NMFS Port of Alaska Visual Monitoring Project Report

NOAA Fisheries Alaska Region

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Executive Summary

Pile driving activities associated with the construction of the Petroleum Cement Terminal (PCT) at the Port of Alaska (POA) occurred during the open water season of 2020 and 2021. Protected species observers (PSOs) were deployed to multiple locations along Knik Arm as part of the required POA monitoring and mitigation program. National Marine Fisheries Service (NMFS) funded a visual marine mammal monitoring project in 2021 to supplement sightings data collected by the POA monitoring program during non-pile driving days in order to evaluate the impacts of anthropogenic activities on the endangered Cook Inlet beluga whale (CIB).

This report focuses on the methodology and preliminary results of the NMFS visual monitoring efforts. NMFS replicated the POA monitoring efforts, as feasible, including use of two of the monitoring platforms, equipment (Big Eye binoculars, theodolite, 7x50 reticle binoculars), data collection software, monitoring and data collection protocol, and observers.

NMFS monitored for 220 hours on 47 non-consecutive days in July, August, September, and October. Environmental conditions, including precipitation, Beaufort sea state, visibility, and overall viewing conditions were favorable for the majority of the monitoring effort. The overall conditions, scaled from 1-10 with 10 being ideal, were rated as 8 or better in over 75 percent of the weather observation records for July, August, and September, and over 50 percent of the records collected in October.

CIB were observed on 29 days; there were 109 groups with a total of 575 whales. Group size ranged from 1 to 34 whales, with an average of 3 to 5.6, depending on the month. September had the highest sighting rate with 4.08 whales per hour, followed by October and August (3.46 and 3.41, respectively). Group composition consisted of 74 percent white, 16.5 percent gray, and 9.5 calf-aged animals. Traveling was recorded as the primary behavior for 80 percent of the group sightings and milling was the secondary behavior most often recorded. Sighting duration varied from a single surfacing lasting less than one minute to 380 minutes.

Post-season, observers completed a questionnaire that provided NMFS with qualitative data regarding beluga behavior. The observers noted changes in behavior patterns during their monitoring efforts in 2020 and 2021, as well as behavioral trends during anthropogenic activities including changing direction, increased dive periods, and increased cryptic behaviors.

NMFS is currently analyzing the visual and acoustic data collected and will publish a cumulative analysis report to address the project objectives.

Background

The waters in lower Knik Arm are used by endangered Cook Inlet beluga whales (CIB) to navigate to important foraging habitat and also serve as the gateway to the largest port in Alaska. Infrastructure at the Port of Alaska (POA) has degraded, resulting in small and large pile driving projects since 2008. The POA has recently begun major improvements to upgrade current infrastructure. The Petroleum Cement Terminal (PCT) project was completed during the summer of 2020 and 2021 and included the installation and removal of a few hundred piles. Construction of the PCT was completed by Pacific Pile and Marine. Marine mammal monitoring during in-water pile driving activities at the POA was implemented by 61 North Environmental.

The POA implemented strict mitigation measures and an extensive marine mammal monitoring program during all in-water pile driving (and some non-pile driving) days to reduce the impacts to CIBs. A complete list of the POA's monitoring and mitigation can be found in the Biological Opinion (NMFS 2020a) and Incidental Take Authorizations (NMFS 2020b). The POA has also prepared a final marine mammal monitoring report (61 North Environmental 2021).

NMFS is concerned about impacts anthropogenic activities may have on the highly endangered CIB; therefore, NMFS funded a visual marine mammal monitoring project to collect additional sighting information on marine mammals near the POA during non-pile driving days. A complementary project that NMFS funded was the deployment of 4 acoustic moorings (2 north of the POA, 2 south of the POA). Acoustic detections will be compared to marine mammal sightings from NMFS's visual monitoring project and the POA's required marine mammal monitoring associated with the PCT project. There has previously been indications that belugas sometimes go quiet during periods of noise; therefore, validating acoustic detections visually will help fill an important gap in knowledge.

The objectives of the project are below; however, this report focuses solely on NMFS's monitoring efforts. The goal of this report is to outline the methodology and preliminary results of NMFS's visual monitoring efforts. NMFS will analyze all three datasets to meet the project's objectives described and the results will be presented and discussed in a future cumulative analysis report.

Photo Credit: Tori Horsley

Project Objectives

1. Estimate the frequency at which beluga whales are present within and adjacent to the POA;
2. Evaluate habitat use and movement of beluga whales during days with and without pile driving activities by comparing all three datasets (NOAA Fisheries visual monitoring project, NOAA Fisheries acoustic monitoring project, and POA marine mammal monitoring program);
3. Evaluate received levels and acoustic propagation.

Methodology

In order to meet the objectives and be able to compare the data collected from NMFS and POA monitoring efforts, NMFS attempted to replicate the POA monitoring efforts as closely as possible. NMFS utilized two of the four POA monitoring platforms/stations (with two observers per station) and rented the same equipment and data collection software system used for the POA monitoring effort. NMFS observers were also observers for the POA monitoring and mitigation program.

Observers & Monitoring Effort

NMFS hired a total of 5 observers over the 2021 monitoring season with one designated field lead. One observer resigned at the end of July and was replaced by another observer. All observers were highly experienced in marine mammal monitoring and had monitored for the POA in 2020 and 2021.

NMFS visual monitoring project completed 47 non-consecutive days of observation, covering all tidal stages. The project originally anticipated monitoring on non-pile driving days from May through November with approximately 10 days of monitoring effort per month, 4 hours per day. However, because of the unpredictability in the construction schedule, NMFS frequently adjusted the number of days and hours per day each month to attempt to get adequate coverage over the season. NMFS originally anticipated monitoring on non-pile driving days every week, however, the POA ended up monitoring for months at a time on pile driving and non-pile driving days. Therefore, NMFS adjusted to monitoring during the months that the POA was not monitoring.

The POA began monitoring April 26, 2021 and expected pile driving would occur throughout the summer; however, they were able to install all piles by June 24, 2021 (61 North monitored 51 of 60 calendar days). Therefore, NMFS began their monitoring on July 8, 2021 and increased the number of days of monitoring in July and August. NMFS monitored the first 3 days of September before the POA began monitoring again and monitored the rest of September during the removal of all the temporary piles. NMFS then began monitoring again on October 2, 2021 and finished monitoring efforts on October 17, 2021.

NMFS observers monitored for 4 hours per monitoring day in the months of July, August, and September. Due to availability within the budget, covid constraints, and the end of the season approaching, NMFS increased the number of monitoring hours per day from 4 hours to 8 hours in October. To reduce observer fatigue and follow NMFS's best management practices for observing, observers had a 1 hour

break in between the two shifts (i.e. no monitoring occurred during this hour). POA monitoring required observers to work 8 to 12 hours per monitoring day (with breaks), throughout the season.

During the month of July NMFS monitoring shifts were set from 8 am to 12 pm for each monitoring day. Due to the daily variability in the tides, monitoring covered all tidal stages. After the first week of August NMFS adjusted the schedule to rotate shifts from 8 am to 12 pm and 12 pm to 4 pm to adequately cover all tidal stages within a week. Due to the time of sunrise in October, observers typically monitored from 9 am to 1 pm and 2 pm to 6 pm. To reduce observer fatigue, throughout the monitoring season, schedules were adjusted to give observers days off where appropriate. For example, the observers monitored for the POA almost every day for the month of September (8 to 12 hours per day), therefore, with input from the observers they were given three days off before starting the NMFS monitoring effort back up in the beginning of October.

Observation Locations & Setup[1]

NMFS received approval from Pacific Pile and Marine to utilize two (out of four) of their monitoring platforms that were also used for the POA monitoring efforts. The most northern (near Cairn Point) and most southern (near Pt. Woronzof) stations were selected 1) for their close proximity to the acoustic mooring locations and 2) to best match the monitoring area covered by POA monitoring (Figure 1). The Point Woronzof observation station (PW) was located in the parking lot of the Downtown Anchorage Viewpoint, on land owned and managed by the Municipality of Anchorage and Ted Stevens International Airport. The northern observation station known as the "north expansion" (NEX) was located on property owned by POA.

Each monitoring station constructed by Pacific Pile and Marine consisted of a covered platform constructed on top of an 8-foot by 8-foot by 20-foot shipping container. The platforms provided unobstructed viewing in all directions and had a shed which provided a protected area for data recording. Photos of the platforms can be found in Appendix B of the POA's PCT Marine Mammal Monitoring Report (61 North Environmental 2021). Observers utilized that same equipment used for POA monitoring. Each observation station was equipped with (1) theodolite, (1) rugged laptop, (2) Binoculars (7x50 with internal compass and range-finding reticle), and (1) large-aperture binoculars with a minimum 25X magnification (Fujinon™ 25X150 MT-SX binoculars) mounted on height-adjustable tripods or hydraulic lifts. Observers used handheld VHF radios and cell phones to communicate between stations. The stations were equipped with 25-watt fixed-mount VHF to ensure reliable reception and transmission of messages.

[1] Additional information on the observation station setup can be found in the POA's Marine Mammal Monitoring Report (61 North Environmental 2021).

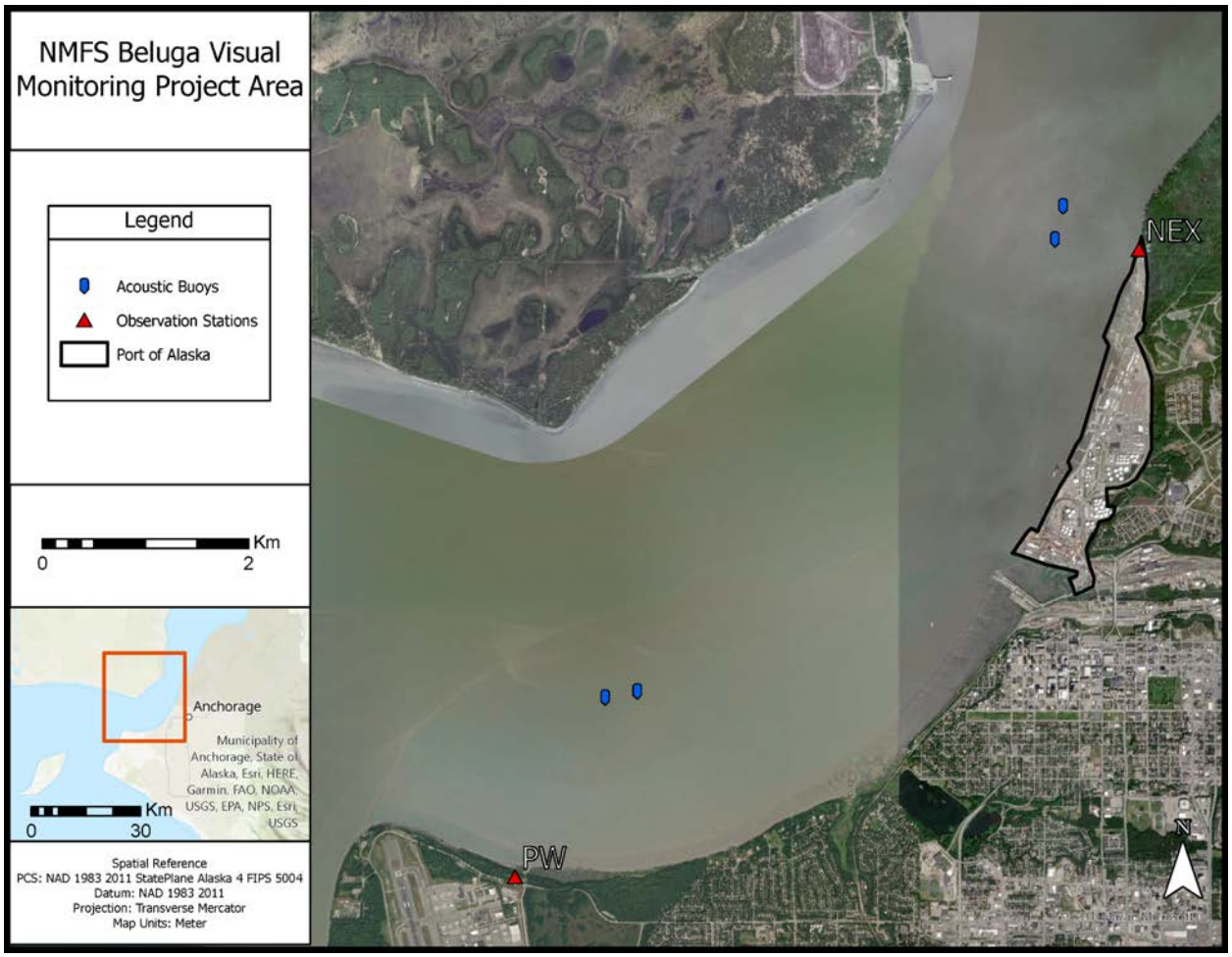


Figure 1. PCT Observation Stations & Acoustic Mooring Locations

Limited Coverage Areas

The contour of the Knik Arm coastline, number and location of observation stations, number of observers on-effort, and anthropogenic structures and associated activities are all factors that impacted the observers ability to observe small portions of the monitoring zone. The observers identified Cairn Point, the freighter docking area, waters directly in front of the PCT construction zone, Ship Creek, and the waters behind Port Mackenzie as locations with limited or no coverage (Figure 2).

