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# Monitoring Beluga Whales at the Port of Anchorage: Pre-expansion Observations, August-November, 2005

by

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This work was done under contract with the Port of Anchorage and the U.S. Department of Transportation Maritime Administration (MARAD).



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## INTRODUCTION

This report summarizes results from a baseline preconstruction study to monitor beluga whale presence, habitat use, and behavior in the Port of Anchorage area. Weekly observations were used to determine the frequency at which beluga whales were present within the Marine Terminal Redevelopment Project Footprint.

The methodology for this study was developed following consultation with Integrated Concepts and Research Corporation (ICRC), the Port of Anchorage (POA), and the National Oceanic and Atmospheric Administration (NOAA) Fisheries. The study was designed to meet the monitoring objectives set forth by NOAA Fisheries within the project scope agreed upon by POA, ICRC, NOAA Fisheries, and the U.S. Department of Transportati

on Maritime Administration (MARAD). MARAD is the federal funding agency for all work associated with the POA Expansion Project, including this monitoring program. This report covers beluga whale monitoring activities from August through November 2005.

## OBJECTIVES

The objectives of this study are to:

1. Estimate the frequency at which beluga whales were present in the Marine Terminal Redevelopment Project Footprint, and
2. Characterize habitat use and behavior of beluga whales near the Port of Anchorage during ice-free months.

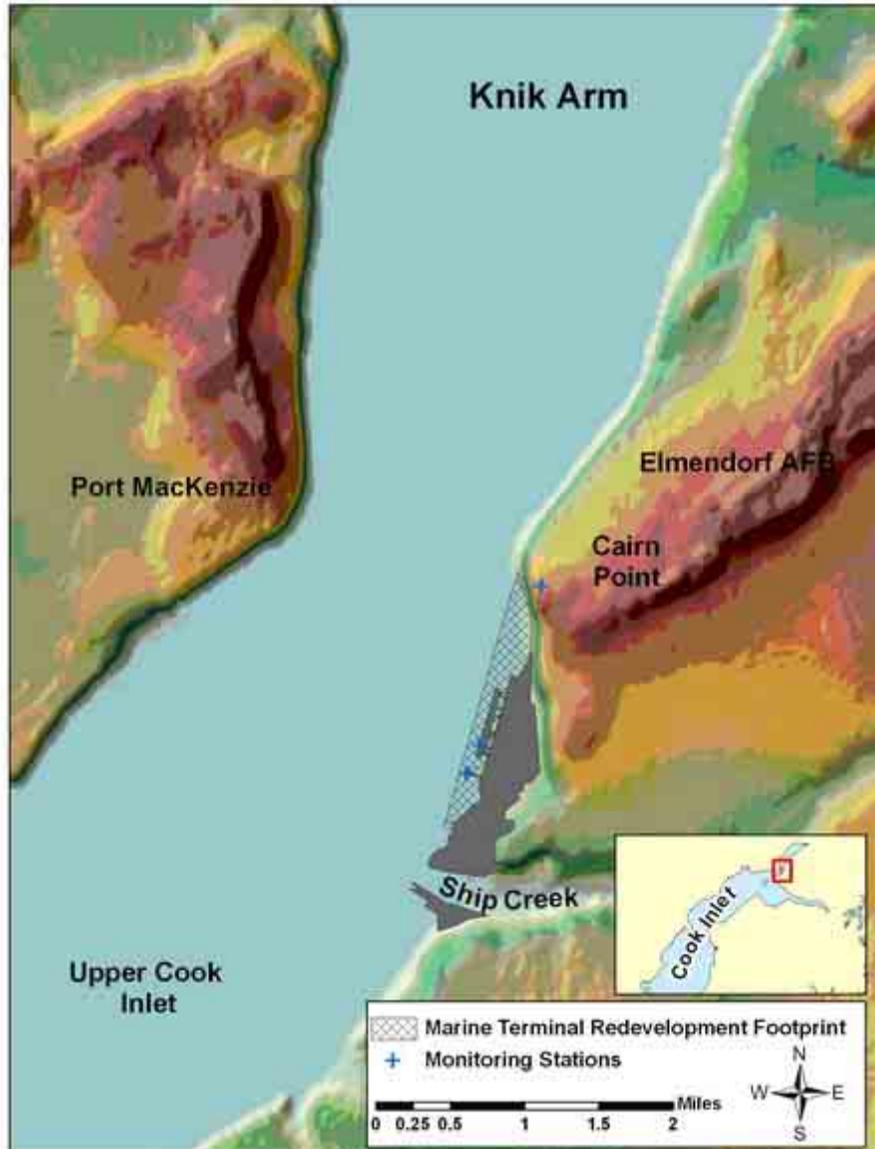
## METHODS

### Study Area

Three monitoring stations were established including two at the Port of Anchorage (Petroleum, Oil and Lubricants Towers, POL-1 and POL-2) and a third at Cairn Point on Elmendorf Air Force Base, overlooking waters directly offshore of the Port of Anchorage (Figure 1). The study area included all water visible from the monitoring stations near the Port of Anchorage, within Knik Arm, upper Cook Inlet, just offshore of Anchorage, Alaska (Figure 2). The focus of the study was the Marine Terminal Redevelopment Project Footprint, as defined by the Marine Terminal Redevelopment Environmental Assessment (Anchorage Port Expansion Team 2005, South End: X=1658512 feet, Y=2642136 feet. North End: X=1661550 feet, Y=2650479 feet; USACE SBC 1978, State Plane Coordinate System).



*Figure 1. Beluga whale monitoring sessions were conducted from: a. the Port of Anchorage (photo: 18-Nov), and b. Cairn Point, Elmendorf Air Force Base (photo: 3-Nov).*



*Figure 2. The study area is shown, with the Port of Anchorage in gray, the Marine Terminal Redevelopment Project Footprint shown in black hatch marks, and monitoring stations (north to south) at Cairn Point, POL-1 and POL-2 denoted by blue crosses.*

### **Monitoring Effort**

From August through November, observation sessions lasting six hours per day were conducted from the Cairn Point monitoring station and one of the POA monitoring stations two days per week. Observations were conducted from 2-Aug through 28 November 2005 over a total of 374 hours during 63 shifts on 51 days. Observations were conducted on 14 days (83.1 hours) in August, 16 days (96.1 hours) in September, 12 days (96.1 hours) in October, and nine days (99.1 hrs) in November (Table 1). Thirty-eight monitoring sessions were conducted without the use of a theodolite and 25 with a theodolite (see Theodolite Tracking below).

Table 1. Beluga whale monitoring effort at the Port of Anchorage (POA) and Cairn Point on Elmendorf Air Force Base (CP) is summarized by day for August-November 2005.

Station	Date	Start Time	End Time	Effort (hr)	Station	Date	Start Time	End Time	Effort (hr)	
POA	2-Aug	11:00	17:00	6	CP	23-Aug	8:00	14:00	6	
	5-Aug	9:00	15:00	6		25-Aug	8:00	14:00	6	
	9-Aug	8:20	14:20	6		28-Aug	9:00	15:00	6	
	11-Aug	10:20	15:20	5		30-Aug	8:00	14:00	6	
	16-Aug	8:00	14:00	6		4-Sep	8:00	14:00	6	
	18-Aug	8:00	14:00	6		6-Sep	8:00	14:00	6	
	22-Aug	8:00	14:00	6		11-Sep	8:00	14:00	6	
	24-Aug	8:00	14:00	6		13-Sep	8:00	14:00	6	
	29-Aug	9:00	15:00	6		18-Sep	8:00	14:00	6	
	31-Aug	8:00	14:00	6		23-Sep	13:03	19:03	6	
	5-Sep	8:00	14:00	6		28-Sep	10:15	16:15	6	
	7-Sep	8:00	14:00	6		30-Sep	11:00	17:00	6	
	12-Sep	8:00	14:00	6		2-Oct	10:45	16:45	6	
	14-Sep	8:00	14:00	6		4-Oct	11:00	17:00	6	
	19-Sep	8:00	14:00	6		13-Oct	10:00	16:00	6	
	21-Sep	11:45	17:45	6		14-Oct	10:15	16:15	6	
	27-Sep	13:05	19:05	6		18-Oct	10:00	16:00	6	
	29-Sep	10:00	16:00	6		20-Oct	10:00	16:00	6	
	6-Oct	11:00	17:00	6		25-Oct	10:00	16:00	6	
	7-Oct	10:40	16:40	6		27-Oct	10:00	16:00	6	
	9-Oct	10:45	16:45	6		1-Nov	10:00	16:00	6	
	11-Oct	9:30	15:30	6		3-Nov	10:10	16:10	6	
	18-Oct	10:00	16:00	6		8-Nov	10:00	16:00	6	
	20-Oct	10:00	16:00	6		10-Nov	9:30	15:30	6	
	25-Oct	10:20	16:20	6		15-Nov	9:40	15:40	6	
	27-Oct	10:15	16:15	6		17-Nov	10:40	16:40	6	
	1-Nov	10:00	16:00	6		21-Nov	10:00	16:00	6	
	3-Nov	10:00	16:00	6		22-Nov	10:00	16:00	6	
	8-Nov	10:00	16:00	6		28-Nov	10:00	14:00	4	
	10-Nov	10:05	16:05	6		<b>Subtotal (CP)</b>				<b>172</b>
	15-Nov	10:00	16:00	6		<b>TOTAL (All Stations)</b>				<b>374</b>
	17-Nov	11:00	16:40	5						
21-Nov	10:00	16:00	6							
22-Nov	10:00	16:00	6							
<b>Subtotal (POA)</b>				<b>202</b>						

## ***Port of Anchorage Activities***

The number and type of vessels at and near the Port of Anchorage were documented during observation sessions throughout the observation period. A combination of regular interval sampling, continuous monitoring, and theodolite tracking were used to monitor vessels within project footprint and within 4 miles (6.5 kilometer) of the Port of Anchorage.

## ***Environmental and Sighting Conditions***

Environmental conditions that could affect observers' ability to sight whales were logged every hour during observation sessions. These conditions included wind speed (measured with an anemometer), sea state, swell height, glare, percent cloud cover, and precipitation.

## ***Beluga Whale Observations***

### **Grid-Cell Mapping**

During the six-hour monitoring sessions, observers used methods described by Funk et al. (2005), systematically scanning for whales during the entire observation session using the naked eye, Fujinon or West Marine 10 x 50 binoculars with an internal compass, and a spotting scope. Sampling rounds consisted of 20-minute periods during which observers scanned the study area for 10-minutes with the naked eye followed by 10-minutes with optical equipment. Basic sighting information included date, time, number of whales sighted by age class (adult, sub-adult, calf, estimated by color), heading, primary and secondary activity, location, and group swimming formation (after Funk et al. 2005). In addition, detailed data were collected regarding the locations, movements, and behavior of beluga whales near the Port of Anchorage (see Detailed Focal Sampling and Theodolite Tracking below).

When a whale group was sighted, the location of the group was recorded using a 500m x 500-meter grid overlaid onto a base map of the study area. From 2-Aug through 23-Sept, observers used the internal compass in the binoculars, land marks, and estimated distance to map locations of whale groups. From 27-Sept and continuing through November, a theodolite was also used to track group locations and movement patterns (see below). Grid cell locations were updated as the whales traveled through the area. For the purposes of delineating sightings inside and outside of the Marine Terminal Project Redevelopment Footprint, grid cells D9 through I9 were considered to overlap the project footprint (Figure 3).

### **Focal Group Interval Sampling**

Whales frequently transited through the study area quickly, limiting the collection of detailed focal behavioral data. On ten occasions whales remained within the study area long enough to carry out detailed focal group behavioral sampling (Mann 2000). Behaviors examined included activity state (traveling, milling, resting, feeding), swimming formation, inter-individual distance/group spread, and noteworthy behavioral events (e.g. spyhopping, vocalizations, rapid chases). Interval sampling (Martin and Bateson 1986) was used to collect focal behavioral sampling data, recorded on paper datasheets every two minutes. Beginning in late September, this method was replaced with real-time theodolite tracking (with continuous behavioral sampling of whale groups) to provide further detail on whale group locations, movements, and activity.

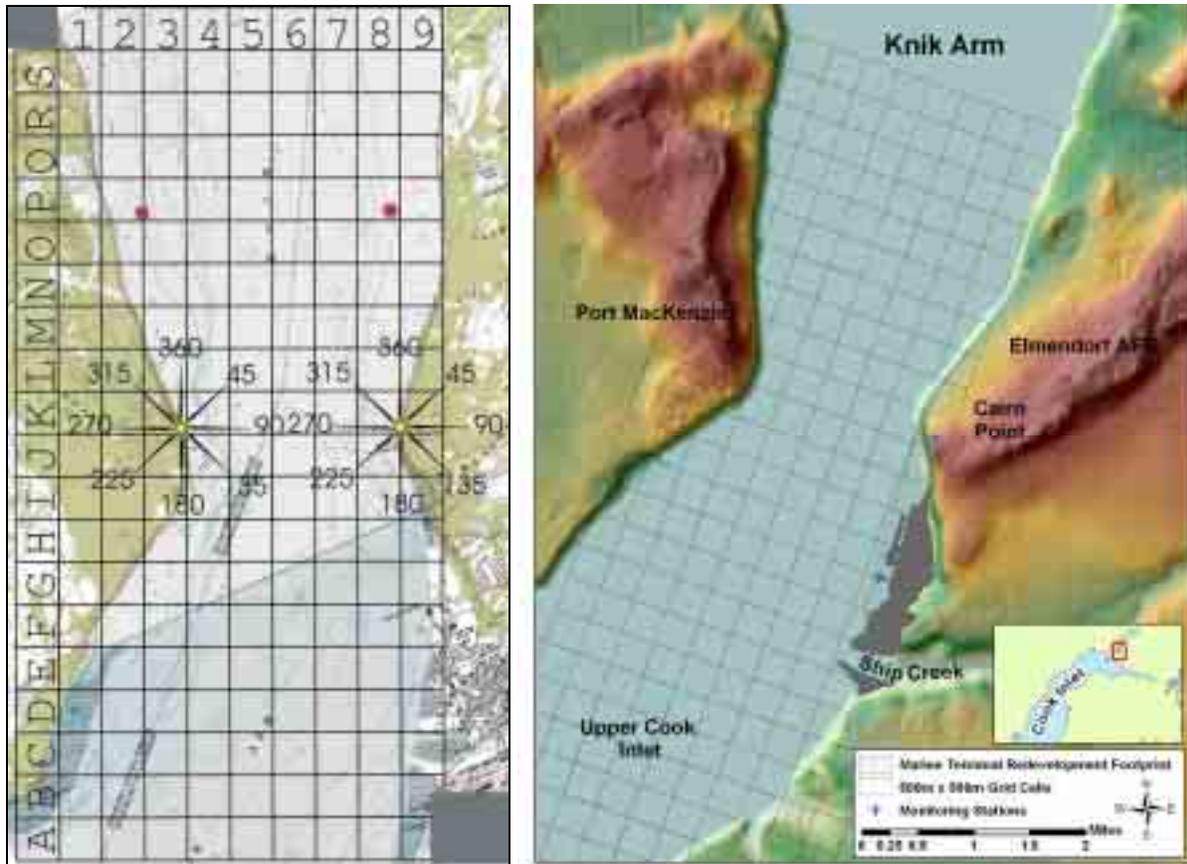


Figure 3. This 500 meter x 500 meter grid cell map (left) was used to document the location of beluga whale groups sighted from the Port of Anchorage and Cairn Point. For reference in the field, this map was oriented relative to magnetic north (compass bearings are shown at the center of the grid). The Port of Anchorage Marine Terminal Redevelopment Project footprint is located in grid cells D9 to I9. The grid cell map is shown in the context of the study area (right), with the Marine Terminal Project Footprint shown in black hatches and monitoring stations shown with blue crosses.

### Theodolite Tracking

Beginning on 27-Sept, whale group movements were monitored with a surveyor's theodolite to improve the accuracy of estimated whale group locations. The theodolite was used either at Cairn Point or at one of the two POA monitoring stations.

Measurement error of whale group locations generally decreased with an increase in the height of the station, a decrease in the distance to the object being fixed, and a decrease in short-term variation in sea surface height (Table 2; Würsig et al. 1991). The POL-1 and POL-2 platforms at the Port of Anchorage and the cliff Cairn Point were approximately 76 feet, 77 feet, and 129 feet above mean low tide level. Assuming these heights obtained from surveyors are accurate within four inches, the maximum expected error in distance to beluga whales tracked in this study was 13 - 128 feet from the POL towers at POA and 7 - 59 feet from Cairn Point, depending on the distance to the whales (Table 2). Less error is predicted for areas close to monitoring stations, including the project footprint.

Table 2. Errors associated with incorrect measurement of cliff height, after Wursig et al. 1991.

Actual Cliff Height	Approximate Error in Height	Distance Error (feet)		
		TRUE DISTANCE TO POSITION ON WATER		
		1,640 ft	8,202 ft	16,404 ft
42 feet	39 inches high	+112	+568	+1273
	4 inches high	+13	+56	+128
	4 inches low	-10	-56	-125
	39 inches low	-98	-564	-1243
98 feet	39 inches high	+56	+278	+587
	4 inches high	+7	+26	+59
	4 inches low	-7	-30	-56
	39 inches low	-56	-278	-581
148 feet	39 inches high	+39	+184	+384
	4 inches high	+7	+16	+39
	4 inches low	-3	-28	-36
	39 inches low	-36	-184	-381
328 feet	39 inches high	+16	+82	+167
	4 inches high	+3	+7	+16
	4 inches low	0	-9	-16
	39 inches low	-16	-82	-167

Time-stamped horizontal (azimuth) and vertical (declination) readings from the theodolite were used to calculate the position of objects such as whales and vessels. A tripod-mounted Topcon DT-102 theodolite was connected to a Dell Inspiron 7500 laptop computer through a RS-232 cable (Figure 4). Data were collected and collated using custom theodolite tracking software, Pythagoras (<http://www.tamug.edu/mmrp/pythagoras/>).

The known surveyed heights of the monitoring stations were entered into the Pythagoras software. Eye height was measured to the nearest centimeter and entered daily into Pythagoras by the observer. Sea surface height was imported from tide tables (data from a tide level monitoring station located at the Port of Anchorage), generated with JTides 4.7 software (<http://www.arachnoid.com/JTides>), and input directly into Pythagoras. The theodolite was checked for balance every 20 minutes. Vessels were fixed once per hour and whale groups were fixed as frequently as possible as they passed through the study area. Other observations logged using Pythagoras included group size, whale behavioral state, and vessel activity.

### Data Entry and Analyses

During observations without use of the theodolite, vessel activities, environmental conditions, and marine mammal data were collected using standardized paper datasheets (Appendix A). Upon completion of monitoring sessions, datasheets were checked for completeness and accuracy, and then used to enter data into a Microsoft Access database. During theodolite tracking sessions, data were entered directly into a laptop computer in an Access database in the field. Both the grid-cell database and the theodolite database were

checked for accuracy. Data were queried in Microsoft Access, with means, standard errors and figures produced in Microsoft Excel.



*Figure 4. LGL field biologists operated the Topcon DT-102 theodolite (a. photo: 27-Oct) linked to a laptop computer (b. photo: 10-Oct) at the Cairn Point monitoring station.*

Summed beluga whale counts and sum of beluga whale groups per 500m x 500m grid cell were mapped for the study period by month and tide height. ArcView 3.2 GIS software was used to map whale grid-cell use, plot GIS-compatible whale tracks generated by Pythagoras from theodolite fixes, and calculate time spent inside versus outside the project footprint. Best counts across stations for each whale group were determined by choosing the count with the best age class representation. For groups whose best count was from a theodolite track, number of whales was included in totals of beluga whale use of overlapping grid cells (using GIS mapping). Summed number of group sightings and best whale counts per grid cell were mapped for August through November 2005, by month and by tide level. Beluga whale sighting rates were analyzed by month and week, with sightings inside the Marine Terminal Redevelopment Project Footprint distinguished from those outside the footprint.

Coverage of tidal levels during observation sessions, observed tidal levels during beluga whale sightings and timing of sightings from low tide were examined. Tide heights for Knik Arm, Alaska were obtained from JTides 4.7 software (<http://www.arachnoid.com/JTides>). The resulting tide tables were input into the Pythagoras software to adjust calculations for changing station height relative to sea level, and were used for tidal analyses. Levels of tides during observation sessions were obtained by querying tide levels for times between the observation start and end times on the date of all observation sessions. Tidal levels during sightings were obtained by querying JTides for the date and from the start to the end of each group observation in order to visualize our study's coverage of tidal levels. Tidal heights were classified as low ( $\leq 13$  feet), mid-level (13-21 feet) or high ( $\geq 21$  feet). Timing of sightings with respect to low tide was gauged by calculating the difference between the midpoint of sighting time and nearest low tide time for each day whale groups were observed. In order to examine the relationship between group heading and tidal stage, each whale group sighting was assigned a value of "ebb"

or “flood” according to whether the tide was falling or rising during the time of the sighting. Percent of beluga whale sightings heading north, east, south, and west at ebb or flood stage was calculated to examine directional patterns in movement in relation to tidal stage.

From sighting records, mean percent values were calculated to examine age class representation and behavior in beluga whale groups. Focal group interval data were used to calculate whale activity budgets. Data analysis modules in Pythagoras were used to calculate mean time and distance between fixes, mean leg speed (speed of group between fixes), reorientation rate (magnitude of course changes along a track line), net and cumulative distance traveled, and linearity (measure of straightness of track line, with a value of one being a straight line). To ensure accurate estimates of whale group movement parameters, a minimum inter-fix interval filter of 20 seconds and a maximum leg speed filter of 20 mph were applied to these data.

## **RESULTS**

### *Vessel Traffic and Obstruction*

Peak vessel activity was noted in September, with a decrease in overall vessel traffic and types of vessels during October and December (Appendix B). Mean obstruction of an observer’s view by vessels over the course of the entire study period was 10 percent. Mean monthly estimated vessel obstruction during August was 15 percent and 9 percent for the rest of the study. We estimate that relatively little area (<5 percent) could not be observed from either the Port of Anchorage station or the Cairn Point station.

### *Variation in Environmental Conditions*

Observers rated environmental conditions affecting the ability to sight whales at the Port of Anchorage as excellent to good on most days from August through November. Viewing conditions were somewhat better during August and September than during October and November (Table 3). Rain was most prevalent in September, although the greatest amount of precipitation (rain, fog, and snow) occurred in the month of November. The amount of glare reported was low in August and September but increased in October and November. Average Beaufort sea state was one (ripples but without foam crests) or zero (mirror like) during all months (Table 3). Mean sea ice concentration was zero in August, September, and October. In November, sea ice occurred at low levels (mean=16 percent) prior to 28-Nov, when observations were discontinued due to >80 percent sea ice cover.

*Table 3. Environmental conditions summarized by month include precipitation ( percent days noted), condition rating, glare ( percent days noted) and sea state (mean Beaufort scale).*

Month	Precipitation (% of sessions)			Condition Rating (days)		Glare	Sea State
	rain	fog	snow	excellent to good	good to poor	(% 6-hr sessions)	(mean Beaufort)
<b>August</b>	5	-	-	14	-	7	1.1
<b>September</b>	40	-	-	15	1	6	1.2
<b>October</b>	17	-	-	11	1	75	1.3
<b>November</b>	11	33	56	7	2	56	0.2

## Beluga Whale Sightings

Twenty-one beluga whale group sightings were documented on 14 days during this study. Beluga whale groups were observed in the project footprint during each month. Five group sightings were recorded on four days in August, 10 group sightings were recorded on six days in September, two group sightings were recorded on two days in October, and four group sightings were recorded on two days in November (Table 4). Detailed accounts of each group sighting may be found in the monthly progress reports from August to November 2005 (Appendix B).

