 | poor      | KW      | Ardiguen                 | 2          | --       | --       |
| 27-Nov-07 | 14:13 | NW                  | good      | KW      | Vostochni                | 2          | --       | --       |
| 11-Mar-08 | 13:00 | n/a                 | n/a       | KW      | Staraya Artil offshore   | 3          | --       | --       |
| 26-Apr-08 | 9:30  | N                   | fair      | KW      | Village                  | 4          | --       | 5        |
| 28-Apr-08 | 11:30 | n/a                 | n/a       | KW      | East Landing             | 4          | --       | --       |
| 4-May-08  | 21:00 | n/a                 | n/a       | KW      | East Landing             | 4          | --       | --       |
| 5-May-08  | 4:15  | n/a                 | n/a       | KW      | East Landing             | 4          | --       | --       |
| 8-May-08  | 14:30 | n/a                 | n/a       | KW      | East Landing             | 4          | --       | --       |
| 21-Sep-08 | 20:00 | E                   | excellent | KW      | Schnagn                  | 5          | --       | 5        |
| 23-Oct-08 | 17:30 | NE                  | fair      | KW      | Village-nearshore        | 3          | --       | --       |
| 25-Oct-08 | 11:15 | N                   | excellent | KW      | Village-nearshore        | 3          | --       | --       |
| 25-Oct-08 | 17:30 | W                   | excellent | FW      | Zapadni Bay Offshore     | 5          | --       | --       |
| 30-Oct-08 | 13:45 | N                   | excellent | KW      | Village-nearshore        | 3          | --       | --       |
| 01-Nov-08 | 13:30 | NE                  | fair      | KW      | Staraya                  | 3          | --       | --       |
| 03-Nov-08 | n/a   | N                   | n/a       | KW      | Village-offshore         | 2          | --       | --       |
| 7-Nov-08  | 11:11 | NNE                 | good      | KW      | Reef Point               | 3          | --       | --       |
| 12-Nov-08 | 11:30 | N                   | n/a       | KW      | Village-nearshore        | 2          | --       | --       |
| 19-Nov-08 | 12:30 | n/a                 | n/a       | UWHALE  | Village-offshore         | --         | 2        | --       |
| 25-Nov-08 | 11:30 | N                   | excellent | KW      | Village-nearshore        | 3          | 3        | 3        |
| 26-Nov-08 | 17:20 | n/a                 | n/a       | KW      | Village-nearshore        | 3          | 3        | 3        |
| 26-Nov-08 | n/a   | n/a                 | n/a       | KW      | Village-nearshore        | 3          | 3        | 3        |

APPENDIX 4. PRIBILOF COMMUNITY HALIBUT LONGLINE FISHERY LOGBOOK



Appendix 4 Figure 1. Front and back cover of the logbook distributed to fishermen in the Pribilof Islands halibut longline fishery.

**Date :** \_\_\_\_\_ **Time:** \_\_\_\_\_ to \_\_\_\_\_  
 \_\_\_\_\_ mmdd/yy

**Observer:** \_\_\_\_\_

**Position (lat/long)** \_\_\_\_\_  
**or location** \_\_\_\_\_

**Your activity**    traveling    anchored    setting    soaking    retrieving  
                          processing    drifting    other \_\_\_\_\_

**Gear**            longline    jig    rod n reel    pot    trawl  
 Other \_\_\_\_\_

**Catch**            Halibut    gray cod    black cod    rockfish    pollock  
 Other \_\_\_\_\_

**Bait**            herring    octopus    cod    squid  
 Other \_\_\_\_\_

**Deterrents**    none    I left    ran gear    noise  
 Other \_\_\_\_\_

**Response**    none    it left    moved farther away    moved closer  
                          startled    Other \_\_\_\_\_

**Photos/video ?**    Y    N    Identifier: Roll # \_\_\_\_\_ Number \_\_\_\_\_

**Circle type of any distinctive marks seen on animal:**  
 Brand    Tag    Debris    Scars    Markings    Other

**Describe:**

**Have you seen this animal or pod before?**    Y    N  
**If so, how identified ?**  
**Where seen before ?**  
**When seen before ?**