The Cairn Point land feature, just north of the NEX station, obstructed the view of the NEX observers in the north and northeast directions. The PW station, approximately nine kilometers (km) to the southwest, provided a view of the shoreline north of Cairn Point; however, distortion and environmental conditions resulted in limited coverage of the area (Figure 3). Southbound belugas were typically detected by the NEX station when the whales swam around the point. Belugas that traveled south past the NEX station toward the construction zone frequently dipped into the freighter docking area, and observers lost visual contact of the whales in this area (Figure 4). Directly in front of the PCT construction zone, vessels and construction equipment made it difficult for observers to track belugas and maintain

visual contact. Vessel traffic, infrastructure, and land also limited coverage of the area near Ship Creek. Belugas frequently milled in the waters behind Port Mackenzie and observers at the NEX station were able to track the sightings most of the time; however, when positioned behind the northernmost dolphins of the port structure, the observers lost sight of the whales.

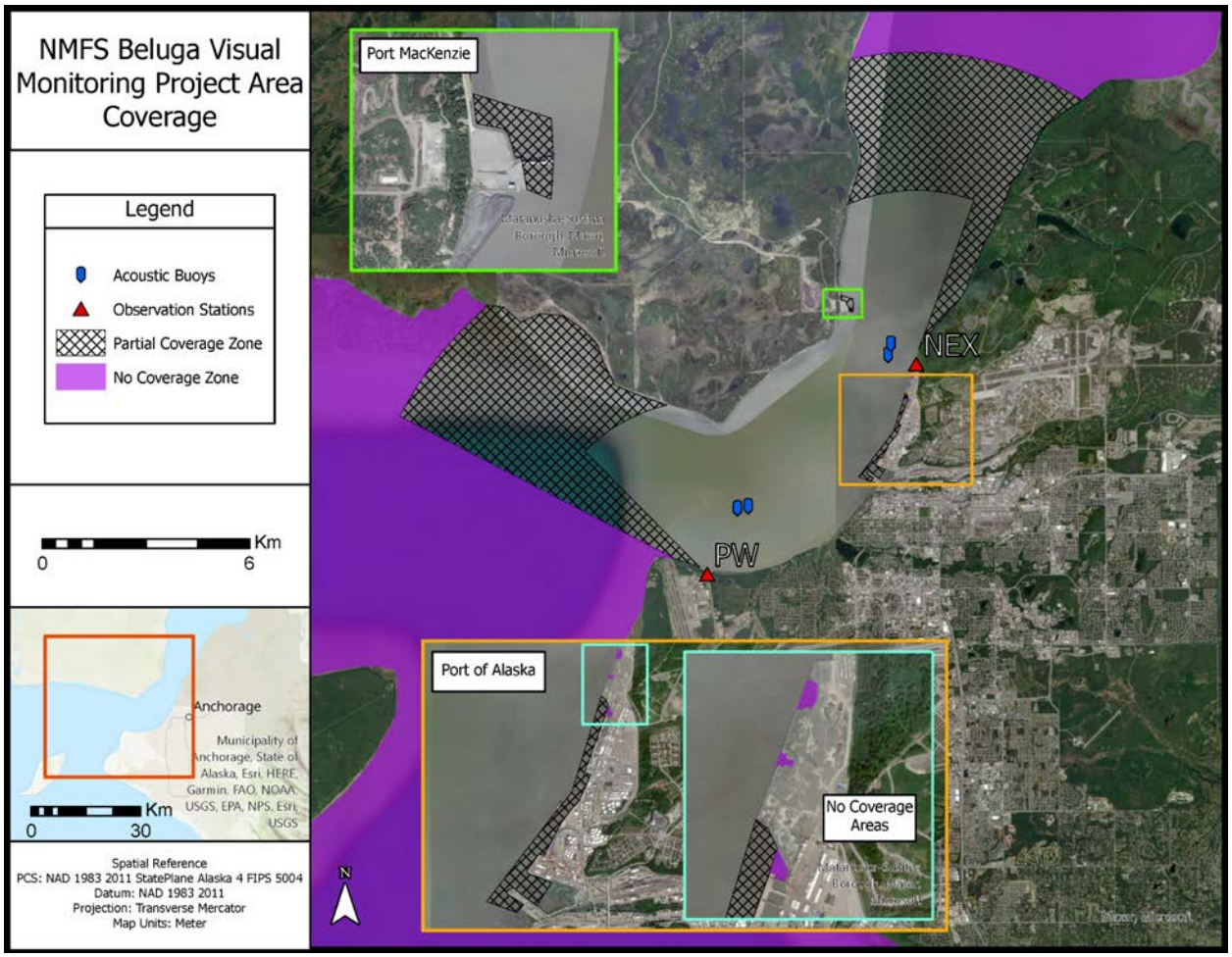


Figure 2. Monitoring coverage of the project area

The POA monitoring effort was able to minimize or eliminate these limited- or no- coverage areas with two additional observation stations and seven additional observers, compared to the NMFS visual monitoring effort. During pile driving activities that produced larger disturbance zones, two observers from the NEX station were positioned on the beach closer to Cairn Point (when possible, during low tide) to promptly detect belugas traveling south. If belugas were presumed in the freighter docking area but not visible, an observer (when available) drove to the location to monitor. Two observers were based at the PCT station located in the PCT construction zone, significantly minimizing, if not eliminating, areas of limited to no coverage in the surrounding waters. The Ship Creek station positioned observers in close proximity to an area frequently used by belugas. The station also enhanced the view of Port Mackenzie.