Table 4. Beluga whale sightings are summarized for Aug-Nov. Number whales, duration, tide height, and heading (N=North, W=West, S=South and V=Variable) are shown for each sighting.

Date	Group #	Adult	Subadult	Calf	Unknown	Total # Whales	Duration	Start tide height (ft)	End tide height (ft)	Heading
18-Aug	1	7	3	1	0	11	56	-1.2	0.7	S Then W
24-Aug-05	1	1	0	0	0	1	37	18.6	23.1	N, W, S
25-Aug-05	1	6	0	0	0	6	32	6.2	7.7	N then V
29-Aug-05	1	9	9	5	0	23	74	7.5	6.1	V Then S
	2	1	0	0	0	1	1	10.1	10.1	N
4-Sep-05	1	1	0	1	0	2	47	25.4	21.5	S
	2	6	2	3	0	11	190	15.2	3.9	S then V
	3	1	0	0	0	1	33	20.7	17.1	S
12-Sep-05	1	7	2	3	0	12	92	5.7	7.0	V then N
13-Sep-05	1	4	1	0	0	5	54	7.9	5.6	S then V
	2	2	0	0	0	2	54	5.0	5.3	S then V
14-Sep-05	1	6	6	2	0	14	80	6.9	10.9	N
21-Sep-05	1	2	0	0	0	2	1	3.0	3.4	V
	2	0	1	0	0	1	1	4.7	4.7	V
23-Sep-05	1	1	0	0	0	1	41	24.9	22.4	N then V
2-Oct-05	1	2	3	1	0	6	42	3.8	7.0	S
27-Oct-05	1	1	0	0	0	1	29	8.3	9.7	N
1-Nov-05	1	1	0	1	0	2	25	10.9	10.9	S
	2	1	0	0	1	2	45	4.6	11.5	S then N
	3	0	0	0	25	25	42	14.6	17.6	V then N
	3a	2	2	0	0	4	5	19.0	19.0	N
	3b	5	4	1	3	13	7	20.0	20.0	N
3c	4	1	0	3	8	2	19.8	19.8	N	
3-Nov-05	1	1	1	1	0	3	217	16.3	6.8	V

For August through November 2005, the numbers of group sightings are displayed by grid cell for the entire study area (Figure 5) and the numbers of summed whale counts from group sightings (Figure 6) are displayed for the area near the Port of Anchorage. Beluga whales were observed in coastal areas within 500 m (1,640 feet) of the shore between Ship Creek and Cairn Point (including the area off the POA) and along shore near Port Mackenzie more frequently than in the center of Knik Arm. Beluga whales were recorded in 40 grid cells, six of which overlapped the project footprint (Figures 5 and 6).

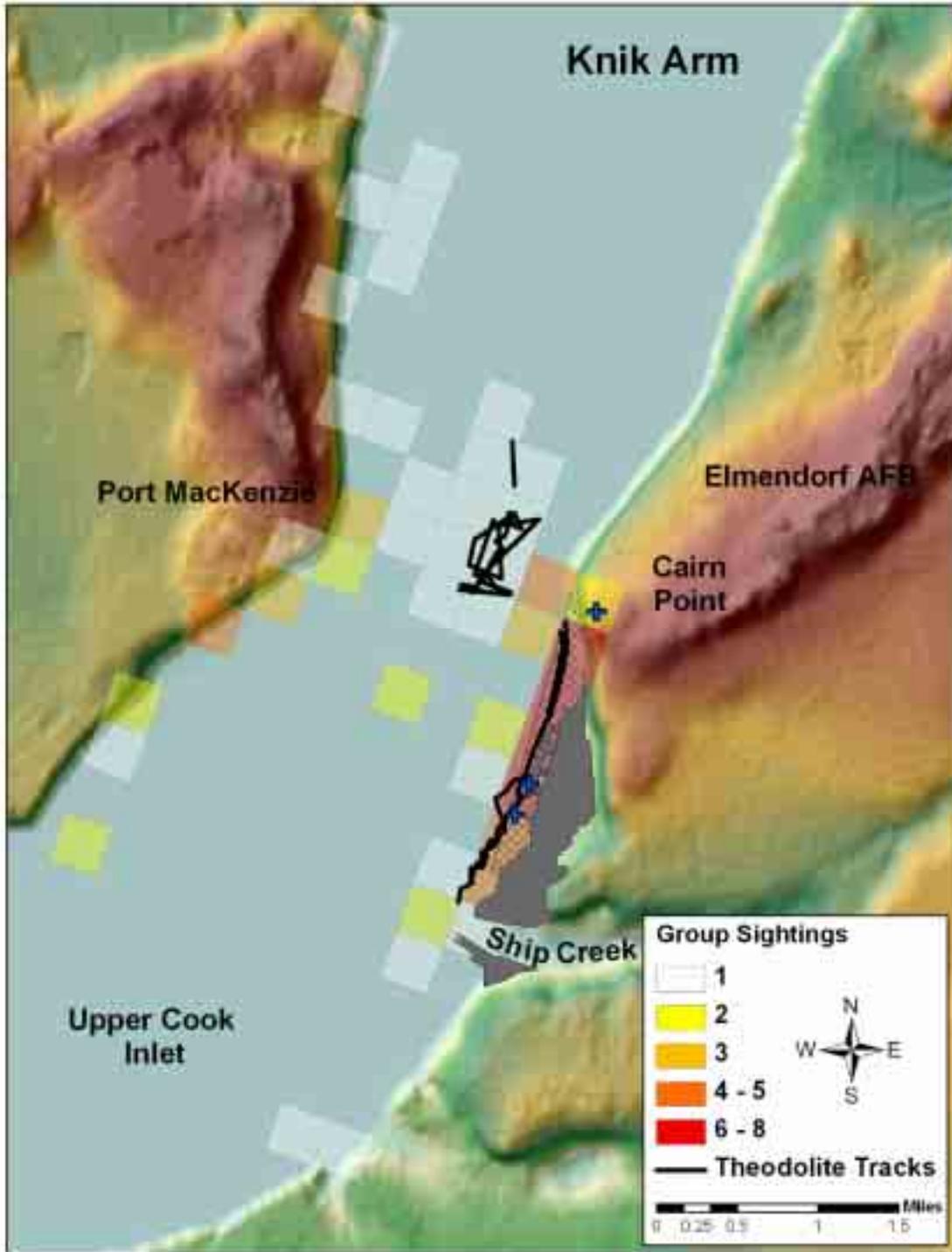


Figure 5. The number of beluga whale group sightings is shown for the study area, August through November 2005. Colored blocks indicate total number of beluga whale groups observed in a 500 meter x 500 meter (1,640 foot x 1,640 foot) grid cell. Theodolite tracks are shown as heavy black lines. The Port of Anchorage is shown in gray, monitoring stations are shown as blue crosses and the Marine Terminal Redevelopment Project footprint is shown with black hatch marks.

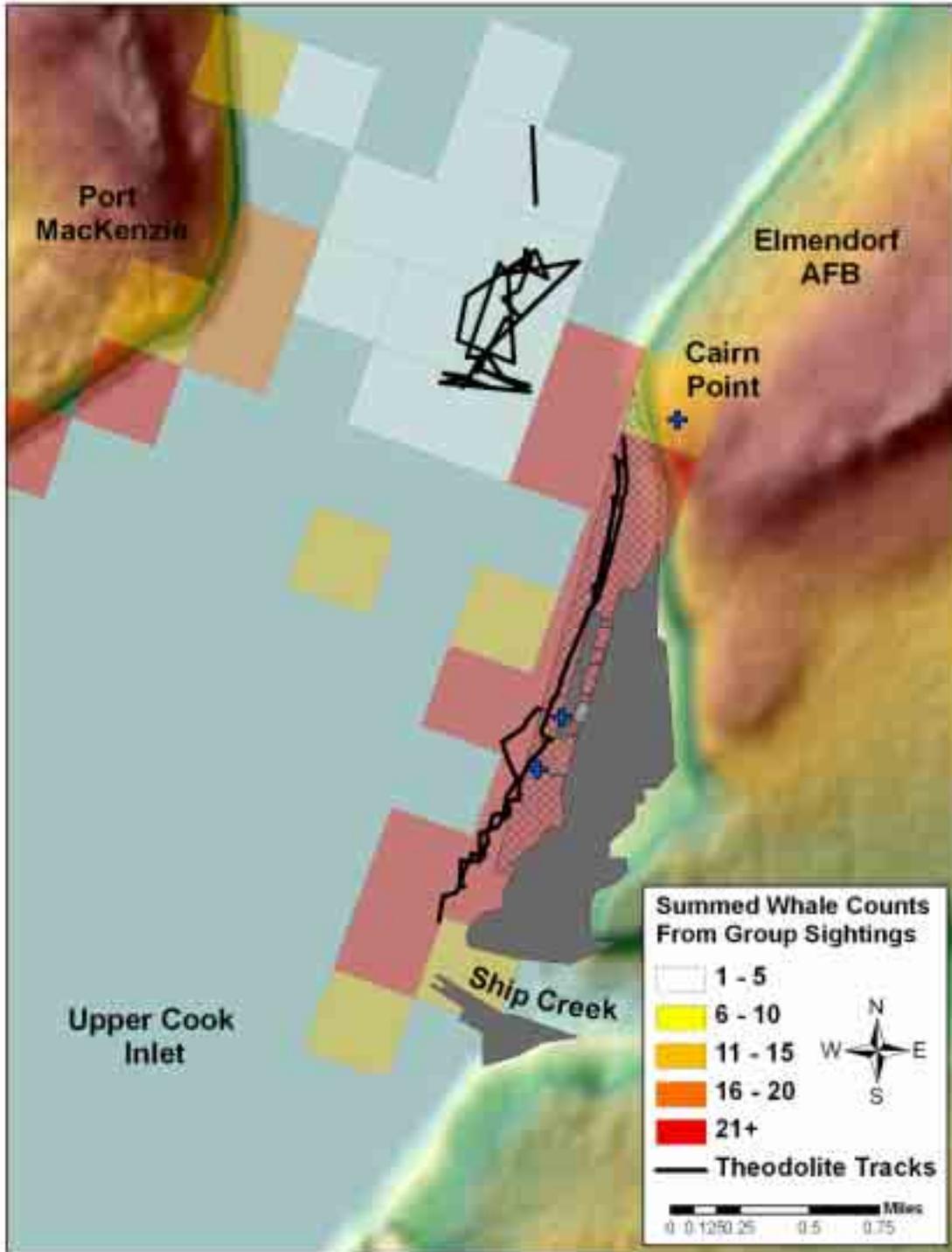


Figure 6. Summed whale counts from group sightings are shown near the Port of Anchorage, August through November 2005. Colored blocks indicate summed whale counts from group sightings observed in a 500 m x 500 m (1,640 feet x 1,640 feet) grid cell. Theodolite tracks are shown as heavy black lines. The Port of Anchorage is shown in gray, monitoring stations are shown as blue crosses and the Marine Terminal Redevelopment Project footprint is shown with black hatch marks.

**Variation in Sighting Rates and Locations**

Overall, beluga whales were sighted at a rate of 0.4 whales per hour. Mean monthly beluga whale sighting rates ranged from 0.1 to 0.6 whales per hour. Beluga whales were observed during 27 percent of monitoring sessions ( $n = 51$  days) with a range of 17 to 38 percent each month (Figure 7). Weekly mean sighting rates varied from zero to 1.4 beluga whales per hour, peaking in early November (Table 5).

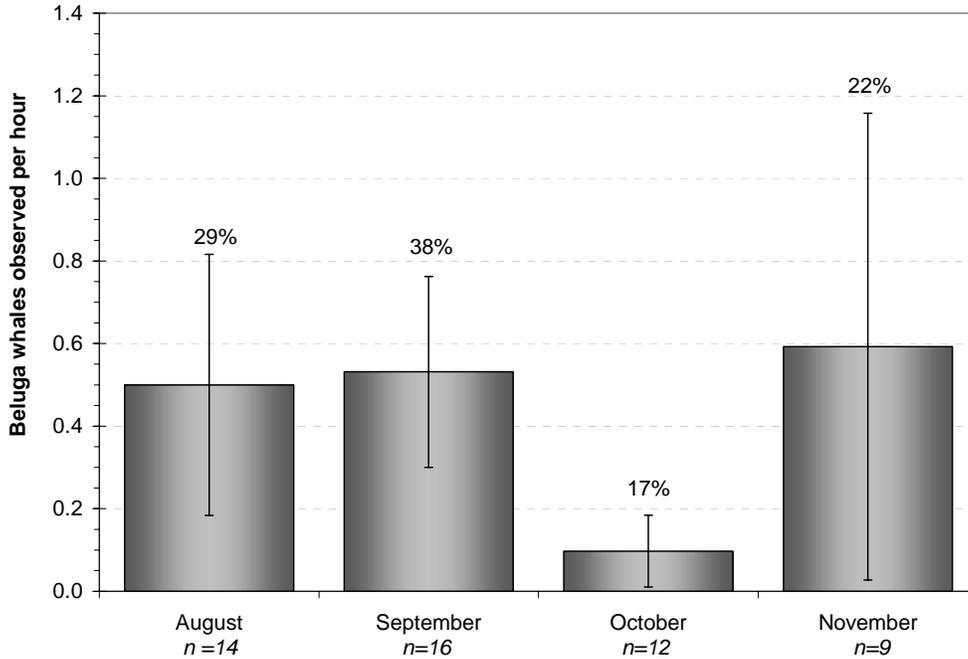


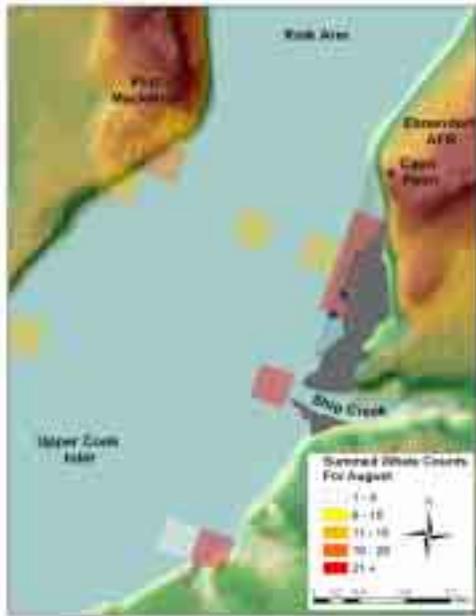
Figure 7. Beluga whales sighted per hour from stations at the Port of Anchorage are compared by month. The lower axis indicates month. Bars represent the mean number of beluga whales observed based on best counts only, with standard errors. Percent of days during which beluga whales were sighted is shown above each bar. Sample sizes are shown in number of days on which observations were conducted during a month.

Table 5. Mean beluga whale sightings by week are shown for stations at the Port of Anchorage, August through November, 2005.

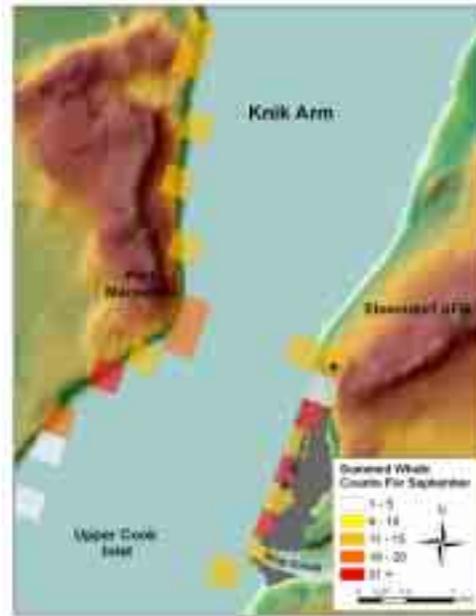
Week Beginning	2-Aug	9-Aug	16-Aug	23-Aug	30-Aug	6-Sep	13-Sep	20-Sep	27-Sep	4-Oct	11-Oct	18-Oct	25-Oct	1-Nov	8-Nov	15-Nov	22-Nov
Whales per hour	0	0	0.6	0.9	0.4	0.4	0.7	0.2	0.2	0	0	0	0.1	1.4	0	0	0

Beluga whales were sighted in five groups on four days (29 percent of days) in August (Table 4). Belugas were sighted in 13 grid cells during the month, with sightings concentrated in grid cells within 500m of the Port of Anchorage, the area off Ship Creek, and southeast of Port Mackenzie. During August, beluga whales were observed in three grid cells overlapping the project footprint (Figure 8a).

(a) Summed whale counts, August 2005



(b) Summed whale counts, September 2005



(c) Summed whale counts, October 2005



(d) Summed whale counts, November 2005



Figure 8. Summed whale counts from group sightings are shown near the Port of Anchorage, for the months of August (a), September (b), October (c), and November (d) 2005. Colored blocks indicate summed whale counts from group sightings observed in a 500 m x 500 m (1,640 feet x 1,640 feet) grid cell. Theodolite tracks are shown as heavy black lines. The Port of Anchorage is shown in gray, monitoring stations are shown as blue crosses and the Marine Terminal Redevelopment Project footprint is shown with black hatch marks.

Both number of sightings and area used by beluga whales inside and outside the project footprint increased in September. On six days in September (38 percent of days), 10 groups of beluga whales were observed (Table 4). Belugas were observed in 22 grid cells, encompassing nearly all visible areas of coastline in the area between Ship Creek and Cairn Point (including the area off the POA) and areas north and south of Port MacKenzie. Whales were observed in all six grid cells overlapping the project footprint during September (Figure 8b).

Numbers of beluga whale sightings, days belugas were sighted, and grid cells used by belugas were lower during October than in August and September. Two groups were observed on 2 days (17 percent of days, Table 4). During October, whales were observed in grid cells in the area immediately off (within 500m) of the Port of Anchorage and (in smaller numbers) passing through the center of Knik Arm off Cairn Point (Figure 8c). Overall, beluga whales were observed in nine grid cells during October, six of which overlapped the proposed expansion footprint (Figure 8c).

Beluga whales were observed on two days (22 percent of days) in November, with four groups observed in 21 grid cells (Table 4). Belugas observed during November traveled through the area immediately off the POA from Ship Creek to Cairn Point, and to a lesser extent, through the central channel of Knik Arm (Figure 8d). During November, whales were observed in all six grid cells overlapping the project footprint (Figure 8d).

### **Beluga whale occurrence within the Marine Terminal Redevelopment Project Footprint**

Beluga whale groups were observed a mean of 2.7 percent of the six-hour observation session inside the footprint, and 3.5 percent outside the footprint (Table 7). During observation periods in which whales were sighted, they spent from 0 percent to 60 percent of a six-hour observation session inside and outside the Marine Terminal Redevelopment Project Footprint (Table 6). Individual whale groups spent from all to none of the time they were seen inside the footprint (sightings in the footprint lasted from zero to 163 minutes; Table 4).

Belugas were sighted within the footprint on 21 percent of observation days in August, 20 percent in September, and 17 percent of the observation days in both October and November (Figure 9). Belugas were observed outside the footprint on 29 percent of observation days in August, 30 percent in September, and 8 percent of the observation days in both October and November. On average, 0.3 beluga whales were sighted per hour in the project footprint ( $se = 0.14, n = 51 \text{ days}$ ). Sighting rates within the footprint ranged from a monthly mean of 0.1 beluga whales per hour in October to 0.5 beluga whales per hour in November. Sightings outside the footprint occurred at similar rates (mean = 0.3,  $se = 0.12$ , Figure 9).

### **Tidal Variation**

Beluga whales were observed in the study area during most tidal stages, with the majority of sightings occurring near low tide (<13 feet) and very few sightings at mid-tide (13-21 feet) or near high tide (> 21 feet). Observation sessions were conducted at nearly all tidal levels (-1 to +33 feet) during the study period (Figure 10a). Tide height during the midpoint time of each beluga whale sighting was -0.3 to 23.7 feet (Table 4, Figure 10b) and the mean midpoint tide height of all sightings was 11.5 feet. The minimum tide level during any whale sighting was -1 feet and the maximum tide height was 26 feet. Of 21 beluga whale group sightings, 16 (76.2 percent) were recorded near low tide, three (14.3 percent) were recorded at mid-tide and two (9.5 percent) were recorded near high tide.

Table 6. Percent of six-hour observation period spent in and out of the Marine Terminal Redevelopment Footprint by beluga whales observed near the Port of Anchorage. Percent of the six hour observation period spent either in or out of the footprint is given by day.