**Species**            KW            SSL            NFS            HS            \_\_\_\_\_

**ID confidence:**    sure \_\_\_\_\_ likely \_\_\_\_\_ not sure \_\_\_\_\_ (describe below)

**Total Number (best estimate)** \_\_\_\_\_

**Number by age**

| Bull Male            | Adult                | Sub-adult            | Calf                 | Unknown              |
|----------------------|----------------------|----------------------|----------------------|----------------------|
| <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |

**Behavior**    (describe or use codes provided)

---

**Interaction with other species**

**Species**            SSL            NFS            HS            HP            \_\_\_\_\_

**ID confidence:**    sure \_\_\_\_\_ likely \_\_\_\_\_ not sure \_\_\_\_\_ (describe below)

**Total Number (best estimate)** \_\_\_\_\_

**Number by age**

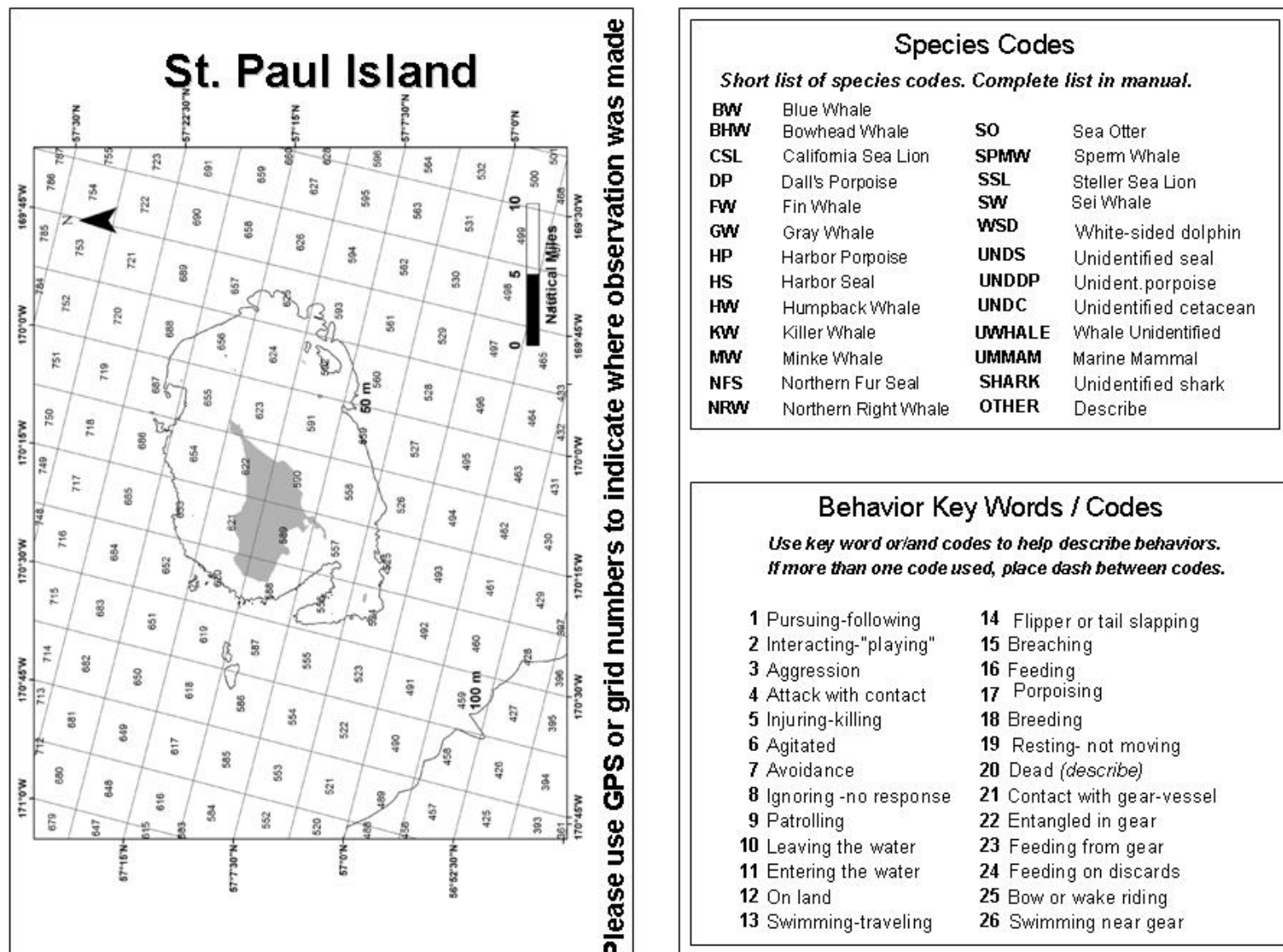
| Bull Male            | Adult                | Sub-adult            | Calf                 | Unknown              |
|----------------------|----------------------|----------------------|----------------------|----------------------|
| <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |