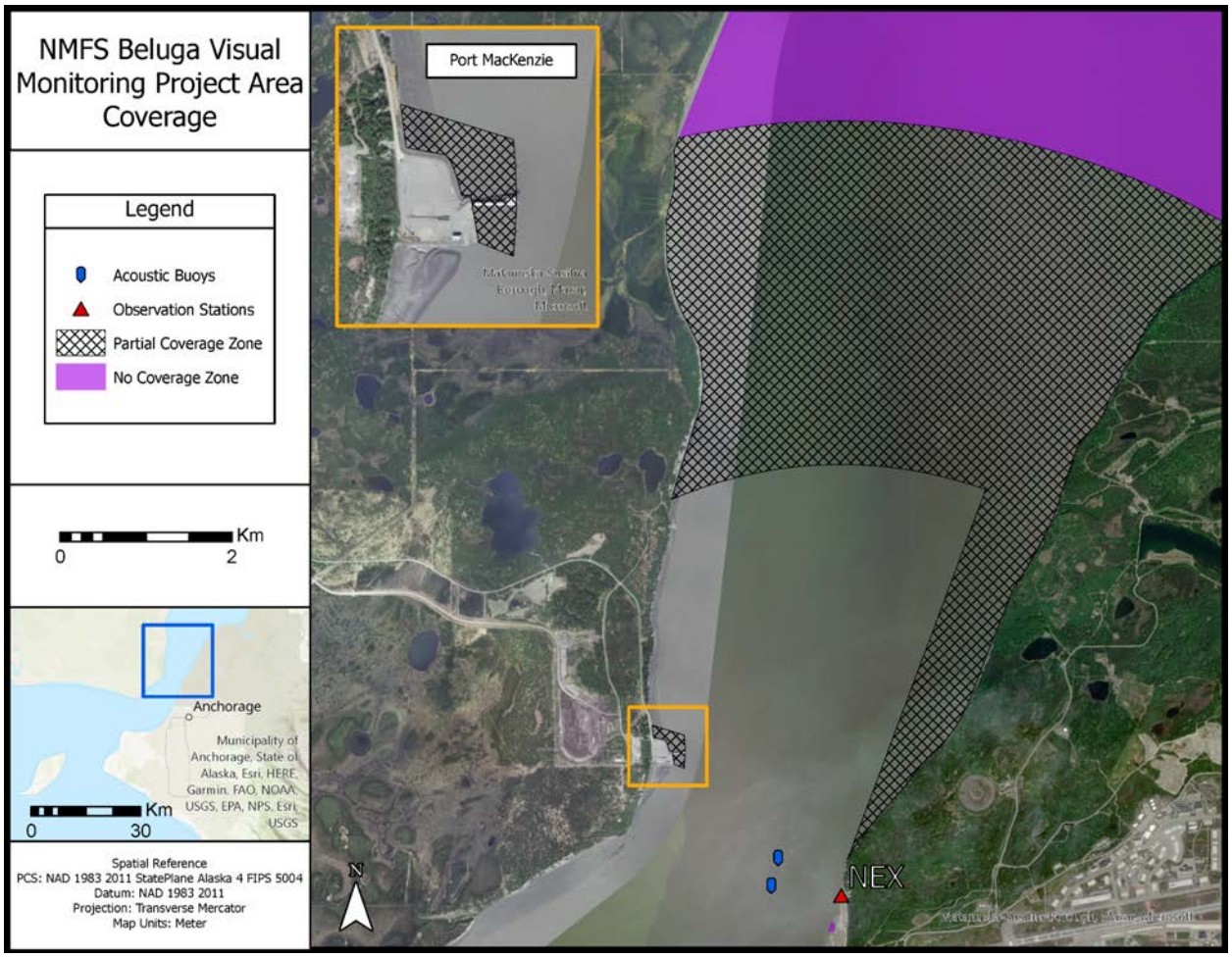


Figure 3. Monitoring coverage of the North portion of the project area

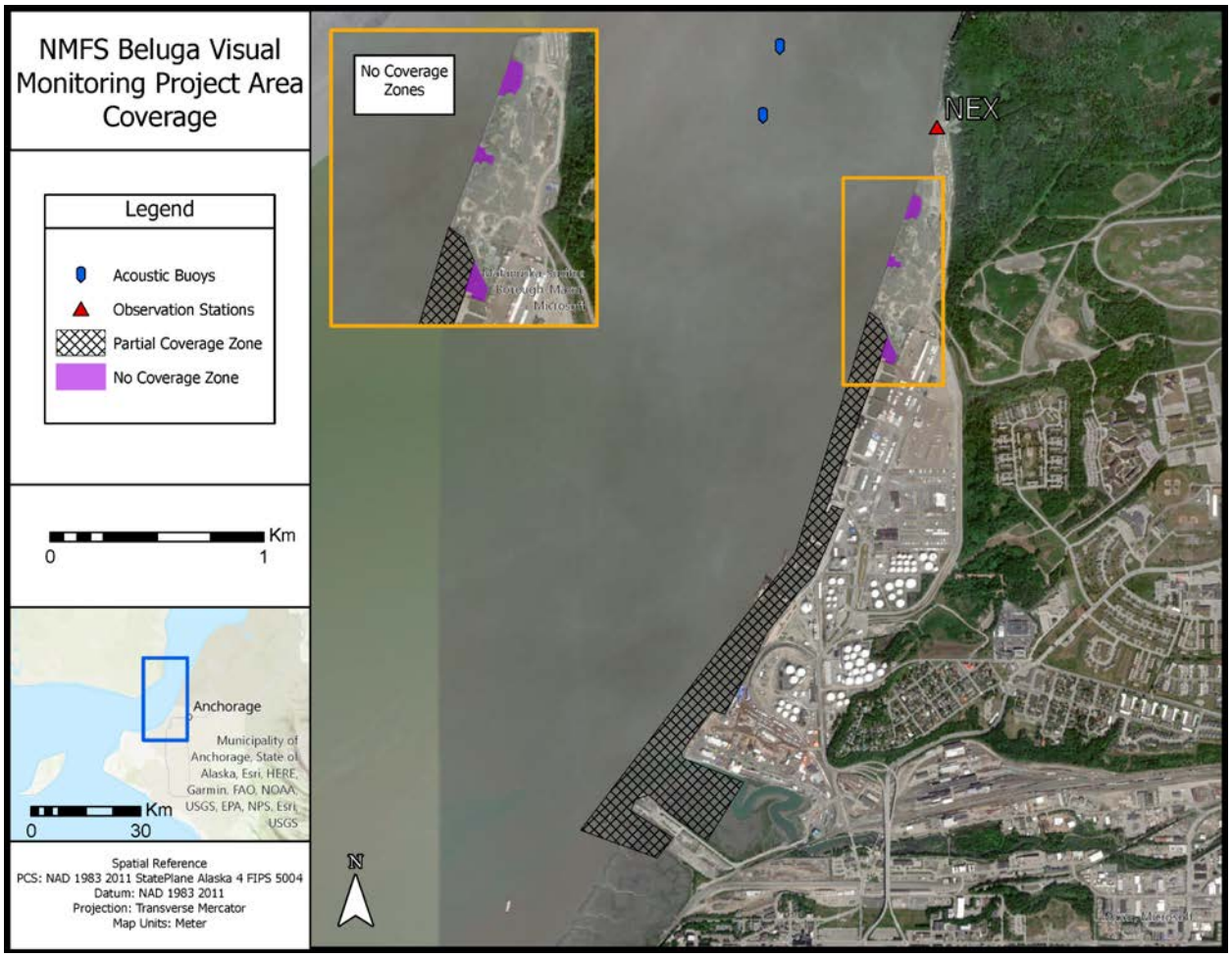


Figure 4. Monitoring coverage near the POA

Theodolite Setup

Prior to use, the elevation and geographic coordinates of each theodolite setup point was surveyed to an accuracy of 10 centimeters or less and entered into the MS Access dataset. The elevations referenced the mean sea level, as defined by the benchmarks associated with the National Oceanic and Atmospheric Administration (NOAA) Tide Station Anchorage 9455920 (NOAA 2019). The 1-minute interval tide level predictions, relative to mean sea level, are pre-loaded into the MS Access database for May through October 2021 (description courtesy of 61 North Environmental 2021).

At the moment each marine mammal fix is entered, the database retrieved the predicted tide level for the time of the sighting and calculated the theodolite height above sea level. The theodolite was linked directly to the laptop computers via a data cable to avoid entry mistakes. At the beginning of each monitoring period, the theodolites were set up on the surveyed location on the platforms, leveled, and back-sighted to a known reference location to "zero" the horizontal angle measurement. After setup, each station would sight in and enter one or more test fixes of known landmarks that were visible on

aerial imagery, to verify the proper operation of the theodolite and software (description courtesy of 61 North Environmental 2021).

Observing Methodology

NMFS's monitoring objective was to gather information on the presence and behavior of marine mammals during each marine mammal monitoring session. This is different from the POA's monitoring objective which was to implement mitigation measures. As described in 61 North Environmental 2021, the POA's observers focused on the shoreline areas with more frequent beluga presence, and areas where Level B exposures occurred more easily (such as near Cairn Point on outgoing tides). The POA monitored the entire visible area with regular scans, but timed sweeps, randomized grids, or other research-focused methods were not generally employed. To keep datasets comparable, NMFS did not request observers change their methodology when scanning for marine mammals.

All four observers rotated stations, team mates, and monitoring duties. There was no set schedule for these rotations. Both observers at a station would scan with the naked eye, the large-aperture binoculars and the 7x50 binoculars to have adequate coverage of the monitoring area. Observers typically rotated between large-aperture binoculars every 30 to 60 mins. When marine mammals were sighted, one observer would enter the shed to record the sighting. The other observer would keep their eyes on the animals.

Data Collection

61 North Environmental developed a cloud based Microsoft Access application for the POA marine mammal monitoring program. 61 North Environmental duplicated this application and created a separate version for NMFS to utilize for data collection. The Microsoft Access application was installed on each station laptop and included two data-entry forms applicable to NOAA Fisheries visual monitoring project, one form collected data on weather and anthropogenic activities and the other form collected information on marine mammal sightings[2]. Visual basic coding was utilized to calculate marine mammal group latitudes and longitudes from the horizontal and vertical angles captured from the theodolites. Data validation was applied to entry fields and drop-down lists were set with default values for the most frequent attributes to allow for rapid entry of a sighting for mitigation purposes. Timestamps were recorded for initial entry, last update, and every location fix (description courtesy of 61 North Environmental 2021).

Environmental Conditions

Environmental conditions were collected at each station at the beginning and end of every monitoring period and every half hour, or as conditions changed. Table 1 provides the definition and unit for each

[2] The application had a third form only used for the POA monitoring effort which was to record PCT construction activities.

attribute of environmental data collected. Information on tides, air temperature, wind speed, wind direction obtained from the meteorological station associated with NOAA tide station 9455920 at the POA. The predicted tide levels were pre-loaded into the Microsoft Access database to auto populate the tide level and stage for each environmental record entry.

Table 1. Environmental attributes and definitions/units collected.

Data Attribute	Definition and/or Units Collected
Time	Database-generated timestamp of the environmental conditions record entry time
Station Id	Indicates which station collected the environmental conditions
Overall Conditions	Overall assessment of environmental conditions on a scale of 1 to 10, with 10 representing ideal conditions. The rating was subjective, but consensus-based by the team at each station.
Weather Conditions	sun, partly sun, partly cloudy, cloudy, mist, light rain, rain, fog, smoke, snow
Light conditions	Light, twilight, dark
Sea State	(0) calm - wave height 0 - Sea is like a mirror. Smoke rises vertically. (1) light air - wave height < ½ ft - Ripples with the appearance of scales are formed, but without foam crests. Smoke drifts from funnel. (2) light breeze - wave height ½ to 1 ft - Small wavelets, still short but more pronounced, crests have glassy appearance and do not break. Wind felt on face. Smoke rises at about 80 degrees. (3) gentle breeze - wave height 2 to 3 ft - Large wavelets, crests begin to break. Foam of glassy appearance. Perhaps scattered white horses (white caps). Wind extends light flag and pennants. Smoke rises at about 70 deg. (4) moderate breeze - wave height 3 to 5 ft - Small waves, becoming longer. Fairly frequent white horses (white caps). Wind raises dust and loose paper on deck. Smoke rises at about 50 deg. No noticeable sound in the rigging. Slack halyards curve and sway. Heavy flag flaps limply. (5) fresh breeze - wave height 6 to 8 ft - Moderate waves, taking more pronounced long form. Many white horses (white caps) are formed (chance of some spray). Wind felt strongly on face. Smoke rises at about 30 deg. Slack halyards whip while bending continuously to leeward. Taut halyards maintain slightly bent position. Low whistle in the rigging. Heavy flag doesn't extended but flaps over entire length. Note: Beaufort Sea State 6 through 12 were also available for selection but were not observed.
Cloud Cover	0 - 100% percentage of cloud cover
Visibility Distance	Distance visible in meters, estimated in 500 m increments from 0-10,000 m with 10,000 m considered full visibility. *For most of the monitoring season, visibility from the PW station to the West was obstructed by foliage and limited to 6,000 m. Visibility increased to 10,000 m mid-October when the leaves fell.
Glare	0–100%. Percentage of water obstructed by glare and grid cells affected by glare or the direction of glare
Ice Coverage	0–100%. Percentage of ice cover and type of ice (no ice present, new, brash, or pancake ice and floes)

Anthropogenic Activities

Observers were primarily focused on detecting and recording marine mammal sightings; however, vessel activity in the area, including barge, tug, recreational, and dredging operations, was documented as time

permitted. Observers recorded vessel presence and movement in one of two ways: brief summary descriptions were recorded during entry of the environmental conditions, or dedicated effort was made to track vessels with the theodolite and specific positions, times, and activities were recorded. Large cargo ships entering and exiting Knik Arm were of particular interest and observers typically captured several fixes as these ships transited. Smaller vessels or vessels that remained in the same general area, were not tracked as frequently or were recorded during the weather observations. This information will be used in the acoustic analysis.

Marine Mammal Sightings

Observers collected data on all marine mammals. Sightings were recorded in a cloud-based database that enabled observers at both locations to view and edit all sightings data in real-time. This allowed observers to “pass” marine mammal sightings from one station to the other as beluga groups moved through the monitoring area. The observers communicated frequently by radio and cell phone regarding group counts, behaviors, locations, and other relevant information.

Collecting Group-level Characteristics

When a marine mammal group was initially sighted, an observer would create a record in the cloud-based Microsoft Access database. Observers entered group-level characteristics (e.g., counts, behaviors, formation, spacing, pace, and sighting comments; Table 2 and 3) into the "parent" record of the sighting. The group-level characteristics and sighting notes could be updated as needed throughout the sighting (description courtesy of 61 North Environmental 2021). Each sighting form had a location for observers to provide additional information on the sighting. For example, if observers noticed “clusters” or sub-groups of animals within a group forming a closer spatial formation during a particular behavior, the observers could capture this information in the sighting form.

Table 2. Marine mammal sighting data attributes and definitions

Data Attribute	Definition and/or Units Collected
Marine Mammal Observation ID	Database-generated unique marine mammal (MM) group number
Created date and time	Database-generated date and time sighting form was created. This did not necessarily match exactly with the initial sighting.
Time of initial and last sighting	Time the group is initially sighted and last sighted
Common Name	Marine mammal species common name
Group Size	Beluga Whales - Beluga white count: best count of white belugas in group - Beluga gray count: best count of gray belugas in group - Beluga calf count: best count of calf belugas in group - Beluga neonate count: best count of neonate belugas in group - Unknown Count: best count of unknown age class in group - Total beluga count: sum of the above, this column was added postseason. Other Marine Mammals - Other maine marine mammal adults: best count of adult non-beluga marine mammals in group (if possible) - Other marine mammal calf/pop: best count of pup/calf non-beluga marine mammals in group - Total other marine mammal count: sum of other non-beluga marine mammals in group
Primary Behavior	Most common marine mammal behavior observed during sighting (see Table 3)
Secondary Behavior	Second most common marine mammal behavior observed during sighting. Additional behaviors were captured in marine mammal sighting notes (see Table 3)
Pace	Most common pace of marine mammal group observed - sedate: relatively slow movement - moderate: moving at an average pace, neither slow nor rapid - vigorous: rapid movement potentially associated with water disturbance
Spread	Distance of beluga group individuals from each other (1 - > 10 body lengths).
Formation	Most common formation of beluga group - Circular: arranged in a circular group while moving in one direction - Parallel: alongside each other, spread perpendicular to direction of movement - Linear: forming a line, spread along direction of movement - Echelon: Arranged diagonally, each marine mammal to the side and behind animal ahead of it; also includes “V” formation - No Formation: Random or un-patterned formation
Sighting Cue	First indication of marine mammals; head, blow, fluke, dorsal fin, body, splash, birds feeding, porpoise, or other.
Comments	Observers commented on behaviors, fix details, counts, sighting progression, which station has "control" of the parent record and is entering fixes, and other sighting details.