Date	Percent inside	Percent outside
2-Aug	0	0
5-Aug	0	0
9-Aug	0	0
11-Aug	0	0
16-Aug	0	0
18-Aug	0	15.6
22-Aug	0	0
23-Aug	0	0
24-Aug	3.9	6.4
25-Aug	0	8.9
28-Aug	0	0
29-Aug	8.3	11.4
30-Aug	0	0
31-Aug	0	0
4-Sep	60.0	9.4
5-Sep	0	0
6-Sep	0	0
7-Sep	0	0
11-Sep	0	0
12-Sep	11.7	13.9
13-Sep	0	29.2
14-Sep	0	13.1
18-Sep	0	0
19-Sep	0	0
21-Sep	0	0.3
23-Sep	11.4	0
27-Sep	0	0
28-Sep	0	0
29-Sep	0	0
30-Sep	0	0

Date	Percent inside	Percent outside
2-Oct	7.8	3.9
4-Oct	0	0
6-Oct	0	0
7-Oct	0	0
9-Oct	0	0
11-Oct	0	0
13-Oct	0	0
14-Oct	0	0
18-Oct	0	0
20-Oct	0	0
25-Oct	0	0
27-Oct	8.1	0
1-Nov	26.4	4.7
3-Nov	0	60.3
8-Nov	0	0
10-Nov	0	0
15-Nov	0	0
17-Nov	0	0
21-Nov	0	0
22-Nov	0	0
28-Nov	0	0
<b>MEAN</b>	<b>2.7</b>	<b>3.5</b>

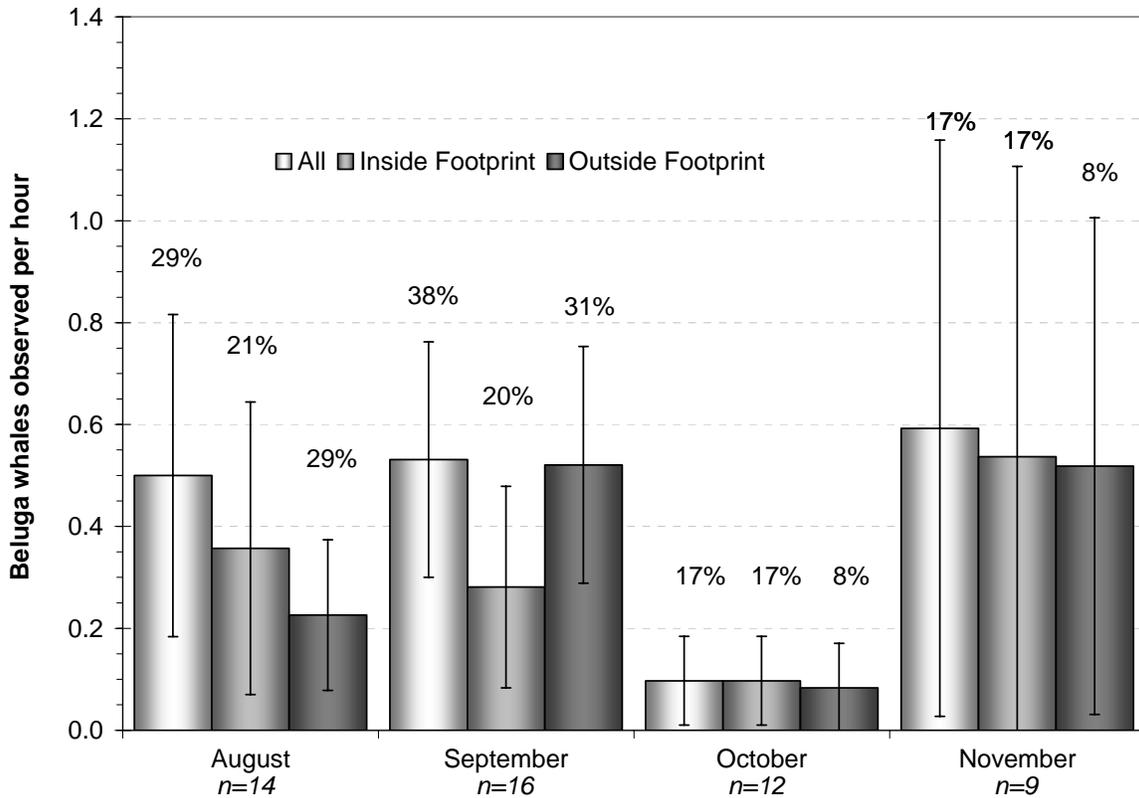
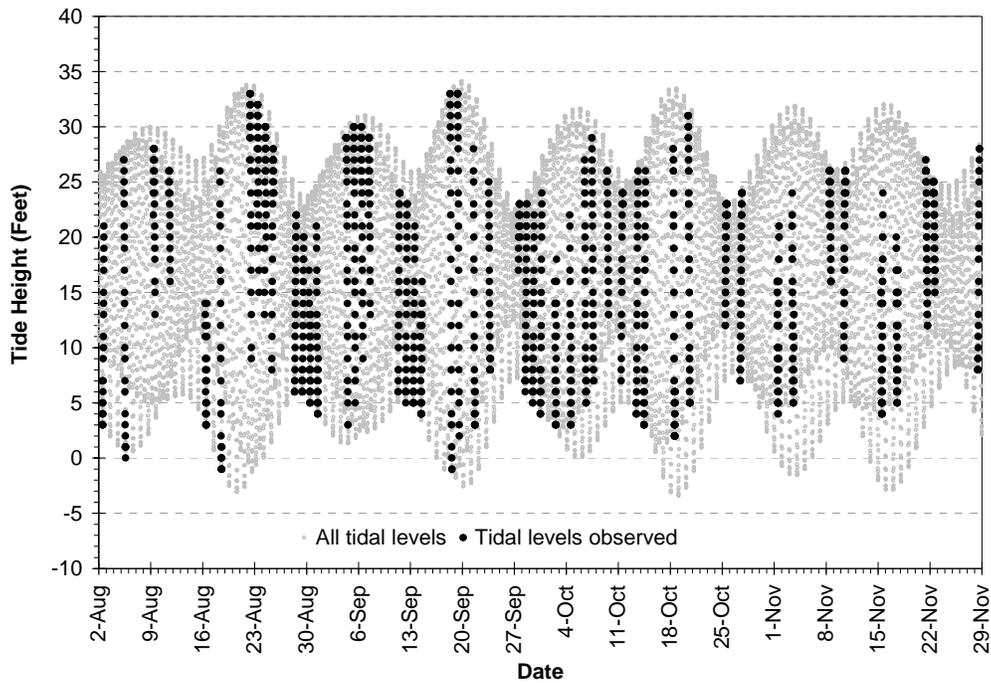


Figure 9. Beluga whales sighted per hour from stations at the Port of Anchorage and Cairn Point are compared by month overall (light gray), inside the project footprint (medium gray) and out of the project footprint (dark gray). The lower axis indicates the month, and the sample size (n= number of days on which observations were conducted). Bars represent the mean number of beluga whales observed based on best counts only, with standard errors (left axis). Percentage of days on which observations were conducted during which beluga whales were sighted overall, inside or outside the project footprint are shown above each bar by month.

Most (80.9 percent) sightings occurred within three hours of low tide (Figure 11), and more than half of the sightings (66.6 percent) occurred within two hours of low tide. Sightings occurred from 266 minutes before to 192 minutes after low tide. The time between midpoint sighting times to low tide varied from eight to 266 minutes. Mean time from low tide to the midpoint of sightings was 108 minutes. Mean monthly timing of sightings from low tide was less than 120 minutes (two hours) for all months (n=21). On average, sightings were just under 120 minutes from low tide in August (n=5) and September (n=10), less than 80 minutes from low tide in October (n=2), and just over 90 minutes from low tide in November (n=4).

As would be expected if they were moving with the tides, whales were most often sighted heading north or west on a flooding tide (Figure 12). Whale groups were more often observed moving south on the ebbing tide, but this relationship was somewhat less clear (Figure 12). For more than half of sightings, whale group heading was variable, suggesting that foraging could be taking place as whales milled about the area.

(a) All tidal levels observed



(b) Tidal levels during sightings

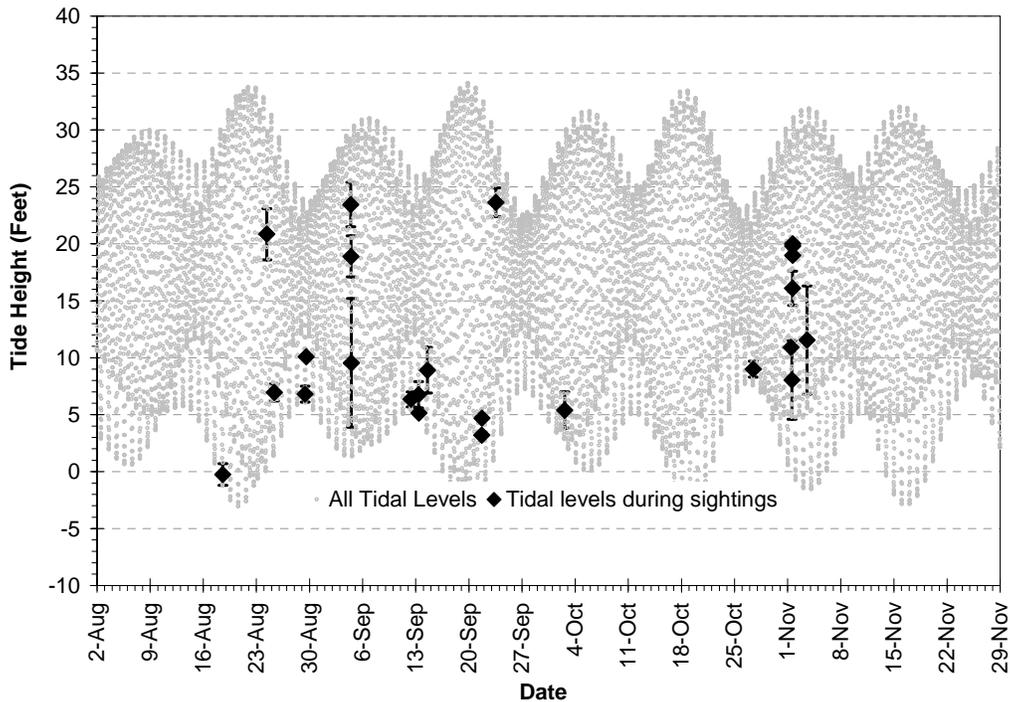


Figure 10. All tidal levels are shown in gray for the study period for the Knik Arm, Anchorage Alaska station (a & b). Tide levels covered during observation sessions are represented by black dots (a). The midpoint tide level for each beluga whale sighting is shown by black diamonds (b). Bars indicate starting and ending water levels for each sighting. Tidal levels were obtained with JTides 4.7 software (<http://www.arachnoid.com/JTides>).

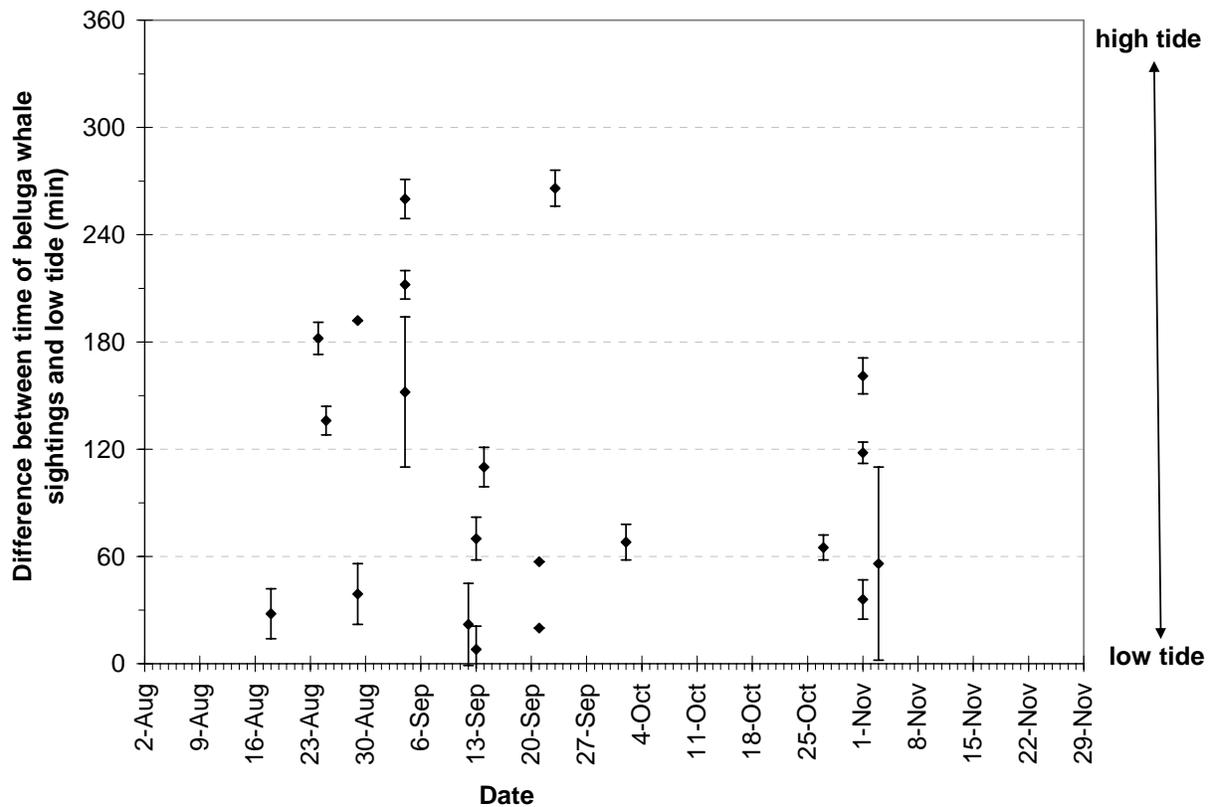


Figure 11. The timing of beluga whale sightings at the Port of Anchorage is shown relative to low tide for Aug-Nov 2005. Timing is presented on the y-axis as the difference between the midpoint time of a sighting and the nearest low tide time in minutes. Zero represents low tide and 360 minutes on the y-axis is approximately high tide. Bars indicate duration of each sighting.

The extent of the area where beluga whales were observed differed by tidal stage. Whales were observed in thirty-seven grid cells around low tide from August to November 2005 (Figure 13a). Around low tide, whales used grid cell areas immediately off of the Port of Anchorage (including the entire footprint), from Ship Creek to Cairn Point, and the coastal areas of water off Port MacKenzie. Whales used grid cells in the Knik Arm narrows off Cairn Point to a lesser extent during low tide than during other tides. Theodolite tracks collected around low tide indicated roughly linear movement suggesting traveling. During mid-tide, belugas were observed in seven grid cells (Figure 13b). Beluga whales were observed in grid cells close to the Port of Anchorage, from Ship Creek to Cairn Point within 500 to 1000 m of the shoreline. Belugas were also observed to a lesser extent in the Knik Arm narrows off Cairn Point. Milling, traveling and diving (indicated by broken tracks) are suggested by the theodolite tracks collected during mid-tide (Figure 13b). Very few whale groups were observed during high tide (Figure 13c). Whales used five grid cells adjacent to the Port of Anchorage at high tide.

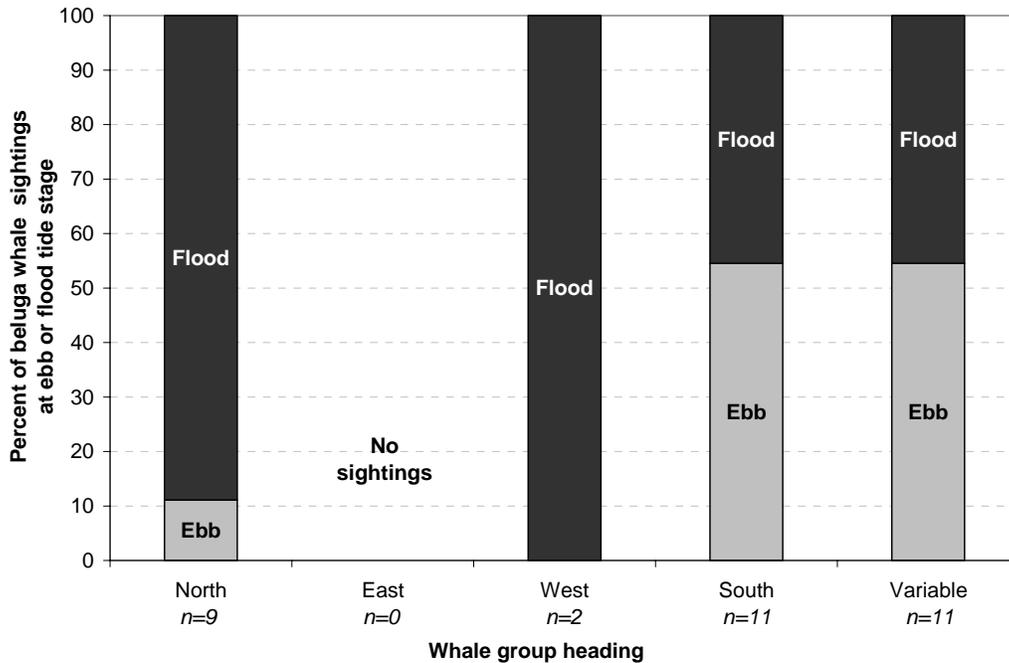


Figure 12. Percent of observed beluga whale group headings are compared for ebbing versus flooding tides. Sample sizes (n) represent number of sightings with a given heading. No sightings were observed heading east between August and November 2005.

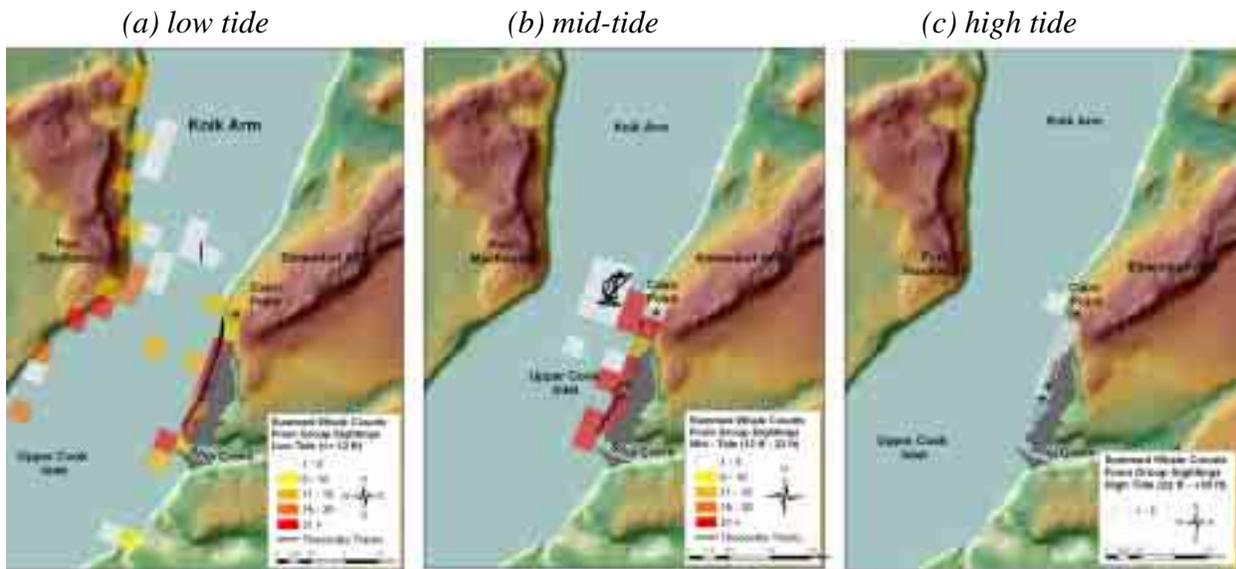


Figure 13. Summed whale counts from group sightings observed during low (a), mid-(b), and high (c) tide. Colored dots indicate grid cell based sightings and lines indicate theodolite based sightings. Size and color of dots correspond to summed whale counts from group sightings. No theodolite tracks were recorded during high tide levels.

### Age Class Distribution

Mean estimated age class composition changed little from August to October (Figure 14). On average, whale groups were comprised of 65±6.3 percent adults, 19±5.4 percent sub-adults, 11±3.4 percent calves, and 5±2.8 percent whales of unknown age class (means ± se, n=21 group sightings). Mean proportion of adults by month ranged from 45 to 81 percent, and subadults comprised 13 to 21 percent of whales observed in groups. On average, calves comprised six to 15 percent of the whales observed near the Port of Anchorage. Whales of undetermined age class were not common, with no whales being classified as unknown age class in August, September and October. In November, seven whales sighted were of unknown age class due to poorer sighting conditions (18 percent). If these whales were adults, the age class distribution would be similar to that observed in August through October (Figure 14).

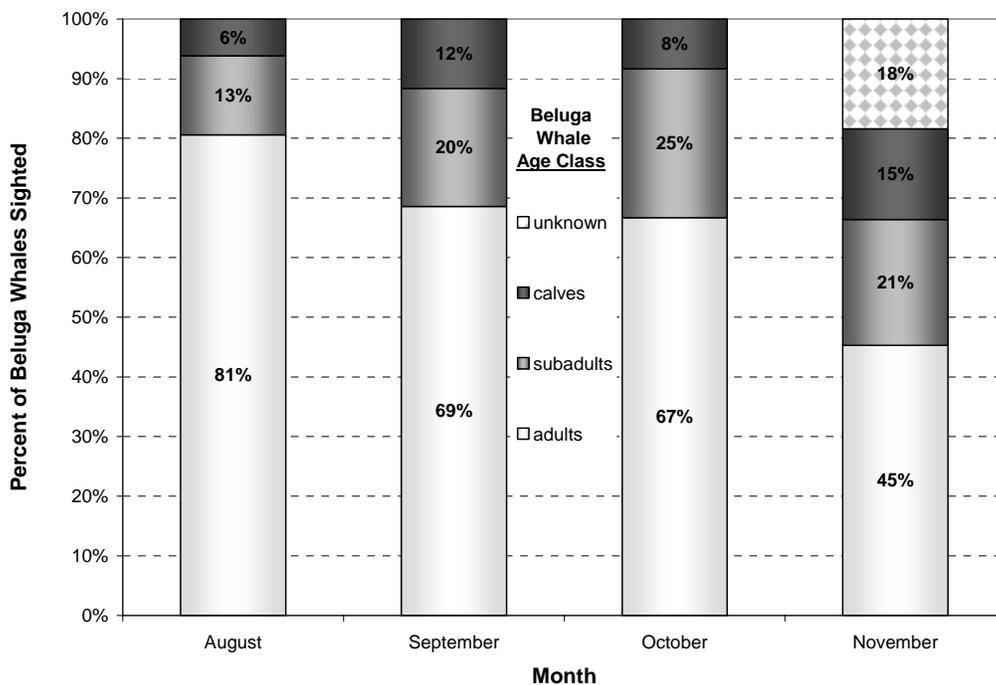


Figure 14. Age class distributions of beluga whales observed from all stations each month are compared. Stacked bars represent the mean (and standard error) proportion of adults, subadults, calves and whales of unknown age class. Sample size in number of sightings is given at the top of each bar.

### Beluga Whale Behavior

#### Beluga Whale Group Activity and Swimming Formation

Traveling was the most frequently recorded primary activity, followed by diving, and feeding (Figure 15). The most common secondary activity was diving, followed by traveling, and feeding.

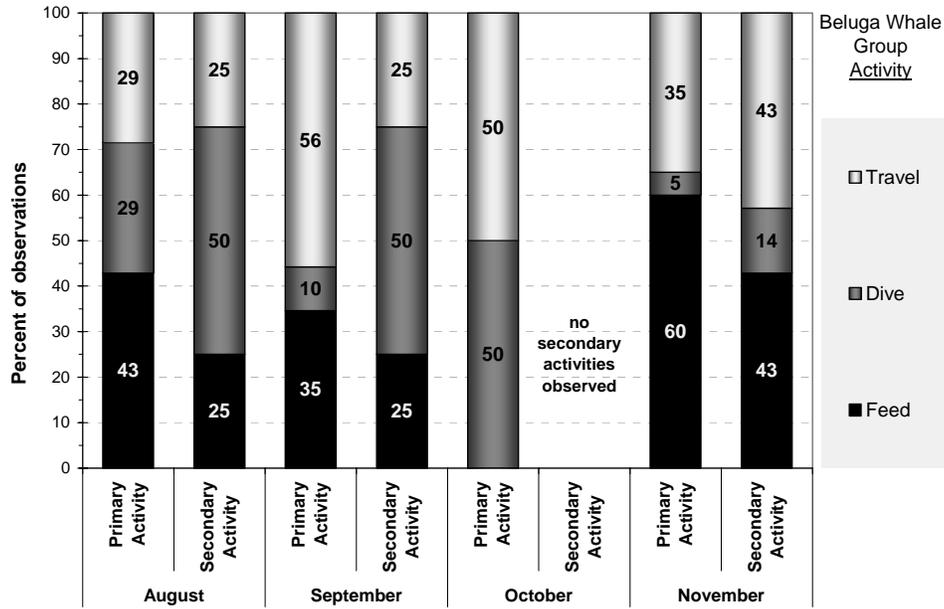


Figure 15. Beluga whale activity from all beluga whale observations is summarized by month. Stacked bars show percent beluga whale groups traveling, diving and feeding.

When beluga whale groups were observed swimming in formation, they most often swam in a linear formation, with fewer groups were observed arranged circularly, in a non-directional line, or in parallel formation (Figure 16). More detailed behavioral sampling was performed for groups observed for longer periods of time using focal behavioral and theodolite sampling (see below).