**Behavior**    (describe or use codes provided)

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**More information, comments, and species ID drawings:**

Appendix 4 Figure 2. Inside pages to record individual sightings in the logbook distributed to fishermen in the Pribilof Islands halibut longline fishery.



Appendix 4 Figure 3. Inside pages of the front and back cover of the St. Paul Island logbook.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Vessel Name:</b> _____</p> <p><b>ADFG #</b> _____ <b>Size:</b> _____</p> <p><b>Logbook dates: Start:</b> _____ <b>End:</b> _____</p> <p style="text-align: center;"><b>When to fill in this logbook</b></p> <ul style="list-style-type: none"> <li>▪ Record all marine mammal sighting other than fur seals or Dall's porpoise occurring on their own, unless they are interacting with other marine mammals.</li> <li>▪ Enter all sightings made at sea. You don't need to be fishing to fill out this log.</li> <li>▪ Return this log book as soon as it is filled to the address provided.</li> </ul> <p style="text-align: center;"><b>General instructions for logbook entries</b></p> <ul style="list-style-type: none"> <li>▪ Please print clearly. Use comment space for clarifications, drawings, and diagrams.</li> <li>▪ Location: Use GPS coordinates or grid number from inside cover.</li> <li>▪ Circle as many actions/codes as relevant during the time of the sighting.</li> <li>▪ Species ID: Circle or enter one marine mammal code. Describe animal in comments.</li> <li>▪ If interactions involve more than two species, enter third on next page with comments.</li> <li>▪ Enter the largest number of animals counted during a sighting.</li> <li>▪ Describe sex and age characteristics of marine mammal if unsure.</li> <li>▪ Behavior: Use key words and codes that best describe behaviors. Use your own words too!</li> </ul> | <p><b>Why are we collecting this information?</b></p> <ul style="list-style-type: none"> <li>• To involve community members in the study of northern fur seal predation</li> <li>• To record local knowledge about the number, location, and times killer whales and Steller sea lions are present in the Pribilofs</li> <li>• To document the nature and extent of marine mammal interactions with the local halibut fishery</li> </ul> <div style="border: 1px solid black; padding: 10px; text-align: center; margin: 10px 0;"> <p>Although we appreciate your sightings,<br/>please keep a</p> <p><b>SAFE and RESPECTFUL DISTANCE</b><br/>from all marine mammals</p> </div> <p><b>Who to contact to report an UNUSUAL<br/>marine mammal sighting event or<br/>entanglement ?</b></p> <p style="text-align: center;">St. Paul Island<br/>Aleut Community of St. Paul Island Tribal Government<br/>Ecosystem Conservation Office (907) 546-3229</p> <p style="text-align: center;">St. George Island<br/>St. George Island Traditional Council<br/>Kayumixtax Eco-Office (907) 859-2448 / 2447 x26</p> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Appendix 4 Figure 4. First and last pages of the logbook distributed to fishermen in the Pribilof Islands halibut longline fishery.