Table 3. Behavior Definitions

Behavior	Definition
Unknown	unable to determine behavior. Could be due to brief sighting time or poor sighting conditions
Avoiding Predation	moving with speed and/or abrupt changes in direction in response to an observed predator.
Breach	jumping clear out of water
Bubbling	producing many bubbles while submerged, not including normal subsurface exhalation associated with surfacing
Calving	atypical behaviors/cues observed that could be indicative of giving birth, e.g. contracting body movements, blood observed, sudden appearance of a calf, fetal folds observed, etc. Provide detailed comments to justify use of this code
Diving	Moving downward through the water column (rapidly or slowly). Whales typically show a strongly arched back and some species may also fluke before diving to depth
Feeding Observed	prey species observed inside of MM mouth
Feeding Suspected	diving, chasing, pursuing prey or lunging which suggest feeding. Proxy events such as jumping fish, associating birds and/or seals, etc., could also indicate possible feeding.
Looking	breaking the surface and looking around, typically a behavior of pinnipeds
Mating Suspected	two or more whales swimming in ventral to ventral contact slowly in same direction or rolling around in one place
Miling	moving in a non-linear, weaving or circular pattern while maintaining the same general position within an area
None	enter when no behavior is observed, typically entered in Secondary Behavior column when only one behavior is observed
Other	behavior not captured by available list of behaviors (must provide a description of the behavior)
Porpoising	leaping rapidly out of water; for this project observers tended to enter porpoising when harbor porpoises were observed since there was no swimming or surfacing option
Resting	floating at or near the surface, with little or no movement for several minutes or more with no other suspected behavior
Side Scanning	beluga specific, swimming (often very slowly) at the surface with lateral aspect (pectoral flipper, tail fluke or side surface of body) visible, often for 30 seconds. Often followed by explosive prey pursuit
Sink	lowers vertically into the water, typically a behavior of seals
Snorkeling	beluga specific, surfacing showing a low profile, with only blowhole, melon, and small portion of dorsal just posterior to blowhole are visible
Socializing	interacting with other whales, indicated by milling, bubbling, tail slapping, physical

	contact or audible vocalization
Spyhopping	holding body vertically with head out of water for several seconds or more
Startled	rapidly changing behavior, dispersing or traveling that indicates a response to external event (must describe disturb
Tail slapping	hitting the tail fluke vigorously against the water surface producing a splash.
Tail waving	holding body vertically with tail out of water for several seconds or more, often slowly waving tail, but not tail slapping
Traveling	moving in a linear or near-linear direction without interruption
Vocalizing	snorting, whistling, or chirping

Taking a Fix

Once a record was created, a separate location data form, linked to the parent record, opened. One observer used the theodolite viewer and crosshairs to pinpoint the location of an animal in the group (or the last surface location), and the other observer, when told, clicked the capture button in the location form. The horizontal and vertical angles captured by the theodolite were converted to GPS coordinates within the application. The coordinates were entered into Google Earth to verify that the location was accurate and adjustments were made, when necessary.

The observers had significant experience using the theodolite and fixes were typically delayed less than 30 seconds. When multiple groups were present, fixes were slightly delayed as the observers navigated between the parent records for each group. There were also delays if whales were present in the monitoring area when the observers arrived to start their shift, before the theodolite was set up. Occasionally the theodolite would need to be re-zeroed or Access would not respond due to internet connection issues. Delays were described in the Comment section of the data form.

Each group's location was collected one to multiple times. Fixes were taken when a new group was sighted, there was an update to the current sighting, another station was taking over the group, a potential change in behavior occurred, or there was a change in direction. Observers typically recorded locations every 5 to 15 minutes. More frequent fixes were recorded when belugas were closer to observation stations. Fewer locations were recorded for harbor seals that remained near the mouth of Ship Creek for hours.

An observer would take a fix on the lead beluga when the group was traveling towards a station (i.e the closest beluga to the station). When it was a larger group of belugas (10 animals or more), a fix was taken on the lead beluga, a beluga in the middle of the group and the trailing whale to document the group spread. The fixes would then resume on the lead beluga. When the whales split into “clusters” a fix was also taken on the different clusters to show spread and/or behavior. When the group was traveling away, a fix was typically taken on the trailing whale; however, depending on the station and direction of travel, fixes were sometimes still taken on the lead whale, but a trailing whale may be

identified with a fix as well. Additionally, if a whale was exhibiting a specific type of behavior that would require documenting (i.e. in distress, breaching, tail-waving, spy-hopping, etc.) then a fix was taken on that specific whale. Fixes were also taken on outlier whales that were part of the group but away from the larger concentration of whales. The target of the fix was identified in the observer comments.

The POA monitoring effort's main objective was to monitor and mitigate (different from NMFS monitoring effort objective); therefore, observers focused on getting a location of the animal closest to the Level B harassment zone. Also the POA did not focus on documenting the spread of a group and did not shoot fixes on the lead, middle, & trailing whale as they passed. Another difference was the POA monitoring required a fix every time a beluga count was changed, and for the NMFS effort, observers consistently noted the time of update in comments instead of taking a fix for that particular occurrence. This was because count updates were happening frequently with fewer observers available to help confirm count numbers as well as cut down on excessive fixes.

Joining or Splitting a Group

Observers took detailed notes on CIB group size when a group separated into more than one group, and when two or more groups joined together. Observers typically watched the behaviors of groups for 5 to 10 minutes before determining if groups of whales were actually splitting or joining together, to ensure accurate depiction of the situation and to avoid confusion. Observers typically used changes in behavior and distance to determine if groups should be split or joined. Groups were separated if specific whales from an identified group altered their behavior from their initial group. For example, if some whales began to travel in a different direction or stayed behind to mill while the rest of the group traveled off, the whales would be recorded as having split into two groups. Groups were joined if groups had no discernable distance between them and were traveling, milling, and/or mixing together. There were some occasions where groups split and then rejoined together later.

Examples:

- A group of 10 whales was traveling south along the far shoreline North of Port Mackenzie and continued south past Port Mackenzie; however, two whales stayed back milling at the Port. The two animals that stayed back at Port Mackenzie would be considered a new group that had separated from the original group.
- There were instances where there was a cow/calf pair milling for an extended period of time in one location. Sometimes a group of whales would pass by and not stop to mill. In this example, the two groups had different behaviors and were not considered one group.
- Groups with animals that had distinct markings or cow/calf pairs were easier to identify as a separate group.

QA/QC Process

Data underwent a three-tiered quality assurance/quality control (QA/QC) process. Observers QA/QCed data records as they were entered into the cloud-based Microsoft Access application in the field. At the end of each day of observations, the lead observer QA/QCed all records from both observation stations

and followed up with observers, as necessary, to resolve any questions. The lead observer would scan each sighting form to ensure all fields were entered, the data entered was correct, and look for any outliers.

Data were then exported from the Access application into a Google Sheets spreadsheet by the Project Manager for review by the Data Manager. This ensured the original database remained an intact backup while allowing for revisions within the spreadsheet. Data were exported and QA/QCed as soon as possible after each day of observations, while observers were more likely to remember specific details. The Data Manager read through the data to look for outliers and ensure there was not conflicting data between attributes and the notes provided by the observers.

Data collected using the two data-entry forms (marine mammal sightings, and weather and anthropogenic activities) in the field were separated into five spreadsheets during post-processing: marine mammal observations, marine mammal locations, vessel observations, vessel locations, and weather observations. Each record was reviewed for clarity, consistency, and accuracy. When an entry required further clarification, the record was highlighted and the lead observer was contacted. All questions were directed to the lead observer, who would reach out to the observer that recorded the data, if necessary. Once resolved, the Data Manager either revised the record or left it unchanged, depending on the circumstances.

The Microsoft Access platform had some defaults that were inaccurate and were corrected in our Google Sheets data. The formation and spread were defaulted incorrectly for a beluga group with one animal, non-beluga marine mammal sightings, vessels, and theodolite tests. For example, the database would display a formation and spread even if there was one animal or vessel. This was updated to NA in the dataset. This may need to be updated in the POA 2020 and 2021 dataset.

Results

Monitoring Effort

NMFS monitored on 47 non-consecutive days for 220 hours over the months of July, August, September, and October (Figure 5). The POA completed monitoring in April, May, June, and September.

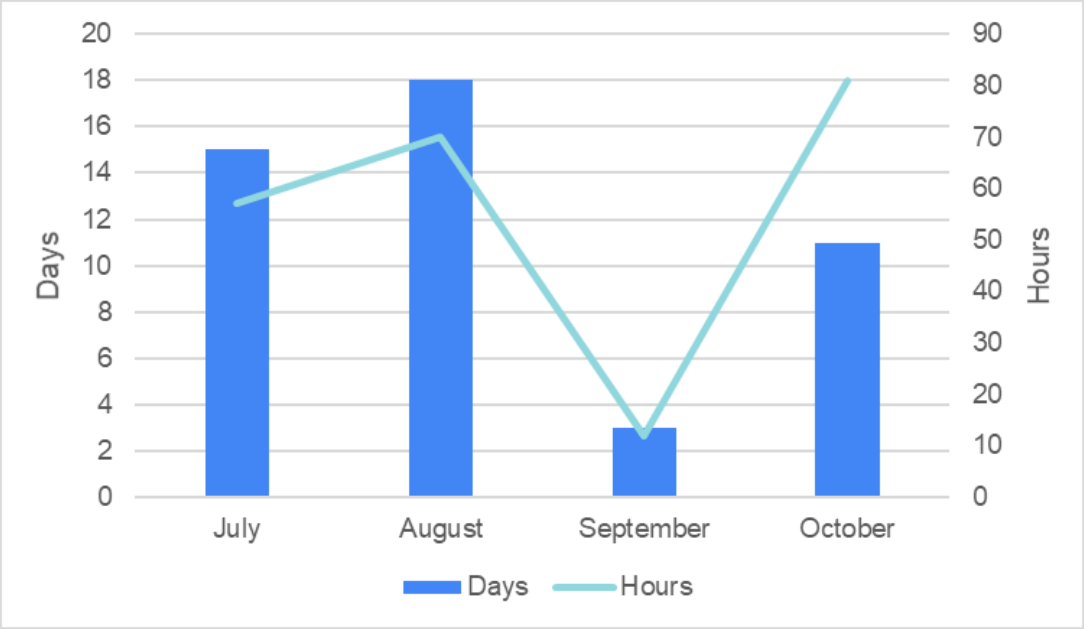


Figure 5. Number of days and hours of NOAA Fisheries monitoring effort per month

Environmental Conditions

In total, 997 environmental records were collected from the PW and NEX stations. All observations were conducted during daylight hours. Glare was documented in 44 records and ranged between 1-15%. There was no ice present in the monitoring area. Precipitation, consisting of fog, mist, light rain, rain, or snow, occurred during 18% of the monitoring effort. The Beaufort sea state ranged between 1-3, with a 2 observed approximately 81% of the time in July and August and 90% in September and October (Figure 6). Visibility ranged from 8 to 10 km for approximately 72% of the observations in July, 81% in August, 77% in September, and 67% in October (Figure 7). Only 10% of the records throughout the monitoring season indicate visibility was less than 6 km. Each environmental record had an overall assessment of the conditions, which was rated on a scale of 1-10 with 10 representing ideal conditions. The overall conditions were rated as 8 or better in approximately 81% of the records in July, 82% of the records in August, 79% of the records in September, and 53% of the records in October (Figure 8).