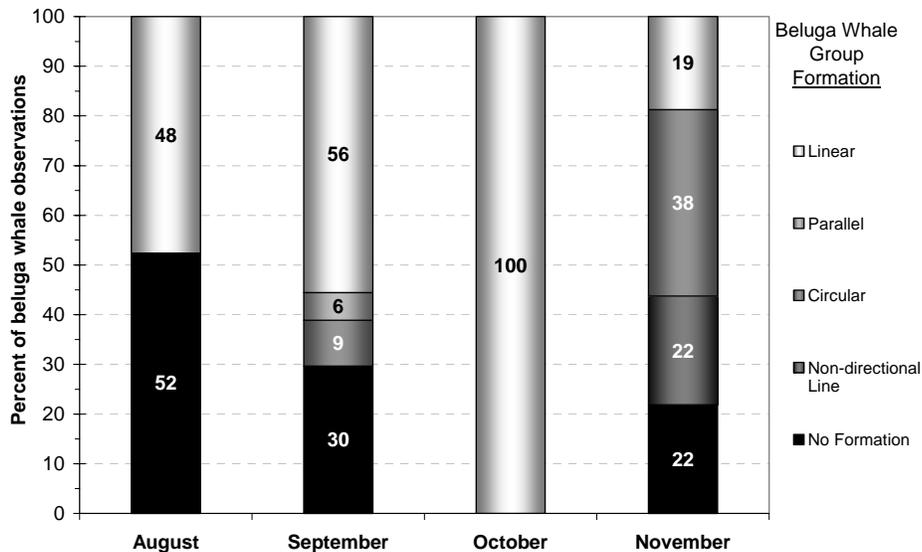


Figure 16. Beluga whale group swimming formation is shown by month. Percent of beluga whale group observations is shown on the y-axis with and months are shown on the x-axis.

**Detailed Beluga Whale Group Behavioral Observations**

***Focal Group Interval Data***

Beluga whales were observed traveling, feeding, and diving during an average of 44 percent, 54 percent. And 2 percent of intervals during August and September (*n = 10 group samples*). Group spread (mode inter-individual distance) was most often (90 percent of the time) less than 8 body lengths: < 1 body length = 26 percent, 1-3 body lengths = 28 percent, 4-7 body lengths = 36 percent, 8-12 body lengths = 7 percent, > 12 body lengths = 3 percent (mean values *n = 10 group samples*). Swimming formation of the whales was most often circular (spread evenly front to back and side to side = 47 percent) or linear (spread from front to back = 48 percent). Parallel swimming formation (spread side to side) was noted during the remaining 5 percent of intervals (mean values *n = 10 group samples*).

***Theodolite Tracking***

Six groups (and three sub-groups) were monitored with the theodolite on four days, with total number of fixes per group ranging from two to 68 fixes. Mean distance between fixes ranged from 0.03 to 0.55 mi and mean time between fixes ranged from 0.7 to 6.0 minutes (Table 7).

*Table 7. Theodolite summary statistics are provided for whale groups tracked in October and November 2005. Total number of fixes, average time between fixes, average leg speed between fixes, net and cumulative distance traveled, reorientation rate, linearity and percent of fixes whales were traveling, milling or resting are shown for each sighting.*

Date	2-Oct	27-Oct	1-Nov	1-Nov	1-Nov	1-Nov	1-Nov	1-Nov	3-Nov
<b>Group Number</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3a</b>	<b>3b</b>	<b>3c</b>	<b>1</b>
Number of Whales	6	1	2	2	25	4	13	8	3
Number of Fixes	61	2	19	39	65	2	15	3	68
Mean Inter-fix distance (mi)	0.03	n/a	0.04	0.04	0.24	n/a	0.06	0.15	0.55
Mean Inter-fix interval (min)	0.7	n/a	1.0	1.7	1.6	n/a	0.9	1.1	6.0
Mean Leg Speed (mph)	3.1	7.8	2.5	2.4	2.6	6.3	3.6	6.6	2.4
Net Distance (mi)	1.50	3.30	0.60	0.07	1.55	0.49	0.40	0.99	0.55
Cumulative Distance (mi)	1.90	n/a	0.61	0.91	3.06	n/a	0.94	1.08	7.47
Reorientation Rate (°/min)	105.2	n/a	31.3	12.2	54.1	n/a	49.5	16.8	15.7
Linearity (1.0 = line)	0.80	n/a	0.99	0.08	0.51	n/a	0.75	0.99	0.07
% Travel	100	100	16	100	45	100	100	100	7
% Mill	0	0	84	0	59	0	0	0	84
% Rest	0	0	0	0	0	0	0	0	9

Beluga whale groups were tracked at mean leg speeds of 2.4 to 7.8 mph when monitored by theodolite. Whales tracked with the theodolite traveled a net distance of 0.07 to 1.55 mi and a cumulative distance of 0.61 to 7.47 mi. Groups had a linearity (1.00 = straight line) of 0.07 to 0.99 and had a reorientation rate of 12.2 to 105.2 °/minutes (Table 7). Whale groups traveling fast and linearly transited quickly through the area, usually riding the tidal currents on the ebb or flood tides, to areas either outside or further north within Knik Arm. Other groups moved more slowly and less linearly, indicating possible foraging in the study area. Whales monitored during theodolite sampling in October were all traveling (Table 7). Theodolite tracks of the whale group during October indicated whales were generally traveling in a straight line through the area (linearity = 0.8; Table 4). In November, whales sampled by theodolite were traveling (7 to 64 percent), milling (36 to 84 percent) or resting (0 to 9 percent; Table 7). Linearity of groups in November ranged from 0.07 to 0.99 (Table 7).

On 3 November, dive times were sampled for 109 minutes for a group that was observed for over 200 minutes. During this sample, whales spent a mean of 2.6 minutes (0.02 to 35 minutes) beneath the surface (dive interval) and two seconds (1 to 5 seconds) above the surface (surface interval). The long dives may indicate whales were feeding at depth.

## **DISCUSSION OF MARINE TERMINAL REDEVELOPMENT PROJECT FOOTPRINT AND ADJACENT AREA USE BY BELUGA WHALES**

As would be expected at a major port, vessel traffic continued throughout this study; dredges, tanker ships, container ships, barges, tugs, and small skiffs moved through the study area. The greatest vessel activity was noted in September, with the number and types of vessels decreasing in October and November (Appendix C)

Beluga whales were seen around the port and vessels consistently during the study period. Environmental conditions were generally favorable for viewing whales. Precipitation, glare, and ice formation on the water surface during the last observation sessions in November contributed to somewhat degraded viewing conditions.

During this study, beluga whales were observed using water areas near the POA (including the waters immediately off of Ship Creek to Cairn Point), the coastal areas north and south of Port Mackenzie, and to a lesser extent, the central areas of deep water in Knik Arm. In August, five group sightings were recorded on four days. Whales were observed in thirteen grid cells, including three that overlapped the project footprint (half the footprint area). Whales used the area closest to shore near the POA, the area off Ship Creek and southeast of Port Mackenzie. During September, 10 whale groups were observed on six days in nearly all areas of visible coastline, including the area between Ship Creek and Cairn Point (including the POA and project footprint), and both north and south of Port Mackenzie. Whale sighting rates in October decreased compared to August and September. Whales used areas adjacent to the POA and passed through the central waters of Knik Arm. During November, whales were observed traveling through the waters immediately adjacent to the POA from Ship Creek to Cairn Point, including all six grid cells overlapping the project footprint.

Beluga whale sightings tended to occur during tide heights of less than +12 feet and to be timed within two hrs of low tide, with whales heading down Knik Arm on the ebb and up the

arm on the flood. These results are consistent with the results of Funk et al. (2005) for observations of beluga whales in Knik Arm. Areas used by beluga whales varied with tidal state. During low tide, whales passed through waters off the POA (from Ship Creek to Cairn Point) and immediately offshore of Port Mackenzie. There were a few sightings of whales at low tide in the middle of Knik Arm off Cairn Point. Theodolite tracks recorded during low tide indicated that whales were likely traveling. Beluga whales were recorded in fewer locations at mid-tide than low tide. During mid-tide, whales were observed in grid cells immediately off the POA, from Ship Creek to Cairn Point; theodolite tracks from mid-tide showed that whales were diving, milling and traveling. Very few whales were recorded at high tide. Most groups observed at high tide passed directly offshore of the POA.

On average, two beluga whales were sighted in the project footprint per six-hour monitoring shift. Whales were observed inside the project footprint for an average of 10 minutes per six-hour shift. On most days, whales were not observed in the project footprint during the monitoring shift.

Mean estimated age class composition of beluga whales within groups changed little from August to November, and was generally consistent with that reported previously (Funk et al. 2005). Over the entire period, mean estimated age class distribution based on field counts was 65 percent adults, 19 percent sub-adults, 11 percent calves, and 5 percent unknown.

Whales observed near the POA from August to November 2005 most often traveled along the shoreline in a linear formation or with no clear swimming formation. Other activities observed included diving and feeding. Theodolite data and focal group behavioral samples indicated that some whale groups traveled quickly in a straight line through the study area, while others meandered more slowly and less linearly in the area. A variable heading was recorded for over half of sightings, indicating that feeding, foraging, or milling may be common activities near the POA.

This study demonstrated that a surveyor's theodolite could be used to effectively track and monitor beluga whales in and around the POA Marine Terminal Redevelopment Project Footprint. This effort yielded high precision measurements of the range of beluga whale locations and movement patterns within and around the project footprint on a scale relevant to ongoing monitoring efforts.

## **Conclusions**

Beluga whales were sighted at a rate of 0.4 beluga whales per hour from August to November 2005. On average, 0.3 beluga whales per hour were seen inside the Marine Terminal Redevelopment Project Footprint. Beluga whales were observed inside the project footprint 2.7 percent of the time monitored, and outside the footprint 3.5 percent of the time. Beluga whales were sighted relatively infrequently (14 of 51 days; 27 percent); however, on the days that they were sighted, whales spent an average of 10 percent of the six-hour observation period in the project footprint. Mean estimated minimum group size was 7 whales (range 1-25). Beluga whale use of the project area peaked around low tide, and was limited during mid-to-high tide. On most days whales were sighted, they moved through grid cells overlapping the project footprint. The primary activity of beluga whales sighted in and around the project footprint was most often traveling in a linear formation. At times, whales were also observed to feed at the

nearby areas at the mouth of Ship Creek and the deep water in the narrows off of Cairn Point. Mean estimated horizontal swimming speeds ranging from 2-8 mph, linearity values ranging from 7-99 percent linear, and re-orientation rates ranging from 12-105 degrees per minute exhibit the variation in movement patterns one would expect given multiple uses of the project area by the whales.

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**Appendix A**

**LGL Data Sheets  
August – November 2005**













Sheet #:

LOCYYMMDDINI  
Ex. POA05081BBB

Date:                      Location:                      Observer:                      Group #:                      Ad:                      S-Ad:                      Ca:                      Un:

Time	Card	Frames	Blanks	Notes

**Start Observation:                      Begin Sample:                      End Sample:                      End Observation:**

<u>Behavior</u>	2 minutes	4 minutes	6 minutes	8 minutes	10 minutes
State	T M R FS FC D				
Heading	N S E W V	N S E W V	N S E W V	N S E W V	N S E W V
Spread	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+
Formation	C P L E N	C P L E N	C P L E N	C P L E N	C P L E N
Lobtail					
Vocalize					

**Dive Record (circle one):                      Individual                      or                      Group**

Event	1	2	3	4	5	6	7	8	9	10
Dive										
Surface										

<u>Behavior</u>	12 minutes	14 minutes	16 minutes	18 minutes	20 minutes
State	T M R FS FC D				
Heading	N S E W V	N S E W V	N S E W V	N S E W V	N S E W V
Spread	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+
Formation	C P L E N	C P L E N	C P L E N	C P L E N	C P L E N
Lobtail					
Vocalize					

Event	11	12	13	14	15	16	17	18	19	20
Dive										
Surface										

<u>Behavior</u>	22 minutes	24 minutes	26 minutes	28 minutes	30 minutes
State	T M R FS FC D				
Heading	N S E W V	N S E W V	N S E W V	N S E W V	N S E W V
Spread	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+	<1 1-3 4-7 8-12 13+
Formation	C P L E N	C P L E N	C P L E N	C P L E N	C P L E N
Lobtail					
Vocalize					

Event	21	22	23	24	25	26	27	28	29	30
Dive										
Surface										

**COMMENTS:** \_\_\_\_\_



**Appendix B**

**LGL Monthly Progress Reports  
August 2005 – November 2005**

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## **LGL Alaska Research Associates, Inc.**

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# Memorandum

**To:** William E. Humphries, V.P., Principal in Charge, Anchorage Port Expansion Team  
Integrated Concepts and Research Corporation

**From:** Tim Markowitz, Ph.D. (signed)

**Date:** 1 September 2005

**Re:** LGL Monthly Progress Report August 2005

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This is a progress report of a study by LGL Alaska Research Associates, Inc., sponsored by Integrated Concepts and Research Corporation (ICRC), the Port of Anchorage (POA), and the U.S. Department of Transportation Maritime Administration (MARAD), to monitor beluga whale presence, habitat use and behavior in the Port of Anchorage area. Data collected during this period will provide baseline information on beluga whale presence and behavior within the Port of Anchorage Marine Terminal Redevelopment Project footprint prior to the planned expansion activities. Sightings within the project footprint area will be distinguished from value-added data collected on beluga whale occurrence and behavior outside the project footprint. MARAD is the federal funding agency for all work associated with the POA Expansion Project including this monitoring program. This report covers project activities during August 2005.

## **Objectives**

The study has three primary objectives:

1. Estimate the frequency at which beluga whales are present in the project footprint.
2. Characterize habitat use and behavior of beluga whales near the Port of Anchorage during ice free months.
3. Map sound levels and attenuation with distance related to POA background noise and expansion activities.

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## Project Coordination and Consultation

Following consultation with ICRC, maps of the Port of Anchorage project footprint were overlaid on a topographic map (Figure 1) used to locate whale groups in 500 m x 500m grid cells, in order to determine when whales were seen inside versus outside the project footprint.

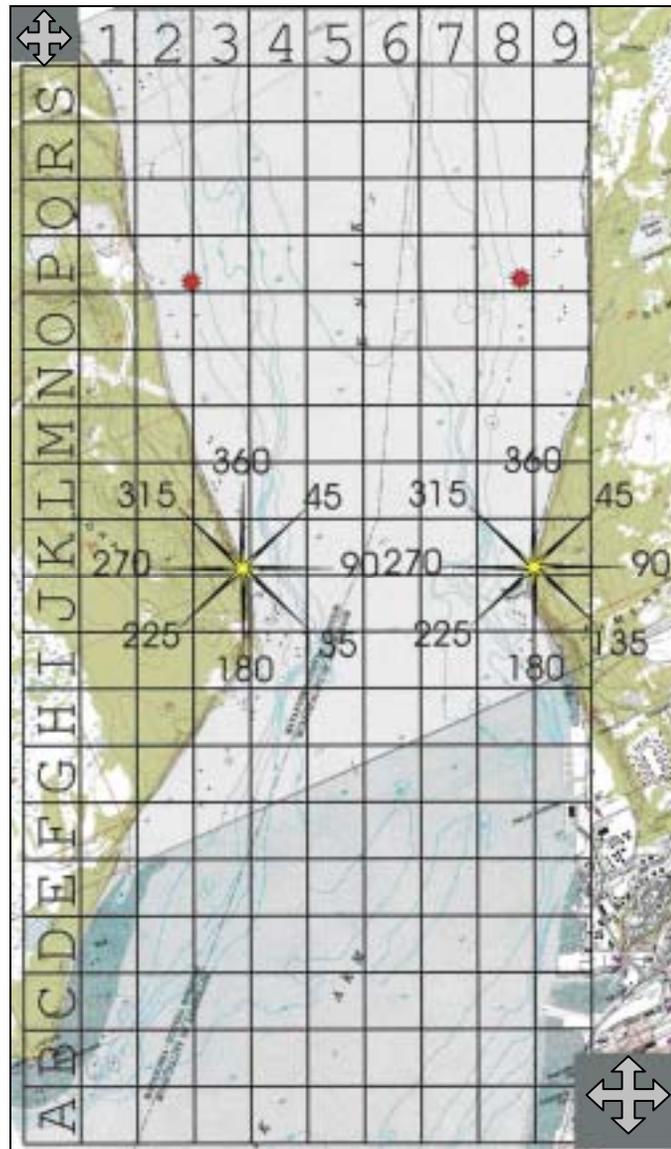


Figure 1. This 500m x 500m grid cell map was used to document the location of beluga whale groups sighted from the Port of Anchorage and Cairn Point. For reference in the field, this map is oriented relative to magnetic north (compass bearings are shown at the center of the grid). The Port of Anchorage Marine Terminal Redevelopment Project footprint is located in grid cells D9 to I9.

## Portion of Study Completed

August represented 7.7% of the work and 6.3% of the pricing expended during the contract period.

## Monitoring Effort

Monitoring was conducted on a schedule of two days per week from the Port of Anchorage (using the POL-2 tower when available), and two days per week from Cairn Point on Elmendorf Air Force Base when possible. Monitoring effort was conducted over 14 sessions lasting six hours each during August 2005 (Table 1). Ten monitoring sessions were conducted from stations at the Port of Anchorage. Four additional monitoring sessions were conducted from Cairn Point on Elmendorf Air Force Base. For the first two weeks of the month all effort was at the Port of Anchorage, as access had not yet been granted to Elmendorf Air Force Base for monitoring from a northern vantage. Once permission was obtained to access Elmendorf Air Force Base, additional monitoring was conducted from the Cairn Point south facing observation station beginning 23 August.

*Table 1. Beluga whale monitoring effort at the Port of Anchorage and Cairn Point is summarized by day for the month of August, 2005.*

<b>Port of Anchorage Beluga Whale Monitoring Effort, August 2005</b>			
<b>Date</b>	<b>Station</b>	<b>Shift Start</b>	<b>Shift End</b>
<b>02-Aug-05</b>	PORT OF ANCHORAGE ALTERNATE	11:00	17:00
<b>05-Aug-05</b>	PORT OF ANCHORAGE POL-2	9:00	15:00
<b>09-Aug-05</b>	PORT OF ANCHORAGE POL-2	8:20	14:20
<b>11-Aug-05</b>	PORT OF ANCHORAGE POL-2	10:20	15:20
<b>16-Aug-05</b>	PORT OF ANCHORAGE POL-2	8:00	14:00
<b>18-Aug-05</b>	PORT OF ANCHORAGE POL-2	8:00	14:00
<b>22-Aug-05</b>	PORT OF ANCHORAGE POL-2	8:00	14:00
<b>23-Aug-05</b>	CAIRN POINT	8:00	14:00
<b>24-Aug-05</b>	PORT OF ANCHORAGE POL-2	8:00	14:00
<b>25-Aug-05</b>	CAIRN POINT	8:00	14:00
<b>28-Aug-05</b>	CAIRN POINT	9:00	15:00
<b>29-Aug-05</b>	PORT OF ANCHORAGE POL-2	9:00	15:00
<b>30-Aug-05</b>	CAIRN POINT	8:00	14:00
<b>31-Aug-05</b>	PORT OF ANCHORAGE POL-2	8:00	14:00

## Environmental Conditions

Mean wind speed was 4 mph, with daily mean values ranging from 2-8 mph. Average air temperature was 15<sup>0</sup> C, with daily mean values ranging from 14-18<sup>0</sup> C. Precipitation (rain) was noted during 5 of the 14 monitoring sessions (36%). Sighting conditions were ranked from good to excellent on all days. Mean estimated maximum sighting distance was 3 miles, and ranged from 2 to 5 miles.

## Vessel Activity and Obstruction of Vantage

Not surprisingly, the port area was used by vessels of all types (e.g. small skiffs, tug boats, barges, container ships, tanker ships, dredges) during the study period. Some of these vessels partly obstructed the view of the project footprint. Table 2 provides summaries of the mean estimated proportion of the footprint obstructed on each day by grid cell.

*Table 2. Mean estimated percent obstruction of the Port of Anchorage project footprint by vessels at the dock is shown by grid cell and by date. The right-most column gives the estimated percent obstruction in the entire foot print area. The bottom row provides mean values for all days monitored in August.*

Date	D9	E9	F9	G9	H9	I9	Foot Print
<b>5-Aug</b>	0	10	20	40	60	50	<b>30</b>
<b>9-Aug</b>	0	10	25	40	50	50	<b>29</b>
<b>11-Aug</b>	0	0	30	40	40	50	<b>27</b>
<b>16-Aug</b>	10	5	20	40	50	40	<b>28</b>
<b>18-Aug</b>	0	0	20	21	40	30	<b>19</b>
<b>22-Aug</b>	10	15	10	0	30	20	<b>14</b>
<b>23-Aug</b>	0	25	25	20	0	0	<b>12</b>
<b>24-Aug</b>	0	0	5	0	30	20	<b>9</b>
<b>25-Aug</b>	0	5	7	0	0	0	<b>2</b>
<b>28-Aug</b>	0	5	30	25	0	0	<b>10</b>
<b>29-Aug</b>	0	0	5	0	20	0	<b>4</b>
<b>30-Aug</b>	0	10	20	30	0	0	<b>10</b>
<b>31-Aug</b>	0	0	0	0	18	0	<b>3</b>
<b>Mean</b>	<b>2</b>	<b>7</b>	<b>17</b>	<b>20</b>	<b>26</b>	<b>20</b>	<b>15</b>

## Beluga Whale Group Sightings

Beluga whales were sighted on four days during August monitoring (Table 3). One whale group was sighted on each of these days. Best minimum counts of the number of whales in these four sightings totaled 11, 1, 6, and 23 whales. They were observed for time periods ranging from 32 to 70 minutes.

Table 3. Number of beluga whales sighted during monitoring at the Port of Anchorage and Cairn Point are shown by age class for the month of August 2005.

Date	Begin Obs	End Obs	Adults	Subadults	Calves	Unknown	Total
2-Aug-05			0	0	0	0	0
5-Aug-05			0	0	0	0	0
9-Aug-05			0	0	0	0	0
11-Aug-05			0	0	0	0	0
16-Aug-05			0	0	0	0	0
<b>18-Aug-05</b>	<b>13:03</b>	<b>13:59</b>	<b>7</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>11</b>
22-Aug-05			0	0	0	0	0
23-Aug-05			0	0	0	0	0
<b>24-Aug-05</b>	<b>8:36</b>	<b>9:13</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>
<b>25-Aug-05</b>	<b>8:10</b>	<b>8:42</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>6</b>
28-Aug-05			0	0	0	0	0
<b>29-Aug-05</b>	<b>9:10</b>	<b>10:20</b>	<b>9</b>	<b>9</b>	<b>5</b>	<b>0</b>	<b>23</b>
30-Aug-05			0	0	0	0	0
31-Aug-05			0	0	0	0	0
<b>Percent</b>			<b>57%</b>	<b>32%</b>	<b>10%</b>	<b>0%</b>	

## Beluga Whale Group Locations

Locations of beluga whale group sightings are shown in Table 4. Whales observed on 18 and 25 August were seen across Knik Arm near Port MacKenzie. Whales observed on 24 and 29 August were seen inside the Port of Anchorage Project footprint.

Table 4. Grid cell locations where beluga whales were sighted during August 2005 are shown by date and time. Grid cells in bold are within the Port of Anchorage Project footprint.

Date	Time	Grid Cell
18-Aug-05	13:03	I3
18-Aug-05	13:07	H3
18-Aug-05	13:10	G2
18-Aug-05	13:24	C1
18-Aug-05	13:29	B1
18-Aug-05	13:40	B0
<b>24-Aug-05</b>	<b>8:36</b>	<b>F9</b>
<b>24-Aug-05</b>	<b>8:40</b>	<b>F9</b>
<b>24-Aug-05</b>	<b>8:45</b>	<b>F9</b>
<b>24-Aug-05</b>	<b>8:50</b>	<b>G9</b>
24-Aug-05	9:06	G8
24-Aug-05	9:13	G6
25-Aug-05	8:10	H3
25-Aug-05	8:42	H3
<b>29-Aug-05</b>	<b>9:10</b>	<b>H9</b>
<b>29-Aug-05</b>	<b>9:20</b>	<b>H9</b>
<b>29-Aug-05</b>	<b>9:30</b>	<b>G9</b>
<b>29-Aug-05</b>	<b>9:40</b>	<b>F9</b>
29-Aug-05	10:00	C8
29-Aug-05	10:20	Q35
29-Aug-05	13:26	P35

## Whale Activity

Traveling and feeding were the most commonly noted behavioral states of whales monitored during August (Figure 2). Diving was also noted in two groups. Resting and milling were not observed. The whales observed were generally fairly tightly grouped (mode inter-individual distance <1 body length = 33%, 1-3 body lengths = 38%, 4-7 body lengths =29%). Movement of the whales was most often in a north or south direction, along Knik Arm and parallel to the port (81%).

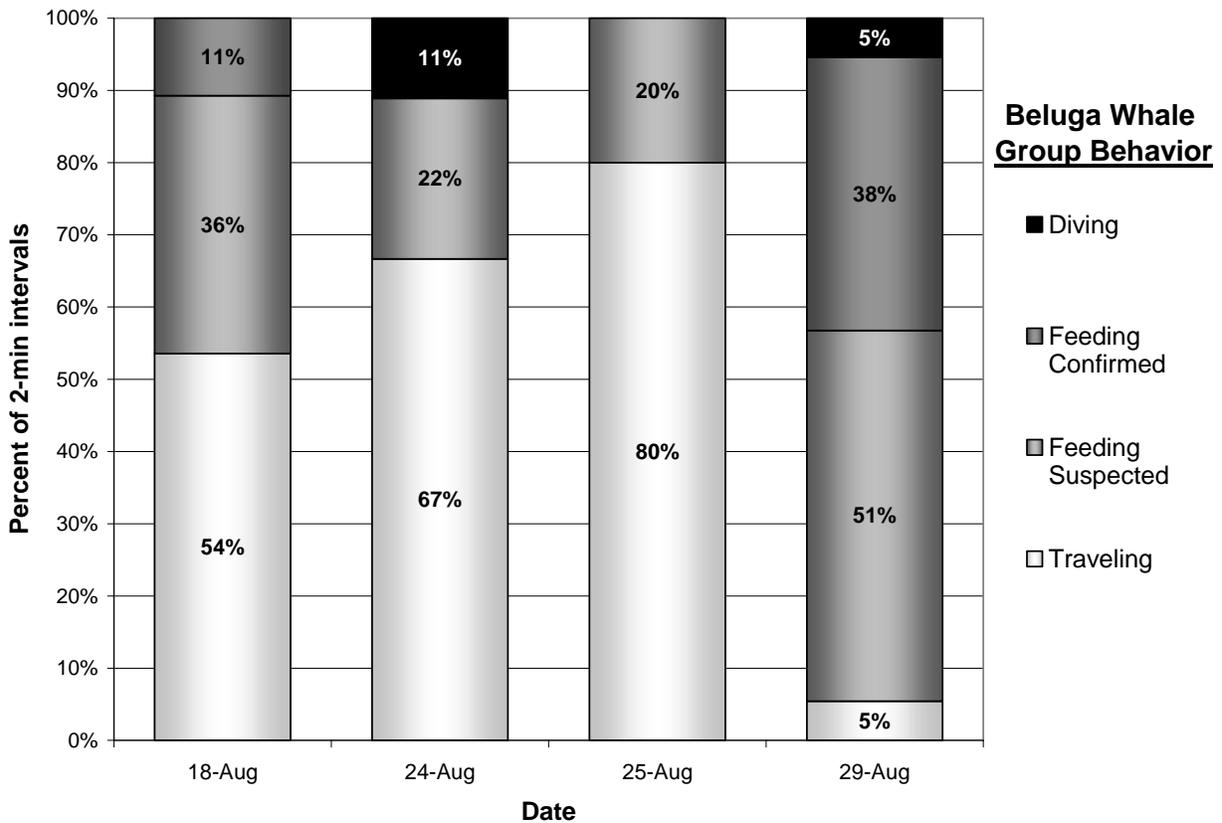


Figure 2. Behavior of whale groups monitored during August 2005 from the Port of Anchorage and Cairn Point.

## Upcoming Field Research

Next month, beluga whale monitoring will be conducted two days per week from stations at the Port of Anchorage (POL-2 when available) and two days per week from Cairn Point on Elmendorf Air Force Base.



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# Memorandum

**To:** William E. Humphries, V.P., Principal in Charge, Anchorage Port Expansion Team  
Integrated Concepts and Research Corporation

**From:** Tim Markowitz, Amanda Prevel (signed)

**Date:** 4 October 2005

**Re:** LGL Monthly Progress Report for September 2005

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This is a progress report of a study by LGL Alaska Research Associates, Inc., sponsored by Integrated Concepts and Research Corporation (ICRC), the Port of Anchorage (POA), and the U.S. Department of Transportation Maritime Administration (MARAD), to monitor beluga whale presence, habitat use and behavior in the Port of Anchorage area. Data collected during this period will provide baseline information on beluga whale presence and behavior within the Port of Anchorage Marine Terminal Redevelopment Project footprint prior to the planned expansion activities. Sightings within the project footprint area will be distinguished from value-added data collected on beluga whale occurrence and behavior outside the project footprint. MARAD is the federal funding agency for all work associated with the POA Expansion Project including this monitoring program. This report covers project activities during September 2005.

### Objectives

The study has three primary objectives:

1. Estimate the frequency at which beluga whales are present in the project footprint.
2. Characterize habitat use and behavior of beluga whales near the Port of Anchorage during ice free months.
3. Map sound levels and attenuation with distance related to POA background noise and expansion activities.

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## Project Coordination and Consultation

Access to monitoring stations was obtained with the assistance of Port of Anchorage and Elmendorf Air Force Base personnel. Staff at Elmendorf AFB also provided technical assistance in obtaining accurate survey information related to the station height for theodolite tracking of whale groups from the Cairn Point site. Station heights for theodolite tracking from the Port of Anchorage were determined by measuring the height of observation towers POL-1 and POL-2 with a survey tape and adding this elevation to deck heights from engineering diagrams for POL-1 and POL-2 provided by POA and ICRC.

## Portion of Study Completed

To date, 23.1% of the work has been completed and 18.9% of the pricing has been expended during the contract period. September represented 7.7% of the work and 6.3% of the pricing expended during the contract period.

## Monitoring Effort

Monitoring was conducted on a schedule of two days per week from the Port of Anchorage, and two days per week from Cairn Point on Elmendorf Air Force Base (Figure 1). When possible, the POL-2 tower was used for observations from the port (Figure 2). On two days when POL-2 was unavailable due to port operations, POL-1 was used as an alternate station. Monitoring effort was conducted over 16 sessions lasting six hours each during September 2005 (Table 1). Eight monitoring sessions were conducted from stations at the Port of Anchorage. Eight additional monitoring sessions were conducted from Cairn Point on Elmendorf Air Force Base.



Figure 1. Beluga whale monitoring sessions were conducted from: a. the Port of Anchorage, and b. Cairn Point on Elmendorf Air Force Base.

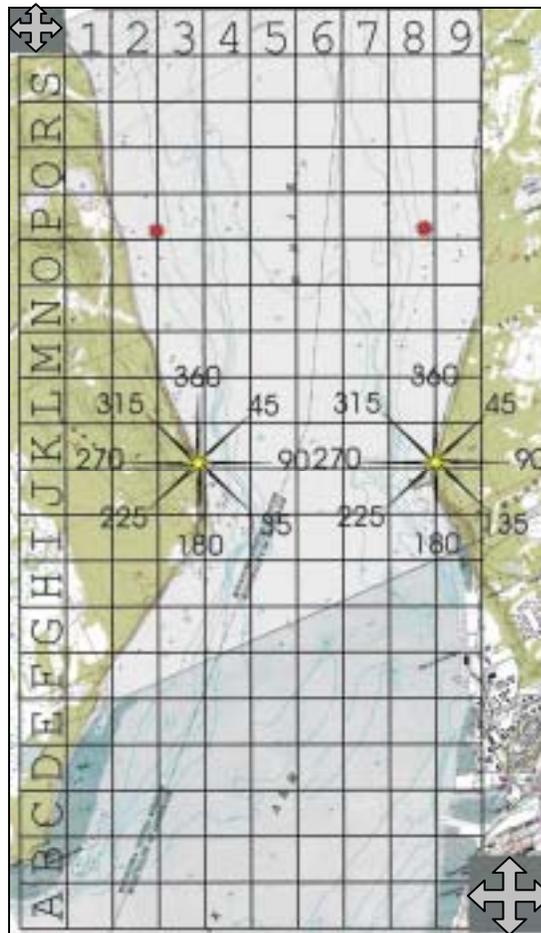


Figure 2. An LGL field biologist climbs the ladder to the POL-2 platform to conduct a beluga whale monitoring session at the Port of Anchorage.

Table 1. Beluga whale monitoring effort at the Port of Anchorage and Cairn Point is summarized by day for the month of September, 2005.

Date	Station	Shift Start	Shift End
4-Sep-05	Cairn Point	8:00	14:00
5-Sep-05	Port of Anchorage POL-1	8:00	14:00
6-Sep-05	Cairn Point	8:00	14:00
7-Sep-05	Port of Anchorage POL-2	8:00	14:00
11-Sep-05	Cairn Point	8:00	14:00
12-Sep-05	Port of Anchorage POL-2	8:00	14:00
13-Sep-05	Cairn Point	8:00	14:00
14-Sep-05	Port of Anchorage POL-2	8:00	14:00
18-Sep-05	Cairn Point	8:00	14:00
19-Sep-05	Port of Anchorage POL-2	8:00	14:00
21-Sep-05	Port of Anchorage POL-1	11:45	17:45
23-Sep-05	Cairn Point	13:03	19:03
27-Sep-05	Port of Anchorage POL-2	13:05	19:05
28-Sep-05	Cairn Point	10:15	16:15
29-Sep-05	Port of Anchorage POL-2	10:00	16:00
30-Sep-05	Cairn Point	11:00	17:00

For the first part of September, whale locations were noted on a 500 m X 500 m grid overlaid on topographic map of the coastline (Figure 1).



*Figure 3. This 500m x 500m grid cell map was used to document the location of beluga whale groups sighted from the Port of Anchorage and Cairn Point. For reference in the field, this map is oriented relative to magnetic north (compass bearings are shown at the center of the grid). The Port of Anchorage Marine Terminal Redevelopment Project footprint is located in grid cells D9 to I9.*

Beginning in mid-September, a surveyor's theodolite (Topcon DT-102) was obtained for more accurate tracking whales and vessels from shore (Figure 4). The theodolite measures horizontal and vertical angles, which are input directly to a laptop computer and time stamped. The data collection software Pythagoras, which computes location and movement information and tabulates other non-fix data, was installed. A Pythagoras database was designed,

incorporating theodolite station information, organizing fix and non-fix data, and adjusting for tide height using imported tide height tables. This theodolite tracking system was used for tracking whales, vessel traffic and environmental conditions beginning 21 September.



Figure 4. LGL field biologists operated a Topcon DT-102 theodolite linked to a laptop computer at: a. POL-2 tower, Port of Anchorage and b. Cairn Point, Elmendorf Air Force Base.

### **Environmental Conditions**

Mean wind speed was 4 mph, with daily mean values ranging from 2-5 mph. Mean air temperature was 12<sup>0</sup> C, with daily mean values ranging from 11-13<sup>0</sup> C. Precipitation (rain) was noted during 40% of monitoring sessions. Sighting conditions were rated from good to excellent on all days except one, when they were rated from poor to good. Mean estimated maximum sighting distance was 3 miles, and ranged from 2 to 4 miles.

### **Vessel Activity and Obstruction of Vantage**

Vessels documented in the port area during the study period included small skiffs, tug boats, barges, container ships, tanker ships, and dredges (Figure 5a). Some of these vessels partly obstructed the view of the project footprint (Figure 5b). Table 2 provides summaries of the mean estimated proportion of the footprint obstructed on each day.



Figure 5. a. The location and activity of vessels, including dredges, barges, tugs, and small skiffs, were documented around the Port of Anchorage. b. At times, the view of the Port of Anchorage Marine Terminal Redevelopment Project footprint was partially obscured by vessels.

Table 2. Mean estimated percent obstruction of the Port of Anchorage Marine Terminal Redevelopment Project footprint by vessels at the dock is shown by grid cell and by date. The right-most column gives the estimated percent obstruction in the entire foot print area. The bottom row provides mean values for all days monitored in September. Means per grid cell apply to 4-Sep through 19-Sep only. Starting 21-Sep, the theodolite was used to monitor locations of vessels obstructing the view of the footprint.

Date	D9	E9	F9	G9	H9	I9	Footprint
4-Sep-05			10%	20%			4%
5-Sep-05			10%	30%	50%	30%	19%
6-Sep-05		1%	10%	20%			5%
7-Sep-05	5%		5%				2%
11-Sep-05		4%	20%	30%			8%
12-Sep-05			10%				2%
13-Sep-05				10%	25%		6%
14-Sep-05		3%		5%	3%		2%
18-Sep-05			15%	25%			6%
19-Sep-05	1%		71%	2%	15%	10%	17%
21-Sep-05	80%	80%					30%
23-Sep-05				50%			7%
27-Sep-05							20%
28-Sep-05							20%
29-Sep-05							0%
30-Sep-05							0%
Mean	3%	3%	19%	18%	23%	20%	9%

## Beluga Whale Group Sightings

Beluga whales were sighted on 6 of 18 days (33.3%) during September monitoring (Table 3). Ten whale group sightings were documented during the month of September: Three on 4-Sep, two each on 13 and 21-Sep, one each on 12, 14 and 23-Sep. Best minimum counts of the number of whales in these ten sightings totaled from one to 14 whales (mean = 5 whales). Whale groups were monitored for time periods ranging from 1 - 170 minutes.

Table 3. Number of beluga whales sighted during monitoring at the Port of Anchorage and Cairn Point are shown by age class for the month of September 2005.

Date	Begin Obs	End Obs	Adults	Subadults	Calves	Total
4-Sep-05	10:03	10:50	1	0	1	2
4-Sep-05	10:50	13:40	6	2	3	11
4-Sep-05	10:58	11:31	1	0	0	1
12-Sep-05	8:08	9:40	7	2	3	12
13-Sep-05	8:09	9:00	4	1	0	5
13-Sep-05	9:26	10:20	2	0	0	2
14-Sep-05	12:20	13:03	6	6	2	14
21-Sep-05	16:43	16:44	2	0	0	2
21-Sep-05	17:20	17:20	0	1	0	1
23-Sep-05	13:04	13:48	1	0	0	1
<b>Percent</b>			<b>59%</b>	<b>24%</b>	<b>18%</b>	
<b>Mean</b>			<b>3</b>	<b>1</b>	<b>1</b>	<b>5</b>

## Beluga Whale Group Locations

Half of the beluga whale groups monitored during September (5 sightings on 3 days) were observed in the Port of Anchorage Marine Terminal Redevelopment Project footprint. Whale groups monitored on 4, 12, and 23-Sep were observed inside the project footprint (Table 4). Whale groups monitored on 13, 14 and 21-Sep were seen outside the project footprint, across Knik Arm near Port MacKenzie (Table 5).

Table 4. Grid cell locations for beluga whales monitored near and inside the Port of Anchorage footprint during September 2005 are shown by date and time. Locations and times inside the project footprint are shown in bold.

Date	Time	Grid Cell
04-Sep-05	10:03	J8
<b>04-Sep-05</b>	<b>10:22</b>	<b>I9</b>
<b>04-Sep-05</b>	<b>10:33</b>	<b>H9</b>
<b>04-Sep-05</b>	<b>10:42</b>	<b>G9</b>
<b>04-Sep-05</b>	<b>10:46</b>	<b>F9</b>
<b>04-Sep-05</b>	<b>10:50</b>	<b>F9</b>
04-Sep-05	10:50	J9
<b>04-Sep-05</b>	<b>10:57</b>	<b>H9</b>
<b>04-Sep-05</b>	<b>11:00</b>	<b>H9</b>
<b>04-Sep-05</b>	<b>11:06</b>	<b>G9</b>
<b>04-Sep-05</b>	<b>11:11</b>	<b>F9</b>
<b>04-Sep-05</b>	<b>11:16</b>	<b>E9</b>
<b>04-Sep-05</b>	<b>11:20</b>	<b>D9</b>
<b>04-Sep-05</b>	<b>11:40</b>	<b>D9</b>
<b>04-Sep-05</b>	<b>12:00</b>	<b>D9</b>
<b>04-Sep-05</b>	<b>12:20</b>	<b>D9</b>
<b>04-Sep-05</b>	<b>12:40</b>	<b>D9</b>
<b>04-Sep-05</b>	<b>13:00</b>	<b>D9</b>
<b>04-Sep-05</b>	<b>13:20</b>	<b>D9</b>
<b>04-Sep-05</b>	<b>13:40</b>	<b>D9</b>
04-Sep-05	10:58	J9
<b>04-Sep-05</b>	<b>11:06</b>	<b>I9</b>
<b>04-Sep-05</b>	<b>11:31</b>	<b>E9</b>
12-Sep-05	8:08	C9
12-Sep-05	8:20	C9
12-Sep-05	8:55	B8
<b>12-Sep-05</b>	<b>9:00</b>	<b>D9</b>
<b>12-Sep-05</b>	<b>9:20</b>	<b>F9</b>
<b>12-Sep-05</b>	<b>9:30</b>	<b>H9</b>
12-Sep-05	9:40	J8
<b>23-Sep-05</b>	<b>13:07</b>	<b>H9</b>
<b>23-Sep-05</b>	<b>13:12</b>	<b>H9</b>
<b>23-Sep-05</b>	<b>13:33</b>	<b>H9</b>
<b>23-Sep-05</b>	<b>13:48</b>	<b>H9</b>

## Whale Activity

Focal group 2-minute interval sampling was used to document whale behavior. Whale activities noted included feeding (mean  $\pm$  se = 63  $\pm$  11.2% of observations) and traveling (mean  $\pm$  se = 37  $\pm$  12.1% of observations). Resting and milling were not noted. Whales observed from the Port of Anchorage and Cairn Point during September were generally tightly grouped, spread less than 3 body lengths apart more than half of the time (Figure 6).

Table 5. Grid cell locations where beluga whales were sighted outside the Port of Anchorage footprint during September 2005 are shown by date and time.

Date	Time	Grid Cell
13-Sep-05	8:09	I4
13-Sep-05	8:24	G2
13-Sep-05	8:40	B1
13-Sep-05	9:00	B1
13-Sep-05	9:26	G2
13-Sep-05	9:40	E1
13-Sep-05	10:00	D1
13-Sep-05	10:20	D1
14-Sep-05	12:20	E1
14-Sep-05	12:26	G2
14-Sep-05	12:28	H3
14-Sep-05	12:33	I4
14-Sep-05	12:36	J4
14-Sep-05	12:45	L3
14-Sep-05	12:47	N2
14-Sep-05	12:52	P2
14-Sep-05	13:00	R1
14-Sep-05	13:03	S1
21-Sep-05	16:43	J4
21-Sep-05	17:20	J4

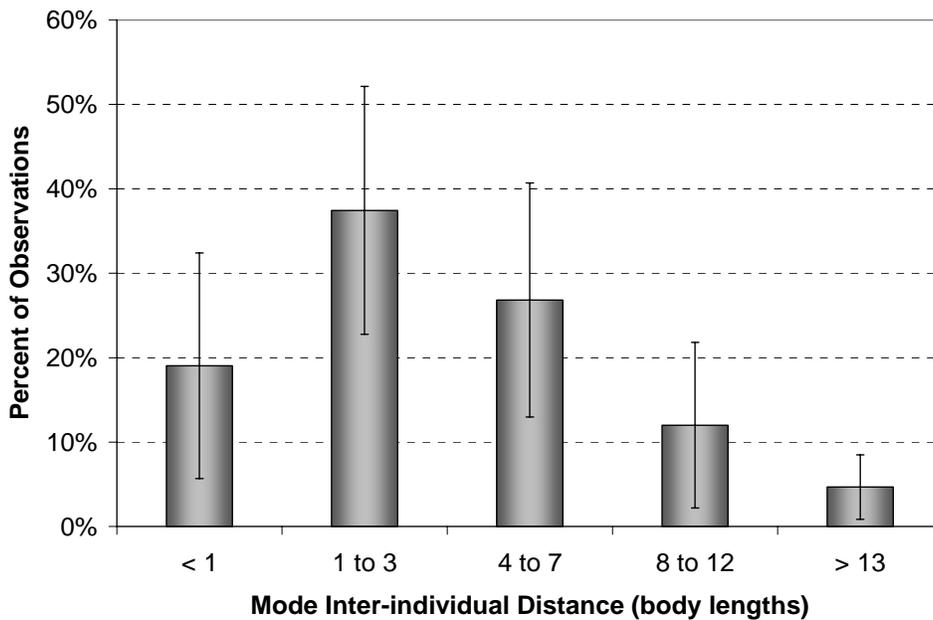


Figure 6. Estimated distance between whales in groups sighted from Cairn Point and the Port of Anchorage was categorized as <1, 1-3, 4-7, 8-12, or > 13 body lengths (1 body length = approx. 12 ft). Bars show mean (and standard error) percent of observations in each of these categories.

### **Upcoming Field Research**

In October, beluga whale monitoring will be conducted two days per week from stations at the Port of Anchorage (POL-2 or POL-1) and at Cairn Point on Elmendorf Air Force Base. Beginning mid-October, all monitoring sessions from the Port of Anchorage and Cairn Point will be conducted concurrently.



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# Memorandum

**To:** William E. Humphries, V.P., Principal in Charge, Anchorage Port Expansion Team  
Integrated Concepts and Research Corporation

**From:** Tim Markowitz, Amanda Prevel (signed)

**Date:** 2 November 2005

**Re:** LGL Monthly Progress Report for October 2005

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This is a progress report of a study by LGL Alaska Research Associates, Inc., sponsored by Integrated Concepts and Research Corporation (ICRC), the Port of Anchorage (POA), and the U.S. Department of Transportation Maritime Administration (MARAD), to monitor beluga whale presence, habitat use and behavior in the Port of Anchorage area. Data collected during this period will provide baseline information on beluga whale presence and behavior within the Port of Anchorage Marine Terminal Redevelopment Project footprint prior to the planned expansion activities. Sightings within the project footprint area will be distinguished from value-added data collected on beluga whale occurrence and behavior outside the project footprint. MARAD is the federal funding agency for all work associated with the POA Expansion Project including this monitoring program. This report covers project activities during October 2005.