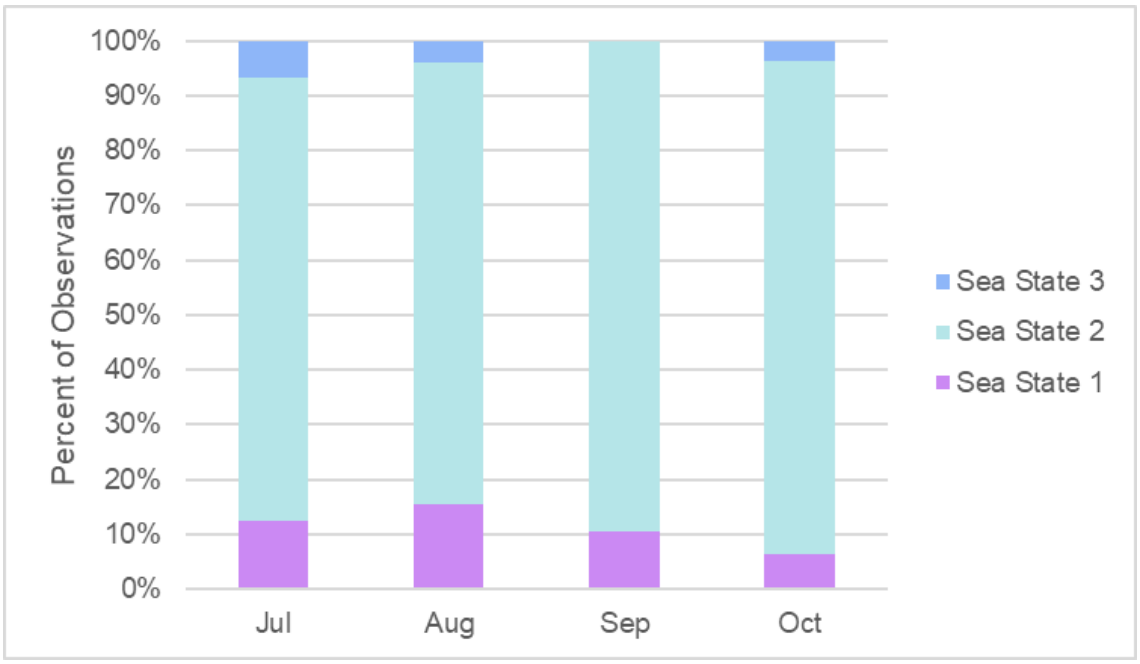


Figure 6. Percentage of Beaufort sea state reported by month.

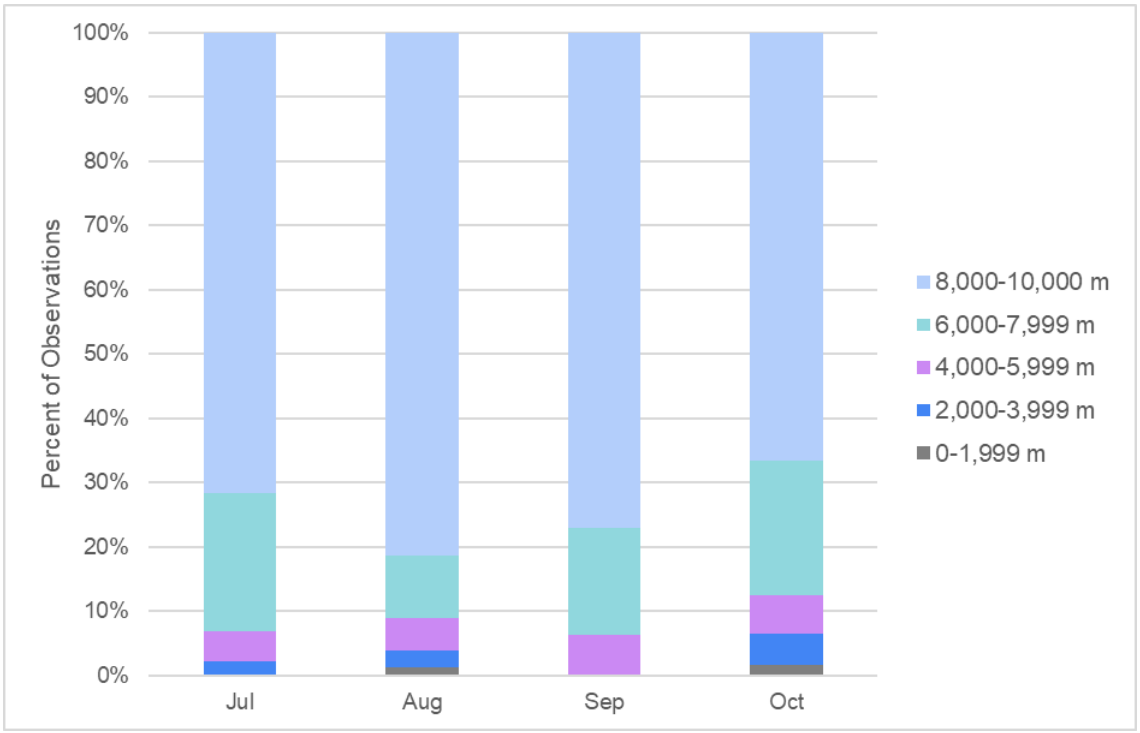


Figure 7. Percentage of visibility distance reported by month.

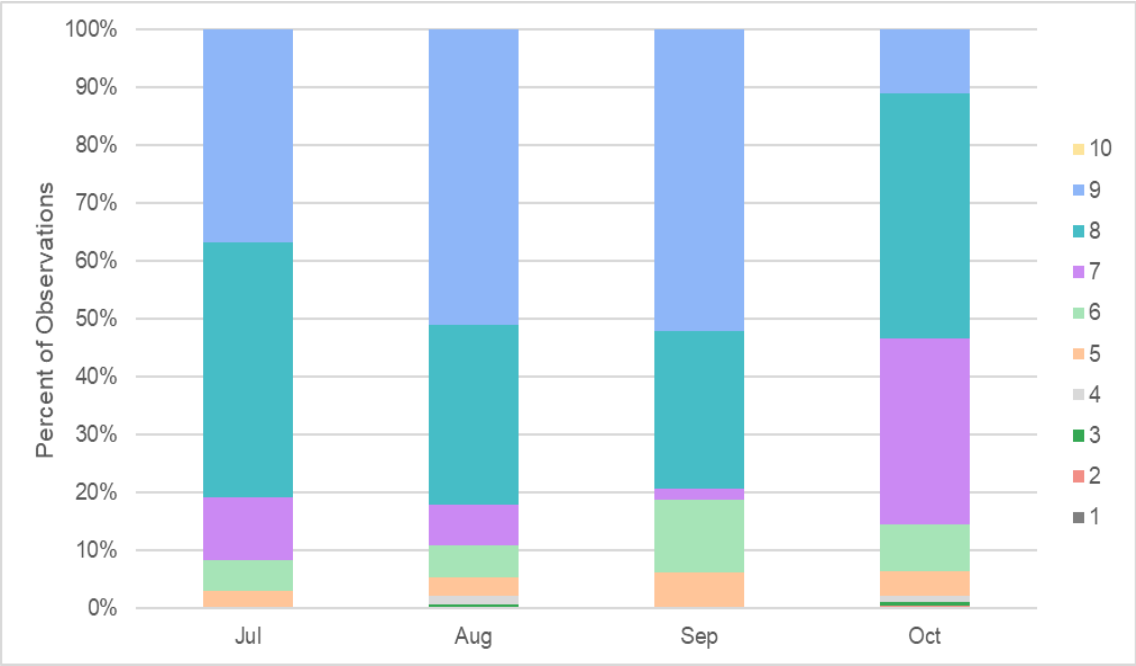


Figure 8. Percentage of overall observation conditions by month

Marine Mammal Sightings

Cook Inlet Beluga Whales

NMFS observers recorded a total of 109 beluga groups with a total of 575 whales (Table 4). Cook Inlet belugas were observed on 29 of the 47 monitoring days in July, August, September, and October. The whales were observed throughout lower Knik Arm, and consistently observed traveling along the coastline (Figure 9). There is likely some observation bias associated with the nearshore sightings, as the probability of detection increases as the sighting distance decreases. The sighting rate, used to account for effort, was calculated by dividing the number of belugas observed by the number of hours of observation effort. September had the highest sighting rate, followed by October and August.

Photo Credit: Tori Horsley

Table 4. Beluga sightings per month

		July	August	September	October	Total
Observation Effort	Days	15	18	3	11	47
	Hours	57	70	12	81	220
Beluga Whales	Groups	3	43	12	51	109
	Animals	7	239	49	280	575
	animals/hour	0.12	3.41	4.08	3.46	Average 2.77

Note: In October, observers had a one hour break in the middle of monitoring effort, therefore, there may be some animals counted twice in a given day.

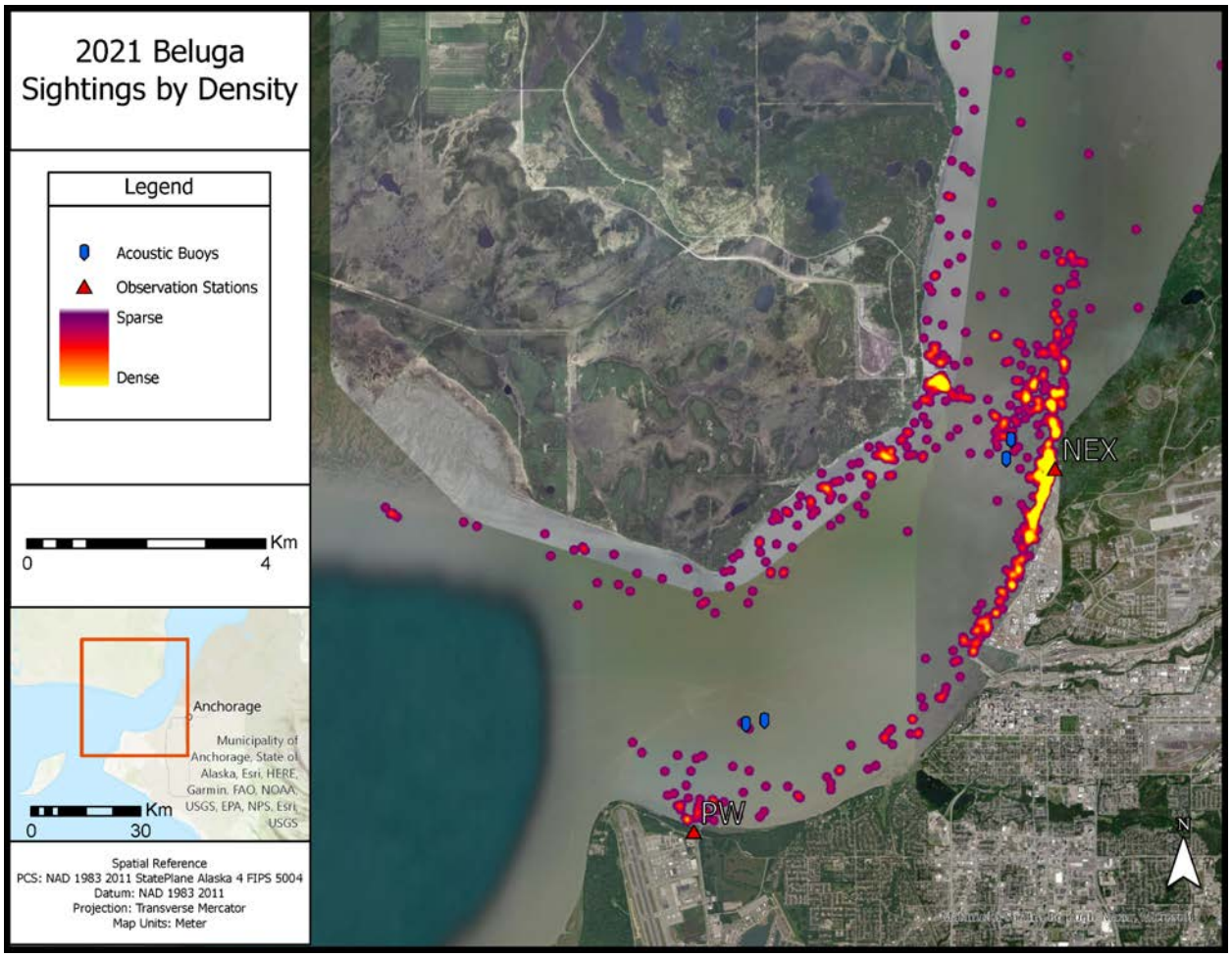


Figure 9. Beluga whale heat map of distribution

Group Size

Group size ranged from 1 beluga to 34 belugas (Figure 10), the average group size was 3 in July (n=3), 5.6 in August (n=43), 4.1 in September (n=12), and 5.5 in October (n=51).