### Objectives

The study has three primary objectives:

1. Estimate the frequency at which beluga whales are present in the project footprint.
2. Characterize habitat use and behavior of beluga whales near the Port of Anchorage during ice free months.
3. Map sound levels and attenuation with distance related to POA background noise and expansion activities.

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## Project Coordination and Consultation

Non-paired monitoring sessions were conducted from Cairn Point on 2, 4, 11, 13-Oct and from the Port of Anchorage on 6, 7, 9-Oct. Following consultation with ICRC on 12-Oct, simultaneous monitoring sessions were conducted from Cairn Point and Port of Anchorage (POL-1 or POL-2) two days per week and were carried out on 18, 20, 25 and 27-Oct.

## Portion of Study Completed

To date, 30.8% of the work has been completed and 25.2% of the pricing has been expended during the contract period. October represented 7.7% of the work and 6.3% of the pricing expended during the contract period.

## Monitoring Effort

Monitoring was conducted on a schedule of two days per week from the Port of Anchorage, and two days per week from Cairn Point on Elmendorf Air Force Base (Figure 1), until 18-Oct, when simultaneous observations began from both sites. When possible, the POL-2 tower was used for observations from the port.

On three days when POL-2 was unavailable due to port operations, POL-1 was used as an alternate station. Monitoring effort was carried out over 12 sessions lasting six hours each during October 2005 (Table 1). Four monitoring sessions were conducted from stations at the Port of Anchorage. Four additional monitoring sessions were conducted from Cairn Point on Elmendorf Air Force Base. Four paired sessions were conducted concurrently from both sites in the latter part of the month.

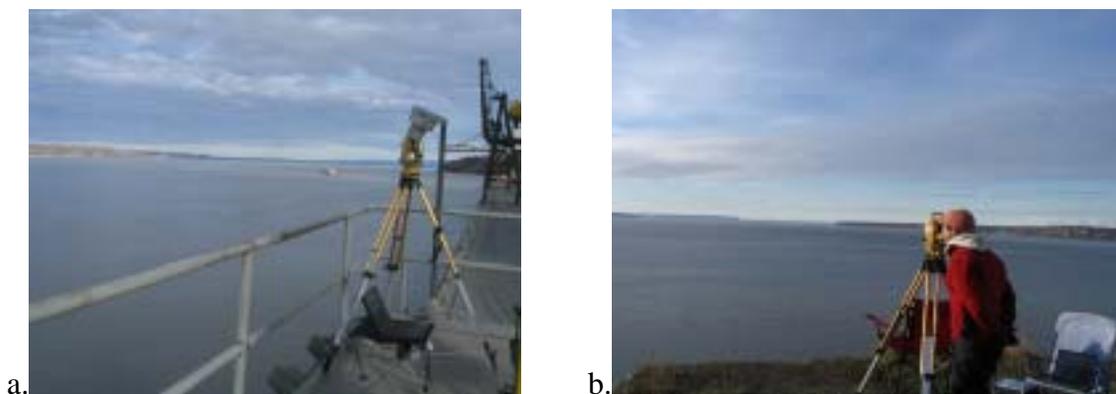


Figure 1. Beluga whale monitoring sessions were conducted from: a. the Port of Anchorage (POL-1 photographed on 10-Oct), and b. Cairn Point on Elmendorf Air Force Base (photographed on 27-Oct).

Table 1. Beluga whale monitoring effort at the Port of Anchorage and Cairn Point is summarized by day for the month of October, 2005.

Station	Date	Shift Start	Shift End
CPS	02-Oct-05	10:45	16:45
CPS	04-Oct-05	11:00	17:00
POA	06-Oct-05	11:00	17:00
POA	07-Oct-05	10:40	16:40
POA	09-Oct-05	10:45	16:45
POA	11-Oct-05	9:30	15:30
CPS	13-Oct-05	10:00	16:00
CPS	14-Oct-05	10:15	16:15
CPS	18-Oct-05	10:00	16:00
POA	18-Oct-05	10:00	16:00
CPS	20-Oct-05	10:00	16:00
POA	20-Oct-05	10:00	16:00
CPS	25-Oct-05	10:00	16:00
POA	25-Oct-05	10:20	16:20
CPS	27-Oct-05	10:00	16:00
POA	27-Oct-05	10:15	16:15

For the first part of October, whale locations were noted on a 500 m X 500 m grid overlaid on topographic map of the coastline (Figure 2). Starting on 18-Oct, when paired observations began, one observer used the grid cell map to place whales sighted.

A surveyor's theodolite (Topcon DT-102) was used to more provide further resolution and accuracy in tracking whales and vessels from shore (Figure 3). The theodolite was used to measure horizontal and vertical angles, input directly to a laptop computer and time stamped. The data collection software Pythagoras (online <http://www.tamug.edu/mmrp/pythagoras/>) was used to compute location and movement information and tabulate other non-fix data. A Pythagoras database was developed to incorporate theodolite station information, organize fix and non-fix data, and adjust for tide height using imported tide height tables. This theodolite tracking system was used during each observation session for tracking whales, vessel traffic and environmental conditions during the first half of October. In the latter half of the month, the theodolite was used for monitoring whales from Cairn Point, while grid cell maps were used to document whale sightings from the Port of Anchorage.

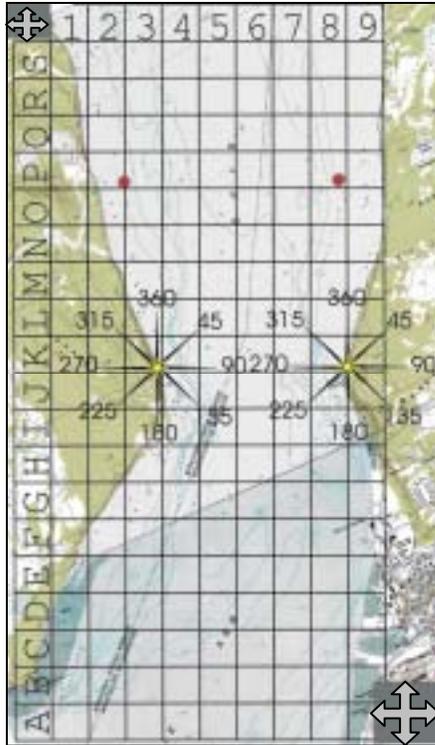


Figure 2. This 500m x 500m grid cell map was used to document the location of beluga whale groups sighted from the Port of Anchorage and Cairn Point. For reference in the field, this map is oriented relative to magnetic north (compass bearings are shown at the center of the grid). The Port of Anchorage Marine Terminal Redevelopment Project Footprint is located in grid cells D9 to I9.



a.



b.

Figure 3. LGL field biologists operated the Topcon DT-102 theodolite (a. photographed on 27-Oct) linked to a laptop computer (b. photographed on 10-Oct) at the Cairn Point monitoring station.

## Environmental Conditions

Mean wind speed during monitoring sessions was 4 mph, with daily mean values ranging from 1-14 mph. Precipitation (rain) was noted during 17% of monitoring sessions. Sighting conditions were rated from good to excellent on all days except one, when they were rated from poor to good. Mean estimated maximum sighting distance was 6.2 miles. Glare affected visibility of the study area in the afternoon during 75% of monitoring sessions in October. Seventy-seven percent of environmental observations recorded glare present (Figure 4.)



Figure 3. Glare often affected visibility of the study area during the afternoon on clear days at: a. the Port of Anchorage (POL-1 photographed on 7-Oct) and b. Cairn Point (photographed on 25-Oct).

## Vessel Activity and Obstruction of Vantage

Vessels documented in the port area during the study period included small skiffs, tug boats, barges, container ships, tanker ships, and dredges (Figure 5a). Some of these vessels partly obstructed the view of the project footprint (Figure 5b). Table 2 provides summaries of the mean estimated proportion of the footprint view obstructed on each day. Daily values ranged from 0-20% obstruction, averaging 9% for the month of October. Paired observations in the latter half of the month substantially reduced the total view obstructed from both monitoring sites. Vessels at the dock physically occupied some space within the footprint; however, we estimate that relatively little area around the vessels (< 5%) could not be observed from either the Port of Anchorage station or the Cairn Point station.



Figure 5. a. The location and activity of vessels, including container ships, dredges, barges, tugs, and small skiffs, were documented around the Port of Anchorage (photographed on 10-Oct). b. At times, the view of the Port of Anchorage Marine Terminal Redevelopment Project Footprint was partially obscured by vessels (photographed on 27-Oct).

Table 2. Mean estimated percent obstruction of the Port of Anchorage Marine Terminal Redevelopment Project footprint by vessels at the dock is shown by date. The right column gives the estimated percent obstruction from each station in the entire foot print area (\*for paired observations % obstruction for both sites combined was substantially reduced). The bottom row provides mean values for all days monitored in October.

Station	Date	Est. Percent Obstruction
CPS	02-Oct-05	10%
CPS	04-Oct-05	10%
POA	06-Oct-05	10%
POA	07-Oct-05	10%
POA	09-Oct-05	20%
POA	11-Oct-05	20%
CPS	13-Oct-05	0%
CPS	14-Oct-05	0%
CPS	18-Oct-05	10%*
POA	18-Oct-05	10%*
CPS	20-Oct-05	0%
POA	20-Oct-05	0%
CPS	25-Oct-05	10%*
POA	25-Oct-05	10%*
CPS	27-Oct-05	10%*
POA	27-Oct-05	10%*
<b>Mean</b>	<b>October</b>	<b>9%</b>

## Beluga Whale Sightings

Beluga whales were sighted on 2 of 11 days (18.2%) during October monitoring (Table 3). Two whale sightings were documented during the month of October, on 2-Oct and 27-Oct. Best minimum counts of the number of whales observed during these two sightings totaled 6 and one. The whales were monitored for 47 and 29 minutes (Table 3). Both sightings occurred during the lower stages of the tidal cycle, within 0.9 to 4.4 ft and 46 to 88 minutes of the low tide (Table 3).

*Table 3. The number of beluga whales sighted during monitoring at the Port of Anchorage and Cairn Point are shown by age class for the month of October 2005. Begin and end times as well as tide heights (with low tide height and time for reference) are shown for each sighting.*

Date	Begin	End	Tide Height	Adults	Sub-adults	Calves	Total Whales
2-Oct	14:28	15:10	3.8 – 7.0 ft (2.6 at 13:42)	2	3	1	6
27-Oct	10:54	11:23	8.3 – 9.7 ft (7.4 at 10:04)	1	0	0	1

## Beluga Whale Locations

Whales monitored on 2-Oct were observed in the Port of Anchorage Marine Terminal Redevelopment Project Footprint. Whales were successfully tracked using the theodolite and Pythagoras software on both days observed. The group of 6 whales on 2-Oct was sighted near Cairn Point at 14:28, and 61 theodolite fixes were taken of this group as it passed south through the Marine Terminal Redevelopment Project Footprint<sup>1</sup>. The last fix of this group in the footprint was at 14:56. They were last monitored just outside the footprint at 15:10 heading in the direction of Ship Creek (Figure 6). The single whale observed on 27-Oct was tracked outside the project footprint, in the Knik Arm narrows. Two theodolite fixes were taken as this apparently lone whale was sighted off Cairn Point at 10:54, then dove and was re-sighted to the north at 11:23 (Figure 6). Whales were noted in six 500 m x 500 m (1,640 ft x 1,640 ft) grid

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<sup>1</sup> Marine Terminal Redevelopment Project Footprint, as defined by Appendix B of the Marine Terminal Redevelopment Environmental Assessment (Anchorage Port Expansion Team 2005). South End: X=1658512 ft, Y=2642136 ft. North End: X=1661550 ft, Y=2650479 ft.

cells overlapping the Marine Terminal Redevelopment Footprint and three grid cells outside the footprint (Figure 7).

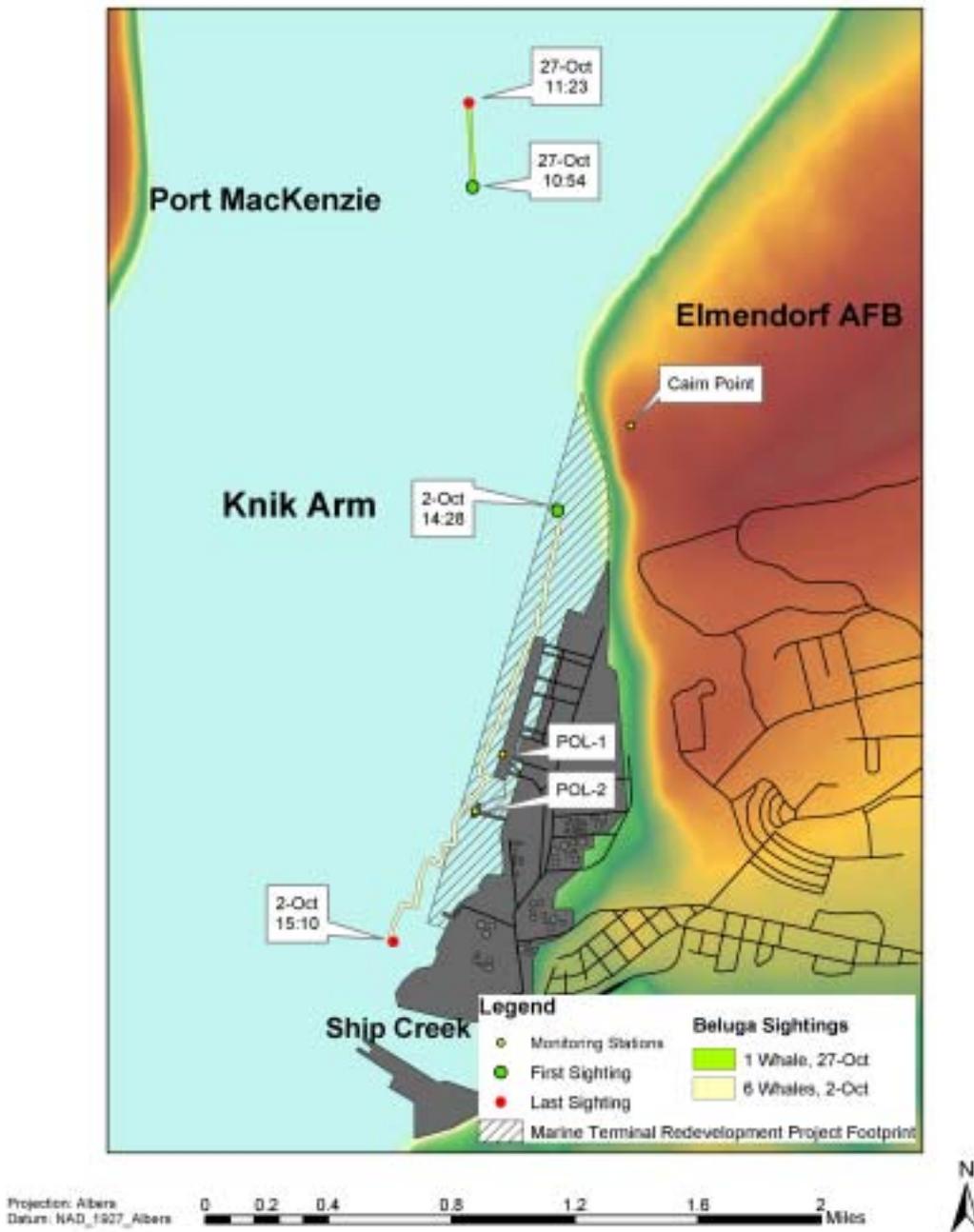


Figure 6. Theodolite tracks of beluga whale locations from the two sightings in October (6 whales on 2-Oct and 1 whale on 27-Oct) are shown relative to the Port of Anchorage (gray) and the Marine Terminal Redevelopment Footprint (black cross-hatched). The beginning of each track (first sighting location) is shown as a green dot, and the end of each track (location last sighted) is shown as a red dot. Yellow dots indicate the locations of the three monitoring stations.

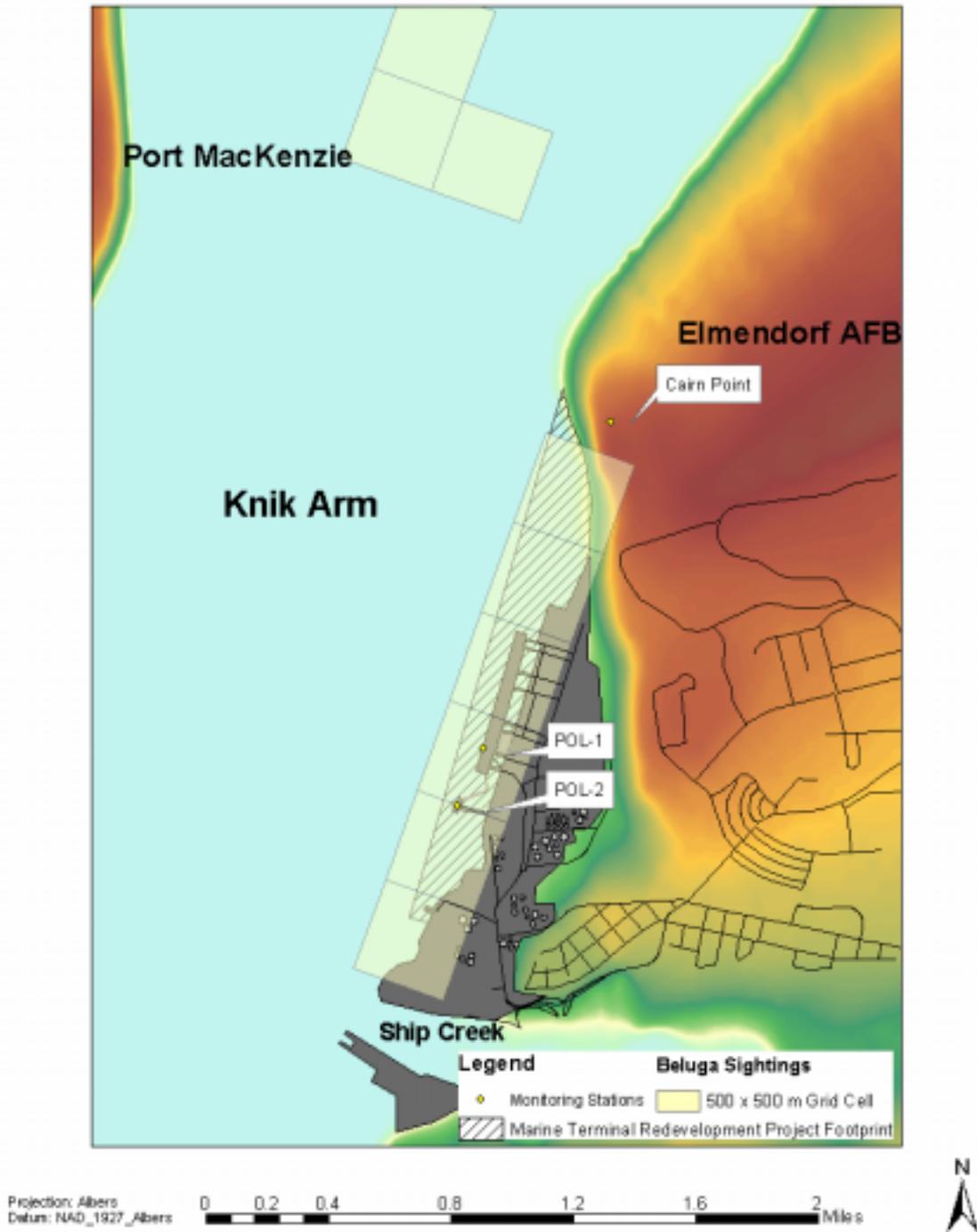


Figure 7. The distribution of beluga whales is shown using 500 m x 500 m (1,640 ft x 1,640 ft) grid cells relative to the Port of Anchorage (gray) and the Marine Terminal Redevelopment Footprint (black cross-hatched). Grid cells in which whales were observed are shaded yellow. Yellow dots indicate the locations of the three monitoring stations.

## Whale Activity

Pythagoras theodolite tracking software was used to document whale behavior, movement patterns, and time inside versus outside the Marine Terminal Redevelopment Footprint (Table 4). A tightly spaced group (1-3 body lengths) of six whales on 2-Oct was tracked for 28 of 42 minutes inside the footprint, traveling 80% linearly at a mean speed of 3.1 mph and covering a net distance of 1.5 miles. They were last seen near Ship Creek heading south, where they were lost from sight in the afternoon glare. The apparently lone whale observed outside the footprint on 27-Oct immediately dove following each of two fixes, between which it moved 3.3 miles to the north, and was not sighted again following the second dive. Feeding, resting and milling were not noted in October, although the long dives of the whale sighted on 27-Oct could indicate foraging at depth.

*Table 4. Theodolite data for whale groups observed during the month of October 2005. Total number of fixes, average time between fixes, average leg speed between fixes, reorientation rate, net and cumulative distance traveled and linearity are shown for each sighting. Mean distance between fixes, mean time between fixes, reorientation rate and linearity could not be calculated with only two fixes taken of the apparently lone whale observed on 27-Oct.*

<b>Theodolite Measure</b>	<b>2-Oct</b>	<b>27-Oct</b>
Best Minimum Whale Count	6	1
Total Number of Fixes	61	2
Mean Distance between Fixes (miles)	0.032	n/a
Mean Time between Fixes (minutes)	0.7	n/a
Mean Leg Speed (miles/hour)	3.1	7.8
Reorientation Rate (°/minute)	105.2	n/a
Net Distance Traveled (miles)	1.5	3.3
Cumulative Distance Traveled (miles)	1.9	n/a
Linearity (where 1.0 = straight line)	0.8	n/a
Time Observed Inside Footprint (minutes)	28	0
Time Observed Outside Footprint (minutes)	4	29

## Upcoming Field Research

In November, beluga whale monitoring will be concurrently conducted two days per week from stations at the Port of Anchorage (POL-2 or POL-1) and at Cairn Point on Elmendorf Air Force Base.



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# Memorandum

**To:** William E. Humphries, V.P., Principal in Charge, Anchorage Port Expansion Team  
Integrated Concepts and Research Corporation

**From:** Tim Markowitz, Amanda Prevel (signed)

**Date:** 30 November 2005

**Re:** LGL Monthly Progress Report for November 2005

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This is a progress report of a study by LGL Alaska Research Associates, Inc., sponsored by Integrated Concepts and Research Corporation (ICRC), the Port of Anchorage (POA), and the U.S. Department of Transportation Maritime Administration (MARAD), to monitor beluga whale presence, habitat use and behavior in the Port of Anchorage area. Data collected during this period will provide baseline information on beluga whale presence and behavior within the Port of Anchorage Marine Terminal Redevelopment Project footprint prior to the planned expansion activities. Sightings within the project footprint area will be distinguished from value-added data collected on beluga whale occurrence and behavior outside the project footprint. MARAD is the federal funding agency for all work associated with the POA Expansion Project including this monitoring program. This report covers project activities during November 2005.

## Objectives

The study has three primary objectives:

1. Estimate the frequency at which beluga whales are present in the project footprint.
2. Characterize habitat use and behavior of beluga whales near the Port of Anchorage during ice free months.
3. Map sound levels and attenuation with distance related to POA background noise and expansion activities.