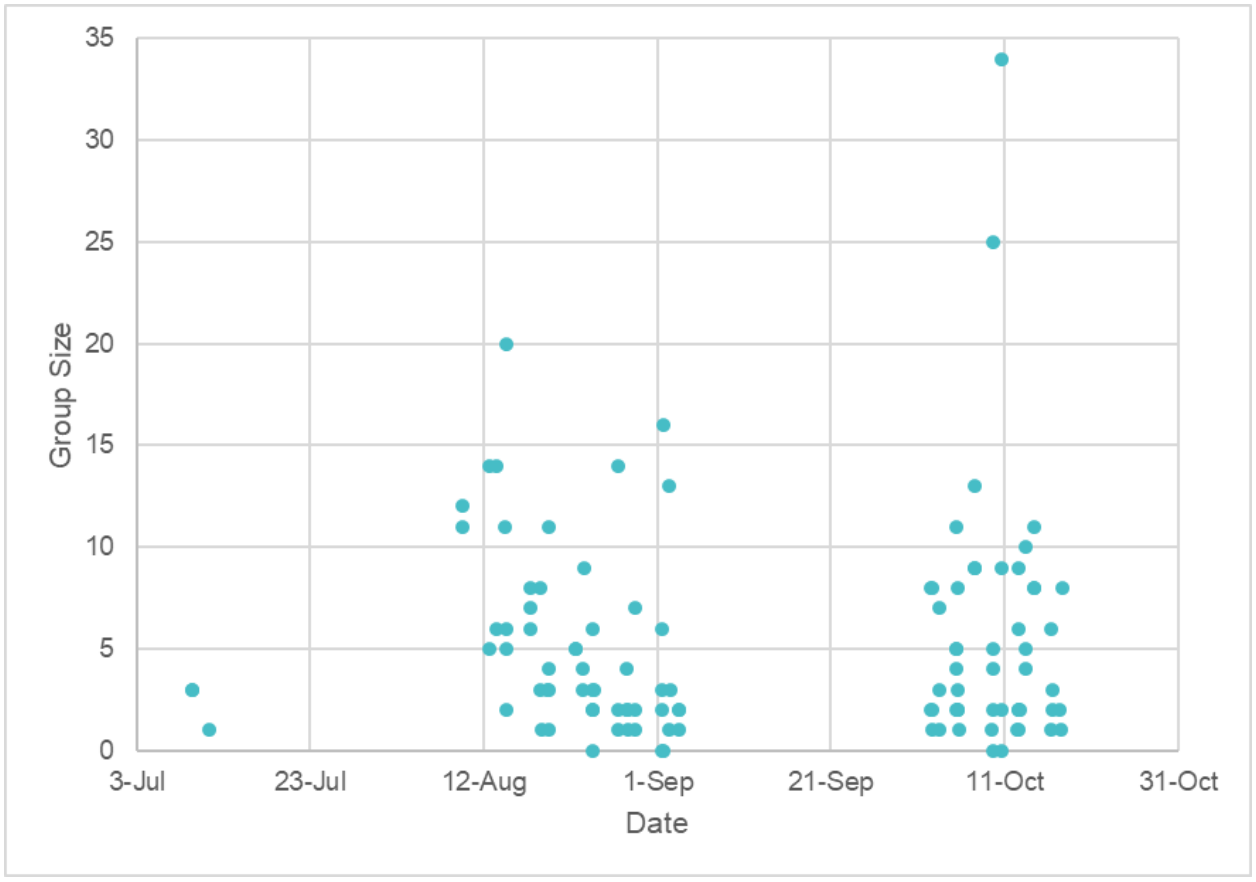


Figure 10. Beluga sighting group size during NMFS monitoring effort from July 9 - September 3 and October 2-17, 2022.

Group Composition

The observers counted the number of white, gray, and calf beluga whales in each sighting. No neonates were recorded and the observers were able to classify all individuals, removing the need for the "unknown" category. The total number of belugas observed and the percentages of each classification are presented below in Table 5 and Figure 11.

Photo credit: Tori Horsley

Beluga color classifications are defined as follows:

- White: large, bright white to dull white
- Gray: large (larger than calves), light to medium gray
- Calf: dark gray, small (⅔ the total length of white belugas), almost always swimming within one body length of a larger whale
- Unknown color: any beluga not confidently identified in the above categories
- Neonate: newborns (estimated to be hours to days old, based on extremely small size (1.5 m), a wrinkled appearance due to the presence of fetal folds, and uncoordinated swimming and surfacing patterns
- Unknown: any beluga not confidently identified to one of the above categories

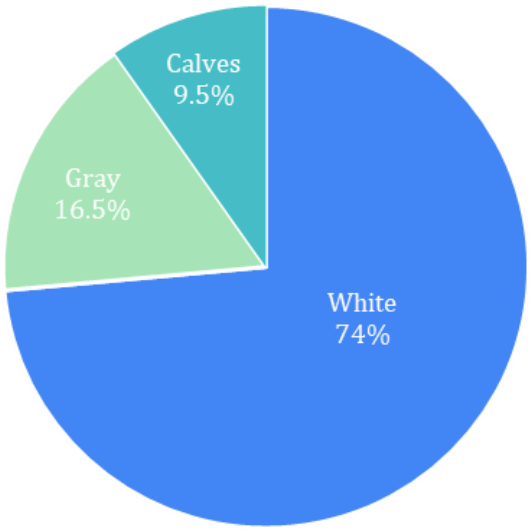


Figure 11. Overall beluga group age class composition during the monitoring season

Table 5. Beluga group age class composition by month

	White		Gray		Calf		Total
	#	%	#	%	#	%	
July	7	100	0	0	0	0	7
August	178	74	42	18	19	8	239
September	34	69	9	18	6	12	49
October	204	73	45	16	31	11	280
Total	243	74	96	16.5	56	9.5	575

Sighting Duration

The duration of a beluga group sighting ranged from <1 to 380 minutes (Figure 10), sometimes groups of belugas were only seen surfacing once. The duration a group was observed was longer during August and September but also ranged up to 250 minutes in October.

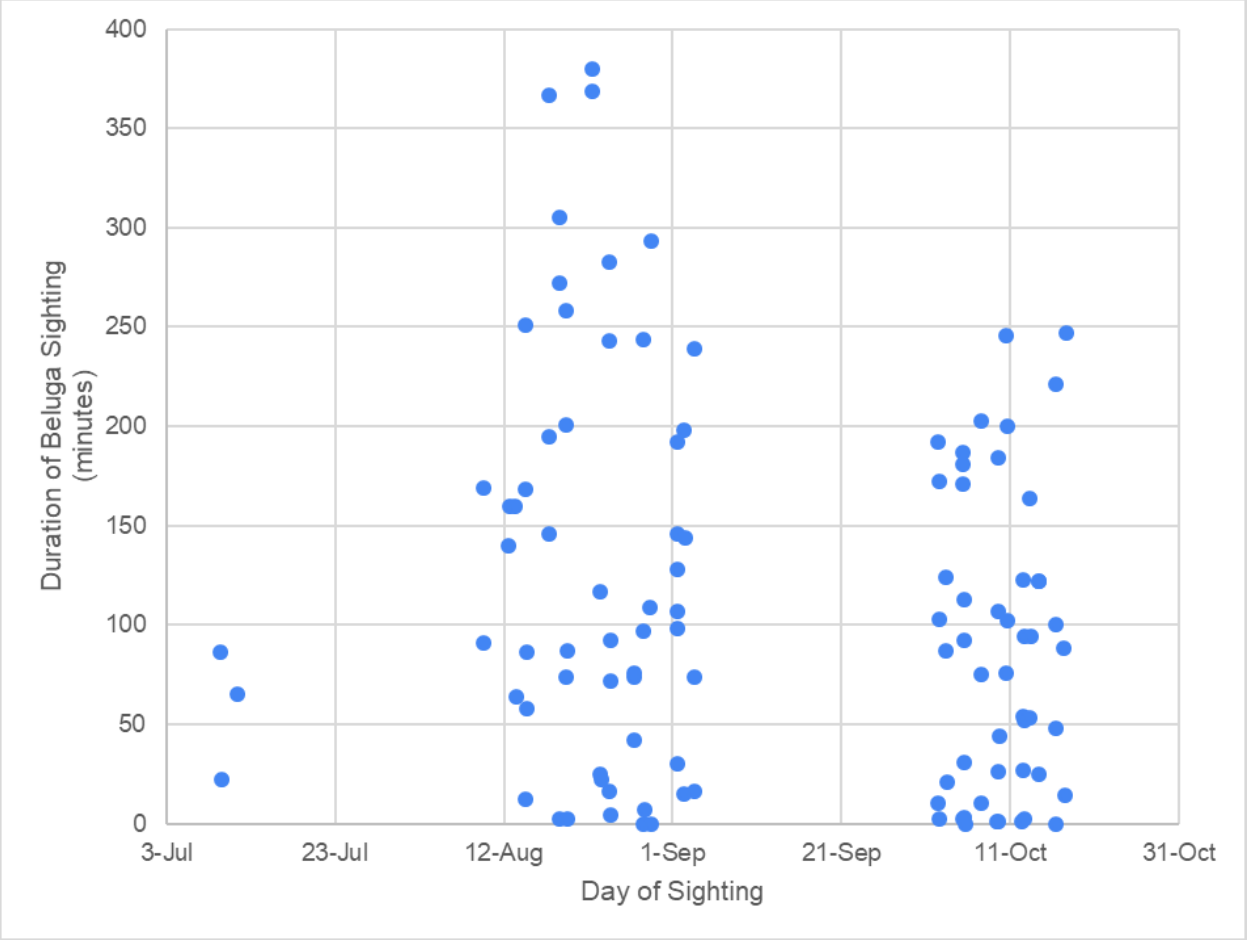


Figure 12. Beluga whale sighting duration

Behaviors

Traveling and milling were the only primary behaviors recorded during the monitoring season, with traveling observed significantly more than milling in all months (Table 6). In total, traveling was recorded as the primary behavior for 87 out of 109 groups (80%). Five behaviors (milling, traveling, tail waving, feeding suspected, and other), as well as "none", were recorded as secondary behaviors during the monitoring season (Table 6; Figure 13). "None" indicated that there was only one behavior, the primary behavior, observed. The observers described the one "other" behavior documented in August as extensive splashing and maneuvering by a group of nine whales. Milling was the predominant secondary behavior observed during the season, particularly in July and August.

Table 6. Beluga primary and secondary behavior categories by month

		July		August		September		October		Total	
		# of Groups	%	# of Groups	%	# of Groups	%	# of Groups	%	# of Groups	%
Primary Behavior	Traveling	3	100	37	86	9	75	38	75	87	80
	Milling	0	0	6	14	3	25	13	25	22	20
Secondary Behavior	Milling	2	67	28	62	4	31	19	36	50	46
	None	1	33	11	24	7	54	24	45	43	39
	Traveling	0	0	4	9	1	8	9	17	13	12
	Tail Waving	0	0	0	0	1	8	1	2	1	1
	Feeding Suspected	0	0	1	2	0	0	0	0	1	1
	Other	0	0	1	2	0	0	0	0	1	1

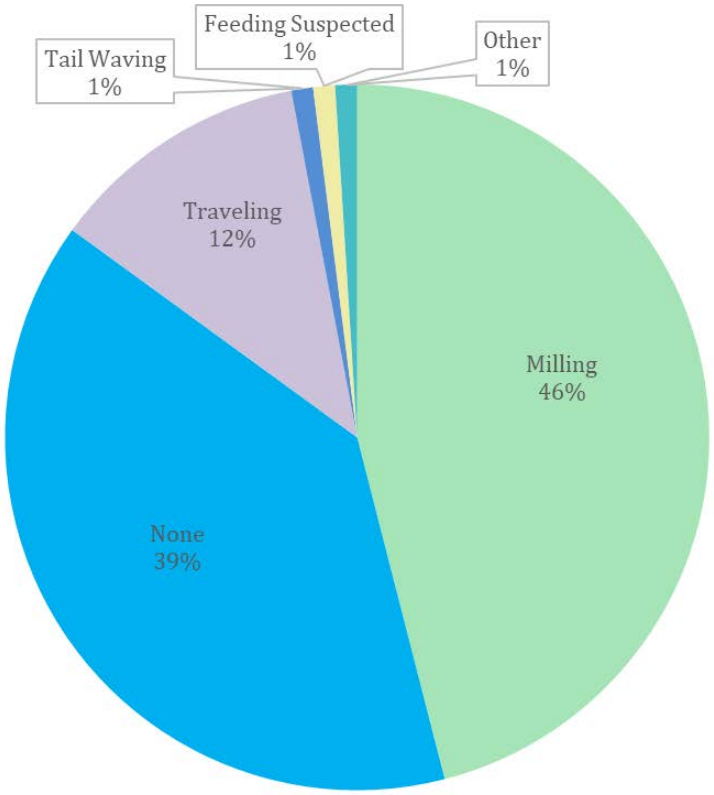


Figure 13. Overall beluga secondary behavior categories recorded during the monitoring season

Beluga Sightings and Tidal Stage

The predicted tide levels from NOAA tide station 9455920 were pre-loaded into the MS Access database and the tide stage[3], determined by an algorithm, was auto-populated in each environmental record entry. The tide stage at the initial sighting time of each group was determined, and compared to the tide stages during all observations. Beluga groups present in the monitoring area within the first 30 minutes of observation were excluded from the analysis. For low slack, low flood, and high ebb tidal stages, the proportion occurring at the time of the initial sightings of beluga groups was roughly equivalent to the proportion for all observation periods (Table 7). There was a larger difference when comparing the proportion of low ebb, high flood, and high slack tidal stages at initial sighting and overall.

Table 7. Comparison of the proportion of tidal stages during observations to proportion at initial sighting of beluga groups

Tidal Stage	Proportion of tidal stage during observations	Proportion of tidal stage at initial sighting of beluga group	Difference
Low ebb	24%	39%	15%
Low slack	13%	15%	2%
Low flood	14%	15%	1%
High flood	15%	8%	-7%
High slack	14%	7%	-7%
High ebb	19%	15%	-3%

Other Marine Mammals

Observers also documented harbor porpoise, harbor seals, Steller sea lions, and a gray whale (Table 8). All sightings of other marine mammals were of single animals except for one group of two harbor porpoise in October. Locations of these marine mammal sightings can be seen on Figures A-1, A-3, A-5, and A-6 of Appendix A.

[3] Additional information on the tide stage and algorithm can be found in Section 4: Environmental and Observation Conditions in the POA's Marine Mammal Monitoring Report (61 North Environmental 2022).

Table 8. Number of other marine mammals sighted per month

		July	August	September	October	Total
Observation Effort	Days	15	18	3	11	47
	Hours	57	70	12	81	220
Harbor Porpoise	Groups	3	1	-	4	8
	Individuals	3	1	-	5	9
Harbor Seal	Groups	4	14	8	7	33
	Individuals	4	14	8	7	33
Steller Sea Lion	Groups	-	1	-	-	1
	Individuals	-	1	-	-	1
Gray Whale	Groups	-	1	-	-	1
	Individuals	-	1	-	-	1

Discussion

Further analysis will be conducted on NMFS visual monitoring data including incorporating in NMFS acoustic monitoring data and the POA's visual monitoring data. NMFS asked all four observers a series of questions post season to help evaluate and understand several project components (Appendix B). This questionnaire was extremely valuable in providing details in this report on the methodology as well as recording anecdotal information from each observer. It is highly recommended that time is allocated to collect information from all observers for any future projects similar to this. Since NMFS will be completing additional analysis of the marine mammal sighting data, this discussion section will focus on summarizing the anecdotal information the observers provided.

Monitoring Effort Effectiveness

As mentioned in the methodology, the NMFS monitoring effort, monitored from 2 of the 4 stations also used by the POA observers. NMFS had 2 observers per station whereas the POA had 3 observers at most stations. Because NMFS observers were also POA observers, we asked the observers the following questions to document potential effectiveness issues.

- What are your thoughts on the ability to detect belugas with 2 people at a monitoring station (compared to 3 per station for the POA monitoring effort; question 2 is related)?
- What are your thoughts on the ability to detect belugas throughout lower Cook Inlet with 2 monitoring stations (compared to 4 stations for the POA monitoring)?

- Given that there were 2 people, 2 stations and the equipment provided (i.e. big eyes, binoculars, naked eye), do you feel there was adequate coverage of the water (disregarding the blindspots)?

Observers expressed that 2 people at a monitoring station was adequate for the NMFS monitoring effort. However, maintaining visual continuity of belugas (or any marine mammals) was occasionally challenging with one observer assisting with taking fixes. The observers also indicated 3 observers were needed for POA monitoring because of the longer monitoring duration (10 to 12 hours) and the implementation of mitigation measures. Three observers allowed for 2 sets of eyes to remain on the water and allow for appropriate breaks.

Observers felt like they were effective in detecting belugas with only 2 monitoring stations, however, it could take longer to detect the presence of belugas and it was challenging at times to track multiple groups of belugas. They also expressed that preferably there would be a third station at Ship Creek. Belugas seemed to congregate not only at the mouth of Ship Creek, but also tucked within the infrastructure at the Port of Alaska. The Ship Creek station during the POA monitoring had the best vantage point for these areas. The station at PCT (only used for POA monitoring) tended to only supplement Ship Creek sightings because Ship Creek had the better vantage point. Likewise, the Ship Creek station could also see around the northernmost dolphins of Port MacKenzie, oftentimes when NEX station cannot. Observers sometimes had a challenge tracking belugas as they would travel toward and mill around Ship Creek.

During POA monitoring the Ship Creek station was utilized and serviced as a handoff station or a station that tracked the belugas in the middle of the project area. Most belugas were spotted by NEX and PW, once belugas traveled down the shoreline or cut across the middle of the Inlet, Ship Creek would "handle" the sighting, allowing either the NEX or PW station to return to scanning the perimeter. During the peak beluga season it was not uncommon for NEX, PW, and Ship Creek (for POA monitoring) to be monitoring multiple groups at once, which can make it very challenging if there is no Ship Creek station.

Overall observers felt that they had adequate coverage of the water partly because of the skill set and experience the observers already had. They indicated that with the use of the theodolite, it was required to have a minimum of two people at a station. The big eyes allowed the PW station to see North of the NEX station, which gave NEX observers a heads up that belugas were headed their way. It was also noted that at NEX, it was important to take time off of the handheld binoculars and scan the water with the naked eye. There were many instances in which belugas popped up in front of the NEX station as they traveled around Cairn Point.

Accuracy of the Theodolite Locations

Theodolite measurements provide an indication of the location and movement during a group sighting but there are a few things to consider when utilizing the marine mammal sighting location information. It can be very challenging to capture a marine mammal within the theodolite viewfinder with the animal right on the cross mark, therefore, observers sometimes had to estimate where the animal last surfaced,

therefore the timing of when an animals surfaced and the time the theodolite fix was can be off by a few seconds or a minute. Also to help understand the constraints with the theodolite measurements NMFS asked observers to describe how accurate they thought theodolite fixes are for animals that are 0 - 500 m, 501 m to 1 km, 2 to 5 km, and >6 km away from the observation station in which the fix was taken from. Observers agreed the accuracy of the theodolite locations waned after 8 to 9 km and was particularly influenced by environmental conditions (i.e. visibility, distortion, glare, surface water conditions. Theodolite locations were fair to very accurate between 2-5 km, where only some adjustments had to be made, but adjustments were still within 100 m of the original theodolite measurement. Locations 501 m to 1 km were very accurate with few minor adjustments, again observers did not have to change the location by more than 100 m. Observers believe theodolite locations between 0 to 500 m away from a station were extremely accurate and if there were any adjustments they were less than 50 m away from the theodolite location.

Anecdotal Information on Beluga Behavior

Observers were asked to describe any changes in beluga behavior they observed based on the two questions below. NMFS plans to evaluate the data and these perceptions further in the cumulative analysis report.

- Have you seen any overall behavioral changes in movement or distribution during your monitoring efforts (e.g. between this year and last year, on a daily basis, throughout the season)?
- Did you see any behavioral changes in movement or distribution when pile driving or other anthropogenic activities were occurring (i.e. cargo ship arriving)?

Observers noted some variation in beluga whale behavior patterns between 2020 and 2021. Belugas appeared to travel across the Inlet and mill in the center of the inlet more in 2021. There also seemed to be an increase in cryptic/erratic behavior, such as very low-profile surfacing that makes them difficult to see at a distance. Dive times appeared longer. There were also fewer belugas seen in 2021 during the months of April through June than the previous year. During late August and into September of 2020, groups of belugas were far more likely to mill continuously at the mouth of Ship Creek throughout the day. In September of 2021, some extended milling behavior was observed at the mouth of Ship Creek, though not as regularly as the previous year. In 2021, a few recognizable belugas would mill either in the middle of the inlet between Cairn Pt and Port MacKenzie, eventually moving to mill at Port MacKenzie almost every day, and fairly predictably. Overall, there seemed to be more erratic movement during September 2021 as opposed to September 2020, with more movement in general and changing of directions.

Observers noted certain behaviors, such as floating or “logging” at the surface, spyhopping, tail-waving, and interactions with harbor seals, were observed several times this year and had not been observed in 2020. These behaviors seemed to be observed more frequently with the NMFS monitoring efforts than the POA monitoring effort.

Observers noted trends in behaviors around anthropogenic activities but also detailed variability in these patterns. Belugas seemed likely to dive, split up groups, and/or change direction when a vessel (cargo ship, survey boat, tugboat, dredge, etc.) crossed in front of them or even straight over them (this happened somewhat frequently). There were many times when smaller vessels such as the tugboats or Port of Alaska survey boats cut through groups of belugas and the whales visibly changed direction or behavior. An observer provided an example, where approximately 5 belugas had been tracked for over 2 hours traveling south from North of Port Mackenzie. The whales made it 1,000-2,000 meters from Point Mackenzie and a large cargo vessel Midnight Sun was arriving. When the vessel came within a few thousand meters of the whales, the whales quickly turned around and traveled north. Another observer mentioned that other times belugas would swim towards or alongside barges and small vessels when they were docked or idle.

Belugas also occasionally reacted to military jet activity from JBER. Belugas were notably far more likely to dive when the military jets passed overhead, especially at NEX where the noise was loud enough to require hearing protection for the observers. The belugas usually had extended dive times of 10+ minutes during these occurrences.

Beluga behaviors in relation to pile driving varied; however, multiple observers noted seeing behavioral changes specifically during impact pile driving and not vibratory pile driving. Belugas were observed sometimes changing direction, turning around, or changing speed during impact pile driving. There were numerous instances where belugas were seen traveling directly towards the POA during vibratory pile driving before entering the Level B harassment zone (POA was required to shutdown prior to belugas entering the Level B harassment zone).

Though this seemed to vary across the months, it seemed slightly more likely for belugas to show more cryptic behavior during pile driving. This also presented challenges for the mitigation aspect- with belugas frequently surfacing only once while well out of the zone without a clear direction and surfacing within the zone after 20+ minutes of not seeing them at all. POA also had out of water construction activities. Observers saw welding occurring with visible sparks above the water, on occasion the whales could be seen traveling right around the pile, below the welder.

Conclusion

As mentioned above this report focuses on capturing the methodology and preliminary results of the NMFS monitoring effort. NMFS visual and acoustic monitoring data and POA monitoring data will be analyzed to address the objectives of this project and come to any conclusions on the effects of anthropogenic activities on CIB.