## Portion of Study Completed

To date, 38.5% of the work has been completed and 31.5% of the pricing has been expended during the contract period. November represented 7.7% of the work and 6.3% of the pricing expended during the contract period.

## Monitoring Effort

The Port of Anchorage (POA) and Cairn Point (CP) on Elmendorf Air Force Base were monitored simultaneously two days per week (Figure 1). When possible, the POL-2 tower was used for observations from the port.

Monitoring effort was carried out over 9 sessions conducted concurrently from POA and CP during November 2005 (Figure 1). Monitoring on 17-Nov was started late due to logistical difficulties gaining access renewal to Elmendorf Air Force Base, and was ended when it became too dark to see whales (Table 1). On 28-Nov, observations were shortened to four hours at CP due to poor viewing conditions (mean visibility distance < 2 km, mean estimated sea ice concentration 83%). Monitoring was not conducted from POA on this day.



*Figure 1. Beluga whale monitoring sessions were conducted from: a. the Port of Anchorage (POL-2 photographed on 18-Nov), and b. Cairn Point on Elmendorf Air Force Base (photographed on 3-Nov).*

Table 1. Beluga whale monitoring effort at the Port of Anchorage and Cairn Point is summarized by day for the month of November, 2005.

Station	Date	Shift Start	Shift End
Cairn Point	01-Nov-05	10:00	16:00
Port of Anchorage	01-Nov-05	10:00	16:00
Cairn Point	03-Nov-05	10:10	16:10
Port of Anchorage	03-Nov-05	10:00	16:00
Cairn Point	08-Nov-05	10:00	16:00
Port of Anchorage	08-Nov-05	10:00	16:00
Cairn Point	10-Nov-05	09:30	15:30
Port of Anchorage	10-Nov-05	10:05	16:05
Cairn Point	15-Nov-05	09:40	15:40
Port of Anchorage	15-Nov-05	10:00	16:00
Cairn Point	17-Nov-05	10:40	16:40
Port of Anchorage	17-Nov-05	11:00	16:40
Cairn Point	21-Nov-05	10:00	16:00
Port of Anchorage	21-Nov-05	10:00	16:00
Cairn Point	22-Nov-05	10:00	16:00
Port of Anchorage	22-Nov-05	10:00	16:00
Cairn Point	28-Nov-05	10:00	14:00
Port of Anchorage	28-Nov-05	--	--

A surveyor's theodolite (Topcon DT-100) was used at CP to provide resolution and accuracy in tracking whales and vessels from shore (Figure 2). The theodolite, which measures horizontal and vertical angles, was used to take position "fixes" of whales relative to the instrument, with data input directly to a laptop computer and time stamped. The data collection software Pythagoras (online <http://www.tamug.edu/mmrp/pythagoras/>) was used to compute location and movement information and tabulate other non-fix data. A Pythagoras database was developed to incorporate theodolite station information, organize fix and non-fix data, and adjust for tide height using imported tide height tables. This theodolite tracking system was used during each observation session for tracking whales, vessel traffic and environmental conditions. The theodolite was used for monitoring whales from CP, while 500 m x 500 m (1,640 ft x 1,640 ft) grid cell maps were used to document whale sightings from the POA (Figure 3).

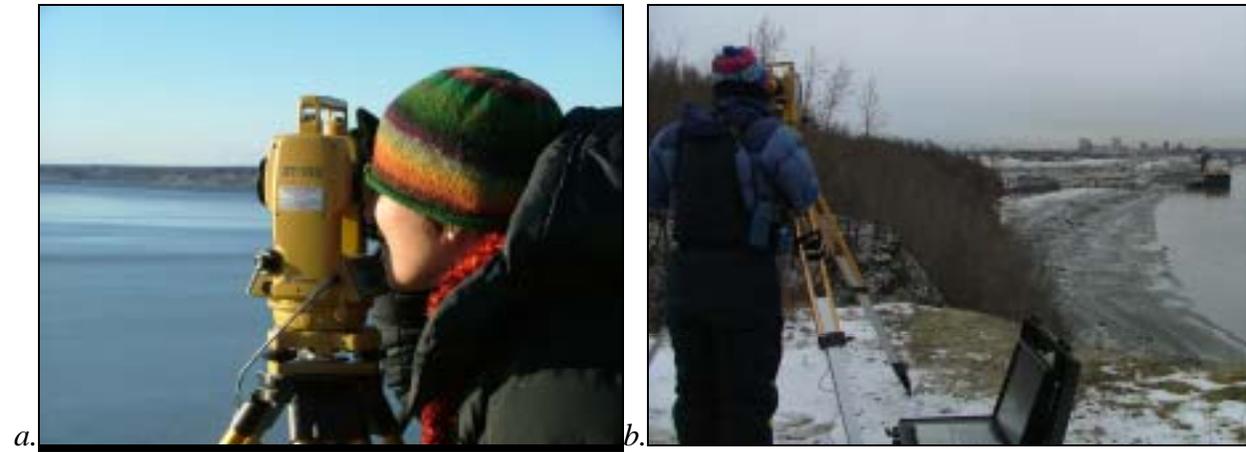


Figure 2. LGL field biologists operated the Topcon DT-100 theodolite (a. photographed on 18-Nov) linked to a laptop computer (b. photographed on 15-Nov) at the Cairn Point monitoring station.

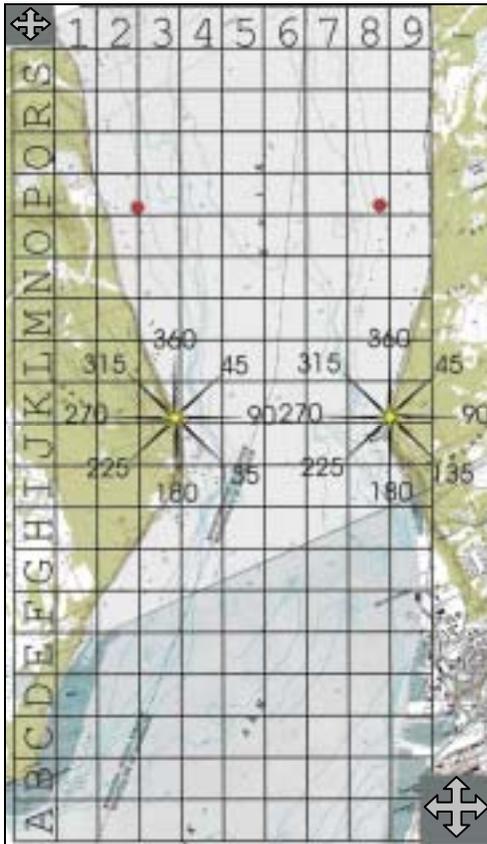


Figure 3. This 500m x 500m grid cell map was used to document the location of beluga whale groups sighted from the Port of Anchorage and Cairn Point. For reference in the field, this map is oriented relative to magnetic north (compass bearings are shown at the center of the grid). The Port of Anchorage Marine Terminal Redevelopment Project Footprint is located in grid cells D9 to I9.

## Data Analysis

Preliminary data analyses for this progress report were conducted using Pythagoras, Microsoft Excel®, Microsoft Access®, and ArcView® software. Minimum inter-fix interval and maximum swim speed filters were applied to track line data for estimating movement parameters including speed (mean leg speed = mean of distance between fixes/time between fixes) and linearity (distance made good/cumulative distance traveled) of whale group movements.

## Environmental Conditions

Mean wind speed during monitoring sessions was 4 mph, with daily mean values ranging from 0-12 mph. Precipitation was noted in the form of rain for 11%, fog for 33% and snow for 56% of monitoring sessions. Sighting conditions were rated excellent on two days, good on five days and poor on two days, with an average of good for the month of November. Mean estimated maximum sighting distance was 5.5 miles. Glare affected visibility of the study area in the afternoon during 56% of monitoring sessions in November (Figure 4.)



*Figure 4. Glare often affected visibility of the study area during the afternoon on clear days at: a. the Port of Anchorage (POL-2 photographed on 10-Nov) and b. Cairn Point (photographed on 1-Nov).*

The mean estimated sea ice concentration was 16% for all days up to 28-Nov when the mean estimated sea ice concentration rose to 83%. On all days prior to the last monitoring

session on 28-Nov, conditions were mostly ice free, with daily mean estimated sea ice concentrations under one-third (Figures 5).

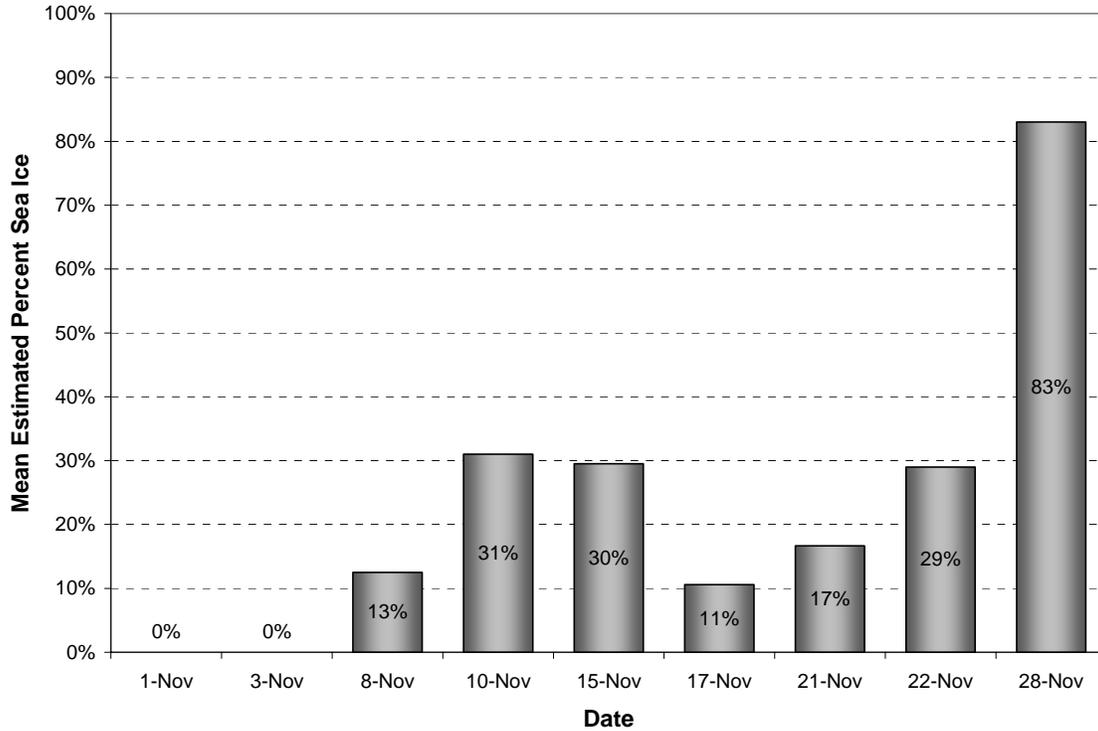


Figure 5. The mean estimated percent sea ice is shown by date.

### Vessel Activity and Obstruction of Vantage

Vessels documented in the port area during the study period included small skiffs, tug boats, barges, container ships, tanker ships, and dredges (Figure 6a). Some of these vessels partly obstructed the view of the project footprint (Figure 6b). Table 2 provides summaries of the mean estimated proportion of the footprint view obstructed from each station on each day. Daily values ranged from 0-20% obstruction from each station, averaging 8% for the month of November. Vessels at the dock physically occupied some space within the footprint; however, we estimate that relatively little area around the vessels (< 5%) could not be observed from either the Port of Anchorage station or the Cairn Point station (Table 2).



*Figure 6. a. The location and activity of vessels, including container ships, dredges, barges, tugs, and small skiffs, were documented around the Port of Anchorage (photographed on 15-Nov from Cairn Point). b. At times, the view of the Port of Anchorage Marine Terminal Redevelopment Project Footprint was partially obscured by vessels (photographed on 1-Nov from POL-2).*

### **Beluga Whale Sightings**

Beluga whales were sighted on 2 of 9 days (22.2%) during November monitoring (Table 3). A total of four whale group sightings were documented during the month of November, and all of these occurred on 1-Nov and 3-Nov. Best minimum counts of the number of whales observed during these four sightings were 2, 2, 25 and 3 whales. Three group sightings were documented on 1-Nov and a single group was sighted on 3-Nov. The largest group of 25 whales, sighted on 1-Nov (group 3) split into three subgroups after the first 25 minutes of observation. The whales were monitored for time periods ranging from 1 to 217 minutes. Sightings occurred

during the lower stages of the tidal cycle, within 0.1 - 15.5 ft and 3 - 180 minutes of the low tide (Table 3).

*Table 2. Mean estimated percent obstruction of the Port of Anchorage Marine Terminal Redevelopment Project footprint by vessels at the dock is shown by date. The right columns give the daily mean estimated percent obstruction in the entire footprint area. The bottom row provides the mean value for all days monitored in November.*

<b>Station</b>	<b>Date</b>	<b>Estimated Percent Obstruction</b>
CPS	01-Nov	10%
POA	01-Nov	20%
CPS	03-Nov	10%
POA	03-Nov	10%
CPS	08-Nov	10%
POA	08-Nov	20%
CPS	10-Nov	0%
POA	10-Nov	10%
CPS	15-Nov	10%
POA	15-Nov	20%
CPS	17-Nov	0%
POA	17-Nov	0%
CPS	21-Nov	0%
POA	21-Nov	0%
CPS	22-Nov	10%
POA	22-Nov	0%
CPS	28-Nov	10%
POA	28-Nov	-
<b>Mean</b>	<b>November</b>	<b>9%</b>

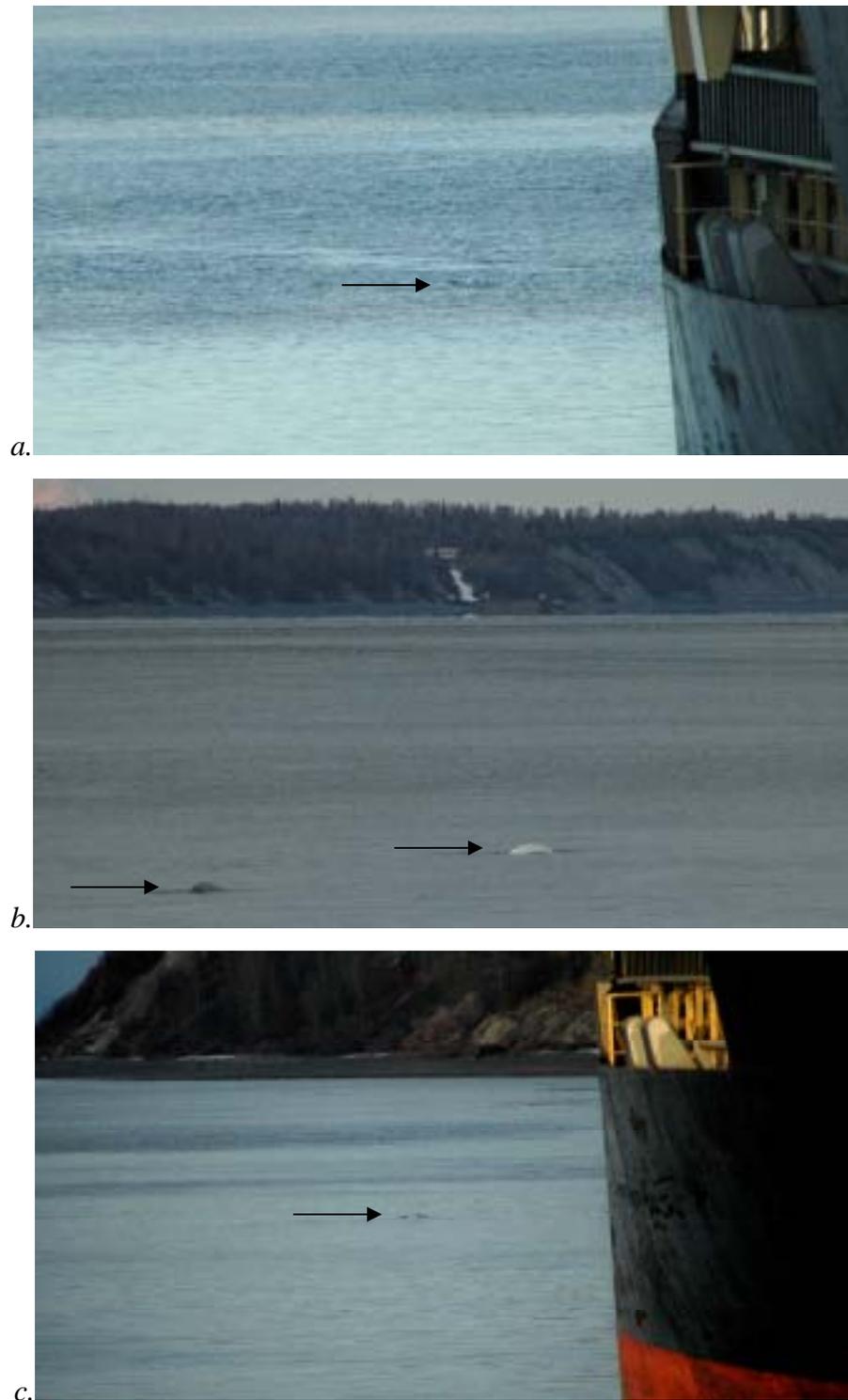
Table 3. The number of beluga whales sighted during monitoring at the Port of Anchorage and Cairn Point are shown by age class for the month of November 2005. Begin and end times as well as tide heights are shown for each sighting.

Beluga Whale Sightings							Port of Anchorage				Cairn Point					
Date	Group #	Adult	Subadult	Calf	Unknown	Total	Begin	End	Tide Height(ft)	Grid Cell	Begin	End	Tide Height(ft)	# of Fixes	# of Fixes	Dir of Travel
1-Nov	1	1	0	1	0	2	11:00	11:00	10.1	G9	10:35	10:50	12.2-10.9	19	19	S
1-Nov	2	1	0	0	1	2	13:45	13:45	6.5	I9	13:00	13:40	4.6-11.5	39	39	S then N
1-Nov	3	0	0	0	25	25	15:11	15:40	15.3-9.0	D9 F9,G9	15:06	15:31	14.6-17.6	65	65	V,N
1-Nov	3a	2	2	0	0	4	-	-	-	-	15:35	15:40	18.3-19.0	2	2	N
1-Nov	3b	5	4	1	3	13	-	-	-	-	15:42	15:49	19.2-20.0	15	15	N
1-Nov	3c	4	1	0	3	8	-	-	-	-	15:45	15:47	19.6-19.8	3	3	N
3-Nov	1	1	1	1	0	3	11:17	14:00	16.3-5.3	L4,P3 J5,O3 K5,Q3	11:17	14:54	16.3-6.8	68	68	V

### Beluga Whale Locations

During four whale group observations on two days in November, whales were successfully tracked using the theodolite and Pythagoras software. Three group sightings were documented on 1-Nov, with whales passing through the Port of Anchorage Marine Terminal Redevelopment Project Footprint<sup>2</sup> on all three occasions. At 10:35 on 1-Nov, two whales (Group 1) were fixed by the observer at Cairn Point (CP) as they traveled south along the shore until they dove at 10:50 near the north end of the POA dock and were not re-sighted. According to the theodolite track, these whales came within 168 ft of the POA dock. At 11:00, one of these whales was sighted surfacing twice adjacent to two ships docked at the dock, in grid cell G9, by the observer at the POA (Figure 7a). These whales were tracked in the footprint for 25 min (Figure 8).

<sup>2</sup> Marine Terminal Redevelopment Project Footprint, as defined by Appendix B of the Marine Terminal Redevelopment Environmental Assessment (Anchorage Port Expansion Team 2005). South End: X=1658512 ft, Y=2642136 ft. North End: X=1661550 ft, Y=2650479 ft, Spatial Reference: Alaska State Plane Zone 4 NAD83.



*Figure 7. Whales observed on 1-Nov (photographed from POL-2): a. POL-2 Group 1, 11:00, with the Mercury Frontier in the foreground, b. POL-2 Group 3 at 15:17 with the opposite shore south of Port Mackenzie in the background. c. POL-2 Group 3 at 15:37 with the Mercury Frontier in the foreground. Arrows indicate the location of the whales in each photograph.*

At 13:00 on 1-Nov, two whales (Group 2) were fixed by the observer at CP, traveling south along the shoreline north of the POA dock. They swam within 363 ft of the POA dock, turned north, and traveled along the shoreline toward CP. This group was tracked with the theodolite until 13:40 when they were lost from sight by the observer at CP. The observer at the POA saw this group once, traveling north along the shoreline at 13:45 in a grid cell adjacent to CP (G9). These whales remained in the footprint for 45 min (Figure 8).

a. Beluga Whale Locations: 1-Nov-05, Group 1

b. Beluga Whale Locations: 1-Nov-05, Group 2

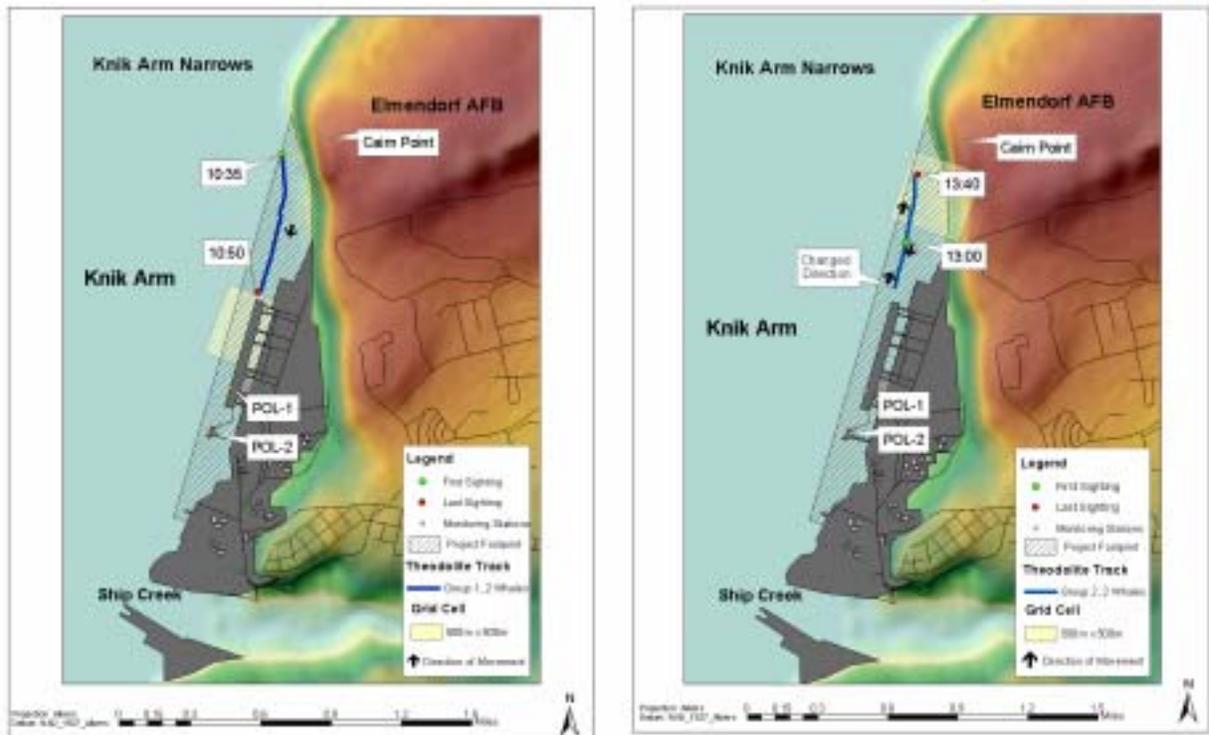


Figure 8. Theodolite tracks of beluga whale locations from group sightings 1 (a) and 2 (b) taken from the Cairn Point station on 1-Nov (2 whales) are shown relative to the Port of Anchorage (gray) and the Marine Terminal Redevelopment Footprint (black cross-hatched). The beginning of each track (first sighting location) is shown as a green dot, and the end of each track (location last sighted) is shown as a red dot. Yellow dots indicate the locations of the three monitoring stations. Animals were diving between fixes. Grid Cells in which the whales were placed by the observer at the POA are shown in light yellow.

At 15:06 on 1-Nov, the observer at CP began tracking twenty-five whales in the glare off of Ship Creek. These whales moved north along the edge of the footprint, with whales surfacing inside the footprint at 15:23. The group dove at 15:23 off POL-1 (approximately 383 ft from the dock) and resurfaced from 15:30-15:31 (approximately 2,553 ft from the dock) within the footprint off CP. The dive from 15:23 to 15:31 covered a distance of approximately 5,975 ft,

with the group traveling at a rate of 10 mi/hr (Figure 9a). This group then split into three subgroups (3a, 3b and 3c) which resurfaced off CP (Figure 9b). Subgroups 3a, 3b and 3c (4, 13 and 8 whales) were tracked with the theodolite by the observer at CP from 15:35 to 15:40, 15:45-15:47 and 15:45-15:47 when they were lost from sight as they passed north around CP. Subgroups 3a, 3b and 3c came within 2,413, 1,380 and 3,091 ft of the POA dock. The whales in subgroup 3a surfaced once in the footprint at 15:35, whales in subgroup 3b remained in the footprint from 15:42-15:48, and whales in subgroup 3b traveled just outside the footprint. The observer at the POA first sighted group 3 in the glare at 15:11. Group 3 was monitored by this observer through grid cells D9, F9 and G9 (in the footprint) before it dove at 15:40. In total, group 3 was tracked approximately 25 minutes, from 15:23-15:48 in the footprint (Figure 9).

a. Beluga Whale Locations: 1-Nov-05, Group 3

b. Beluga Whale Locations: 1-Nov-05, Subgroups 3a, b, c

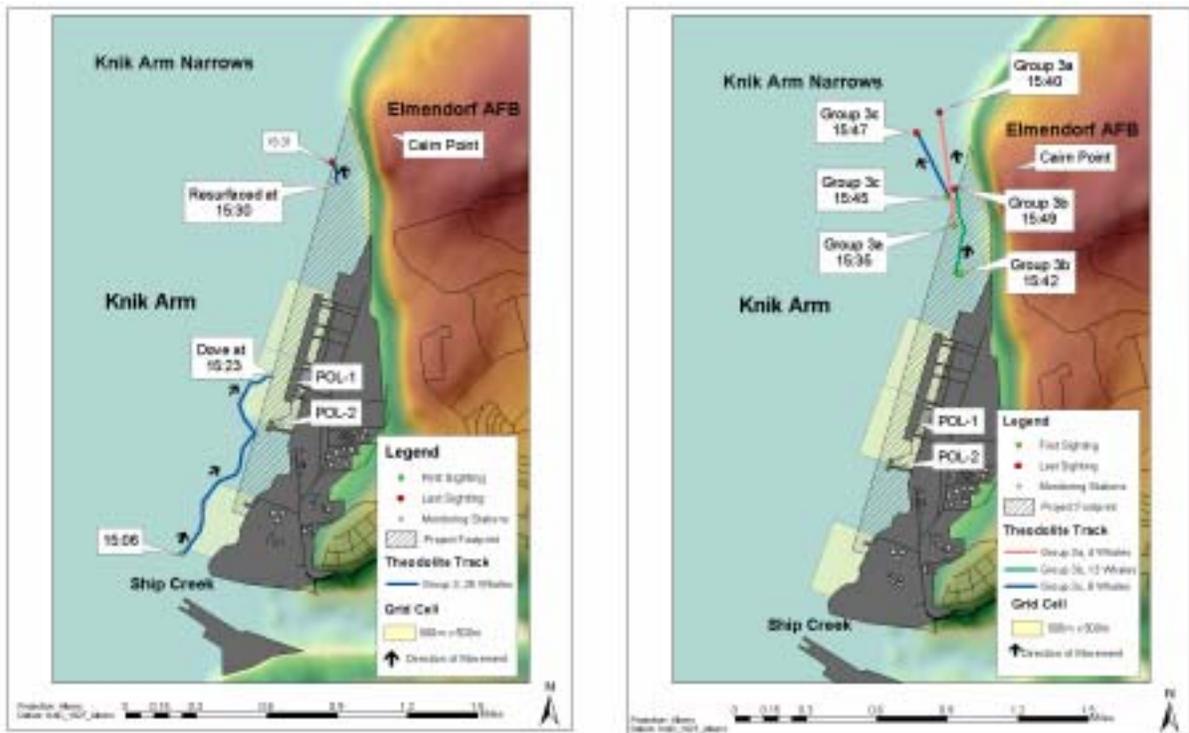
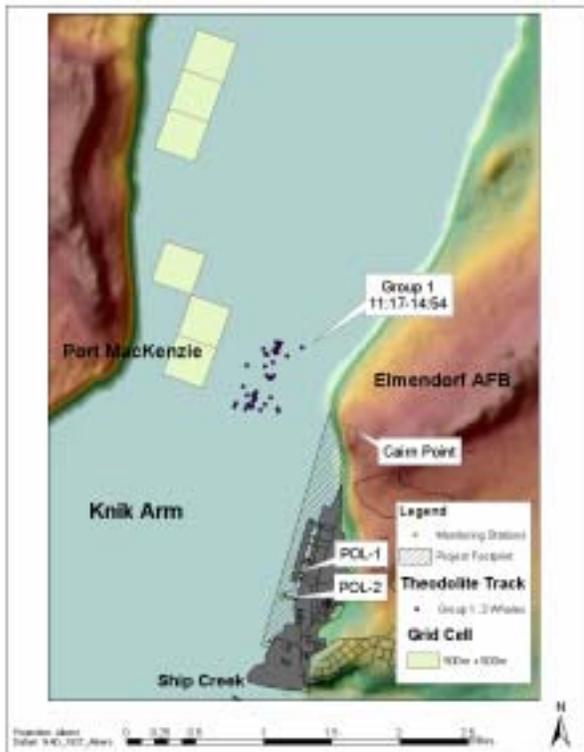


Figure 9. Theodolite tracks of beluga whale locations from group sighting 3 taken from the Cairn Point station on 1-Nov are shown relative to the Port of Anchorage (gray) and the Marine Terminal Redevelopment Footprint (black cross-hatched). a. This track line shows the movement of this group of 25 whales, with a gap in the line when the whales dove. b. Three separate track lines show this group splitting into 3 subgroups (3a, 3b, and 3c). The beginning of each track (first sighting location) is shown as a green dot, and the end of each track (location last sighted) is shown as a red dot. Yellow dots indicate the locations of the three monitoring stations. Animals were diving between fixes. Grid Cells in which the whales were placed by the observer at the POA are shown in light yellow.

One whale group was monitored on 3-Nov. The group (3 whales) was monitored from CP from 11:17-14:54 diving in the narrows between Port Mackenzie and Cairn Point. This group never entered the footprint, and the closest it came to the POA dock was approximately 4,326ft (0.82 mi). It ranged as far as approximately 7,015 ft (1.3 mi) from the POA dock. This group was observed by the observer at the POA from 11:17 to 14:00. The group dove repeatedly between the area just north of the Port Mackenzie Gravel Dock to the narrows between Port Mackenzie and CP, in grid cells L4, P3, J5, O3, K5 and Q3 (Figure 9). The difference in distance from CP and the POA to the whales being observed (> 1 mi) may account for the difference in the placement of whales on the 500 m x 500 m (1,640 ft x 1,640 ft) grid cell map by the observer at the POA when compared to the theodolite tracks from CP (Figure 10). The difference in height of the two stations as well as the method of tracking whales may also have contributed to this discrepancy, resulting in lower accuracy of distant grid cell positions than theodolite positions.

Beluga whale locations 3-Nov-05, Group 1



*Figure 10. Theodolite fixes of beluga whale locations from the sightings of group 1 on 3-Nov (3 whales) are shown relative to the Port of Anchorage (gray) and the Marine Terminal Redevelopment Footprint (black cross-hatched). The beginning of each track (first sighting location) is shown as a green dot, and the end of each track (location last sighted) is shown as a red dot. Grid cells in which whales were observed from the POA are shaded light yellow. Yellow dots indicate the locations of the three monitoring stations.*

During November, observers at the POA noted whales in three 500 m x 500 m (1,640 ft x 1,640 ft) grid cells overlapping the Marine Terminal Redevelopment Footprint and six grid cells outside the footprint. Theodolite fixes from the Cairn Point station show that these whales actually passed through a greater area than the nine grid cells noted above, which may indicate that the station has a better vantage of the study area (Figure 11).

November 2005, Beluga Whale Observations Summary

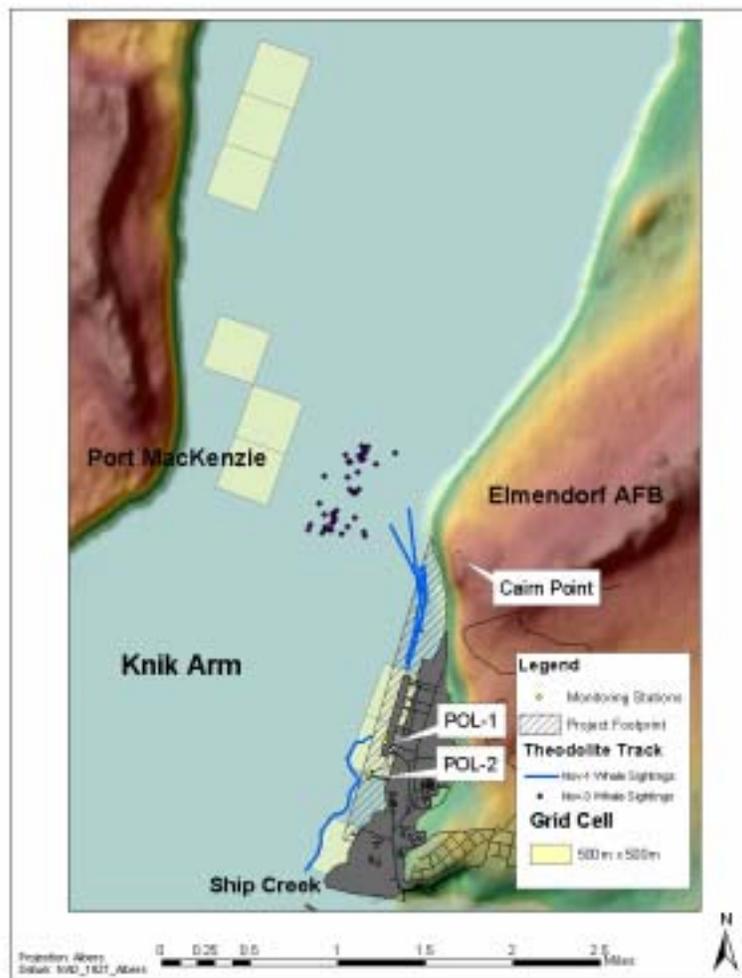


Figure 11. The distribution of beluga whale sighting locations using 500 m x 500 m (1,640 ft x 1,640 ft) grid cells and theodolite tracks in November are shown relative to the Port of Anchorage (gray) and the Marine Terminal Redevelopment Footprint (black cross-hatched). Grid cells in which whales were observed from the POA are shaded light yellow. Theodolite tracks are shown in blue. Yellow dots indicate the locations of the three monitoring stations.

## Whale Activity

Pythagoras theodolite tracking software was used to document whale behavior, movement patterns, and time inside versus outside the Marine Terminal Redevelopment Footprint (Table 4). On 1-Nov, a cow and calf (group 1) was tracked for 25 minutes in the footprint, traveling 99% linearly at a mean speed of 2.5 mph and covering a net distance of 0.60 miles. The calf engaged in two tail-ups and in several underwater chases, which may indicate feeding. This group was last seen in the POA footprint heading south, where the pair dove and was not re-sighted.

The second sighting on 1-Nov was a tightly spaced pair (1-3 body lengths) of whales that was tracked for 45 minutes in the footprint, traveling 8% linearly at a mean speed of 2.4 mph. The group covered a net distance of 0.07 miles (cumulative distance of 0.91 miles) as it headed south along the shoreline from CP to the POA dock, turning back north before being lost from sight around CP.

The third sighting on 1-Nov was of a loosely spaced group (4-7 body lengths) of 25 whales tracked heading north from the Ship Creek mouth for 25 of 43 minutes inside the footprint, traveling 51% linearly at a mean speed of 15.8 mph. This group dove for 8 minutes when it was adjacent to POL-2, traveling at a rate of 10.0 mph for approximately 1.13 miles before resurfacing. This third group sighted traveled a net distance of 1.55 miles before it split into subgroups 3a, 3b and 3c at the north end of the footprint. Subgroup 3a on 1-Nov was a loosely spaced (4-7 body lengths) subgroup of four whales that traveled north at 6.3 mph, covering a distance of 0.49 miles as it was fixed twice. Subgroup 3b on 1-Nov (13 whales) was tightly clustered (1-3 body lengths) as it was traveled 75% linearly at a mean speed of 3.6 mph for 0.40 miles. Subgroup 3c (8 whales) was tightly grouped (1-3 body lengths), traveling 99% linearly at a mean speed of 6.6 mph for 0.99 miles. Subgroups 3a, 3b and 3c were lost from sight to the north around CP.

On 3-Nov, a very loosely spaced group (group 1, 4-7 to 13+ body lengths) of three whales was observed outside the footprint diving synchronously for 217 minutes in the narrows between CP and Port Mackenzie. This group traveled 7% linearly at a mean speed of 7.5 mph as it traveled a net distance of 0.55 miles (cumulative distance of 7.47 miles). Mean time spent below the surface (dive interval) during a 109-minute behavior sample was 2.6 min (0.02-35 min) and mean time spent above the surface (surface interval) was 2 sec (1-5 sec).

*Table 4. Theodolite data for whale groups observed during the month of November 2005. Total number of fixes, average time between fixes, average leg speed between fixes, reorientation rate, net and cumulative distance traveled and linearity are shown for each sighting. Mean distance between fixes, mean time between fixes, reorientation rate and linearity could not be calculated with only two fixes taken of group 3a on 1-Nov.*

	<b>Group 1</b>	<b>Group 2</b>	<b>Group 3</b>	<b>Group 3a</b>	<b>Group 3b</b>	<b>Group 3c</b>	<b>Group 1</b>
<b>Theodolite Measure</b>	<b>1-Nov</b>	<b>1-Nov</b>	<b>1-Nov</b>	<b>1-Nov</b>	<b>1-Nov</b>	<b>1-Nov</b>	<b>3-Nov</b>
Best Minimum Whale Count	2	2	25	4	13	8	3
Total Number of Fixes	19	39	65	2	15	3	68
Mean Distance between Fixes (miles)	0.04	0.040	0.24	n/a	0.06	0.15	0.55
Mean Time between Fixes (minutes)	1.0	1.7	1.6	n/a	0.94	1.1	6.0
Mean Leg Speed (miles/hour)	2.5	2.4	15.8	6.3	3.6	6.6	7.5
Reorientation Rate (°/minute)	31.3	12.2	54.1	n/a	49.5	16.8	15.7
Net Distance Traveled (miles)	0.60	0.07	1.55	0.49	0.40	0.99	0.55
Cumulative Distance Traveled (miles)	0.61	0.91	3.06	n/a	0.94	1.08	7.47
Linearity (where 1.0 = straight line)	0.99	0.08	0.51	n/a	0.75	0.99	0.07
Time Observed Inside Footprint (minutes)	25	45	25	1	6	0	0
Time Observed Outside Footprint (minutes)	0	0	18	4	1	2	217

### Upcoming Field Research

Field research will begin again in ice free months starting spring 2006.

**Appendix C**

**Daily Vessel Counts  
August 2005 – November 2005**

<b>Crane Dredge</b>		<b>Container Ship</b>	
Date	Count	Date	Count
02-Aug-05	6	02-Aug-05	11
05-Aug-05	6	09-Aug-05	5
09-Aug-05	5	11-Aug-05	1
11-Aug-05	5	16-Aug-05	14
16-Aug-05	4	18-Aug-05	4
18-Aug-05	4	23-Aug-05	6
22-Aug-05	6	25-Aug-05	2
23-Aug-05	5	28-Aug-05	6
24-Aug-05	6	30-Aug-05	6
25-Aug-05	6	04-Sep-05	6
28-Aug-05	6	11-Sep-05	11
29-Aug-05	6	13-Sep-05	6
30-Aug-05	6	14-Sep-05	6
31-Aug-05	6	18-Sep-05	6
04-Sep-05	6	27-Sep-05	9
05-Sep-05	5	02-Oct-05	9
06-Sep-05	12	04-Oct-05	8
07-Sep-05	6	09-Oct-05	17
11-Sep-05	6	11-Oct-05	8
12-Sep-05	6	18-Oct-05	5
13-Sep-05	6	25-Oct-05	7
14-Sep-05	12	27-Oct-05	6
18-Sep-05	6	01-Nov-05	4
19-Sep-05	6	08-Nov-05	6
23-Sep-05	3	15-Nov-05	10
27-Sep-05	5	22-Nov-05	6
28-Sep-05	8		
29-Sep-05	1		
30-Sep-05	7		
02-Oct-05	7		
20-Oct-05	1		

<b>Motorized Barge</b>		<b>Motorized Dredge</b>	
Date	Count	Date	Count
05-Aug-05	1	02-Aug-05	6
22-Aug-05	1	05-Aug-05	6
23-Aug-05	1	09-Aug-05	5
24-Aug-05	7	11-Aug-05	5
07-Sep-05	8	16-Aug-05	7
21-Sep-05	7	18-Aug-05	4
23-Sep-05	3	22-Aug-05	6
30-Sep-05	1	23-Aug-05	5
		24-Aug-05	6
		25-Aug-05	6
		28-Aug-05	6
		29-Aug-05	6
		30-Aug-05	6
		31-Aug-05	6
		04-Sep-05	6
		05-Sep-05	5
		06-Sep-05	6
		07-Sep-05	6
		11-Sep-05	6
		12-Sep-05	6
		13-Sep-05	6
		14-Sep-05	12
		18-Sep-05	6
		19-Sep-05	6
		21-Sep-05	7
		23-Sep-05	13
		27-Sep-05	10
		28-Sep-05	14
		29-Sep-05	13
		30-Sep-05	6
		02-Oct-05	8
		04-Oct-05	6
		06-Oct-05	8
		07-Oct-05	8
		09-Oct-05	6
		11-Oct-05	6
		13-Oct-05	11
		14-Oct-05	7
		18-Oct-05	5
		20-Oct-05	9
		25-Oct-05	7
		27-Oct-05	9
		01-Nov-05	5

Other		Skiff	
Date	Count	Date	Count
11-Aug-05	1	02-Aug-05	6
18-Aug-05	4	05-Aug-05	7
05-Sep-05	5	09-Aug-05	12
07-Sep-05	6	11-Aug-05	7
23-Sep-05	12	16-Aug-05	6
27-Sep-05	3	18-Aug-05	7
28-Sep-05	5	22-Aug-05	8
29-Sep-05	2	23-Aug-05	6
30-Sep-05	8	24-Aug-05	9
02-Oct-05	7	25-Aug-05	27
04-Oct-05	7	28-Aug-05	18
11-Oct-05	6	29-Aug-05	15
13-Oct-05	18	30-Aug-05	10
14-Oct-05	1	31-Aug-05	20
18-Oct-05	5	04-Sep-05	21
20-Oct-05	9	05-Sep-05	34
25-Oct-05	6	06-Sep-05	22
27-Oct-05	7	07-Sep-05	19
03-Nov-05	6	11-Sep-05	6
		12-Sep-05	8
		13-Sep-05	6
		14-Sep-05	15
		18-Sep-05	7
		19-Sep-05	8
		21-Sep-05	6
		23-Sep-05	9
		27-Sep-05	1
		28-Sep-05	10
		29-Sep-05	10
		30-Sep-05	11
		02-Oct-05	6
		04-Oct-05	4
		06-Oct-05	6
		07-Oct-05	5
		09-Oct-05	7
		11-Oct-05	1
		13-Oct-05	2
		14-Oct-05	6
		18-Oct-05	5
		20-Oct-05	23
		25-Oct-05	4
		27-Oct-05	11
		03-Nov-05	3

<b>Tug &amp; Barge</b>		<b>Tanker Ship</b>	
Date	Count	Date	Count
02-Aug-05	2	02-Aug-05	18
05-Aug-05	3	05-Aug-05	6
09-Aug-05	20	09-Aug-05	5
11-Aug-05	15	11-Aug-05	5
16-Aug-05	14	18-Aug-05	4
18-Aug-05	12	12-Sep-05	6
22-Aug-05	12	14-Sep-05	6
23-Aug-05	12	18-Sep-05	6
24-Aug-05	18	19-Sep-05	6
25-Aug-05	13	21-Sep-05	6
28-Aug-05	15	23-Sep-05	4
29-Aug-05	6	27-Sep-05	1
30-Aug-05	8	06-Oct-05	7
31-Aug-05	6	07-Oct-05	9
04-Sep-05	12	03-Nov-05	6
05-Sep-05	13		
06-Sep-05	15		
07-Sep-05	12		
11-Sep-05	12		
12-Sep-05	12		
13-Sep-05	12		
14-Sep-05	9		
19-Sep-05	11		
13-Oct-05	2		
27-Oct-05	2		
10-Nov-05	3		
28-Nov-05	4		

<b>Tug Boat</b>	
<b>Date</b>	<b>Count</b>
02-Aug-05	7
05-Aug-05	3
09-Aug-05	15
11-Aug-05	9
16-Aug-05	14
18-Aug-05	12
22-Aug-05	5
23-Aug-05	5
24-Aug-05	7
25-Aug-05	8
28-Aug-05	6
29-Aug-05	11
30-Aug-05	8
31-Aug-05	15
04-Sep-05	12
06-Sep-05	12
07-Sep-05	12
11-Sep-05	24
12-Sep-05	12
13-Sep-05	12
14-Sep-05	30
18-Sep-05	15
19-Sep-05	14
21-Sep-05	23
23-Sep-05	12
27-Sep-05	11
28-Sep-05	4
29-Sep-05	10
30-Sep-05	18
02-Oct-05	7
04-Oct-05	10
09-Oct-05	6
11-Oct-05	16
13-Oct-05	20
14-Oct-05	5
18-Oct-05	6
20-Oct-05	11
25-Oct-05	11
27-Oct-05	7
01-Nov-05	8
03-Nov-05	10
08-Nov-05	13
10-Nov-05	9
15-Nov-05	20
17-Nov-05	10
21-Nov-05	12
22-Nov-05	12