Acknowledgements

Thank you to the NMFS Alaska Region for funding this project. This project was successful because of the skilled and experienced observers that had a great attention to detail. Thank you to our observers Tori Horsley (lead observer), Jessica Roberts, Thomas Droz, Olivia Kavanaugh, and Neil Walsh. Jessica Roberts also created GIS figures for this report. This project could not have occurred without the support of the POA and Pacific Pile and Marine, who allowed us to access POA property and utilize the monitoring stations used for POA monitoring. Finally thank you to 61 North for allowing us to rent equipment and their marine mammal data collection platform.

Appendix A

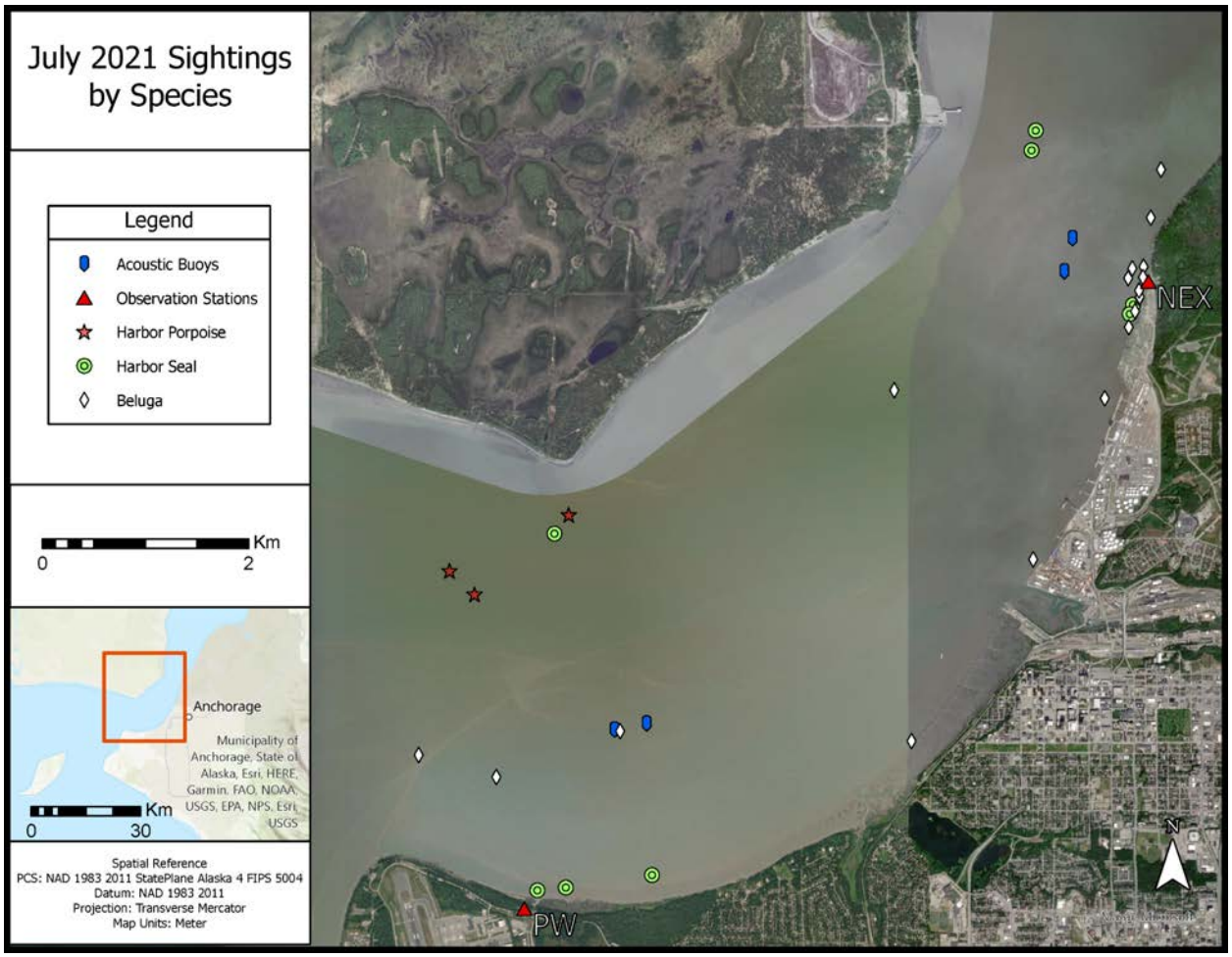


Figure A-1. July marine mammal sightings

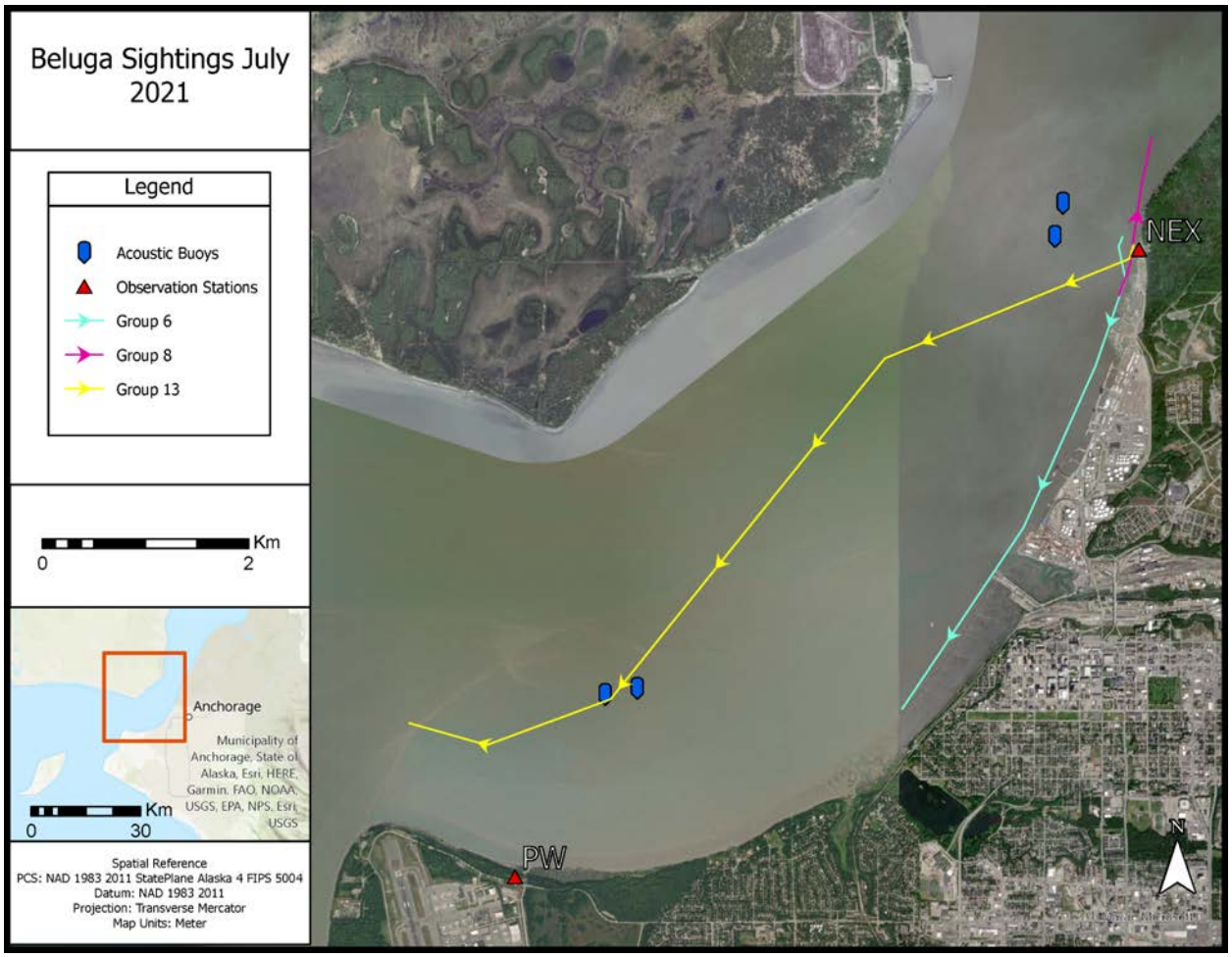


Figure A-2. July beluga whale sightings and tracklines

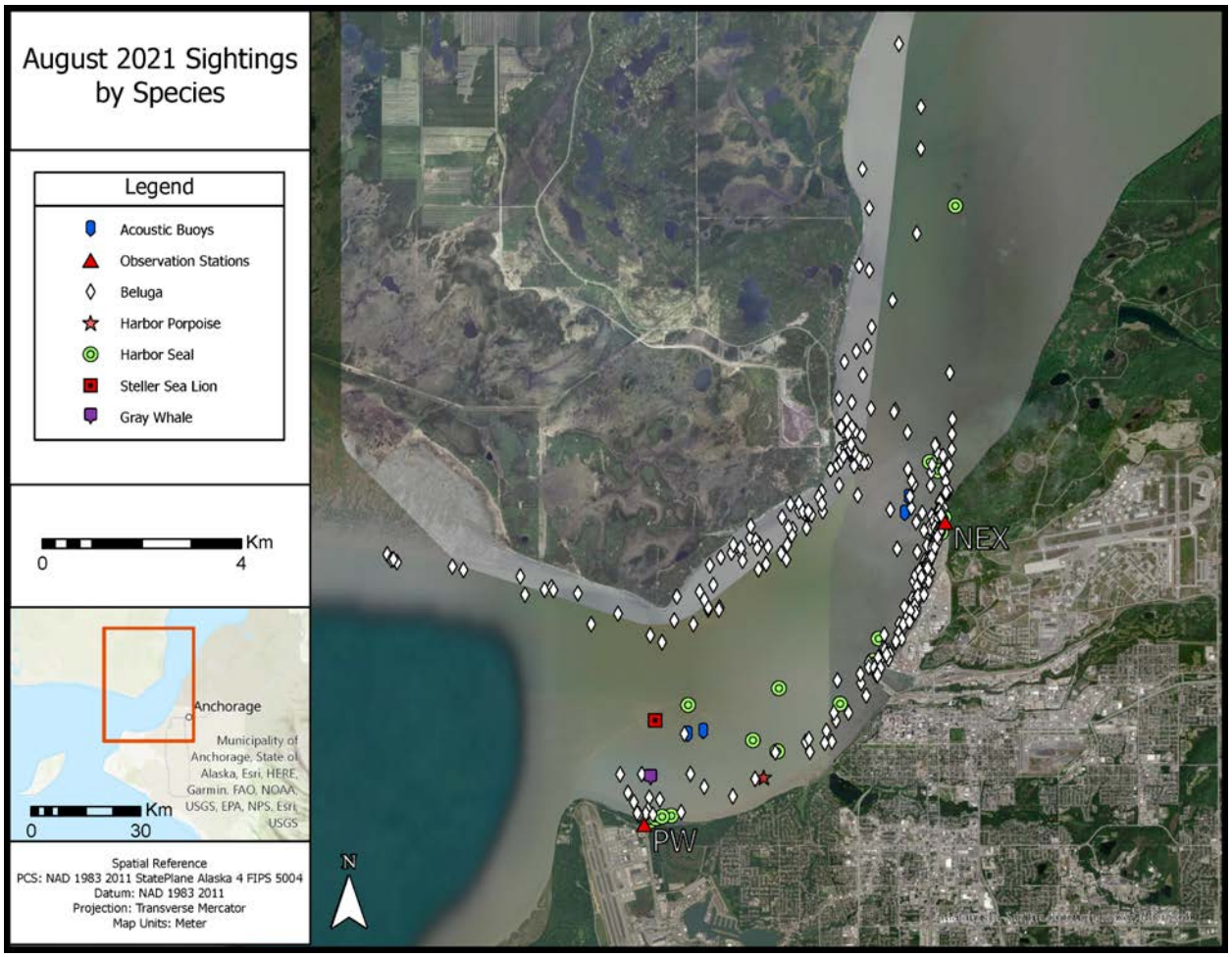


Figure A-3. August marine mammal sightings

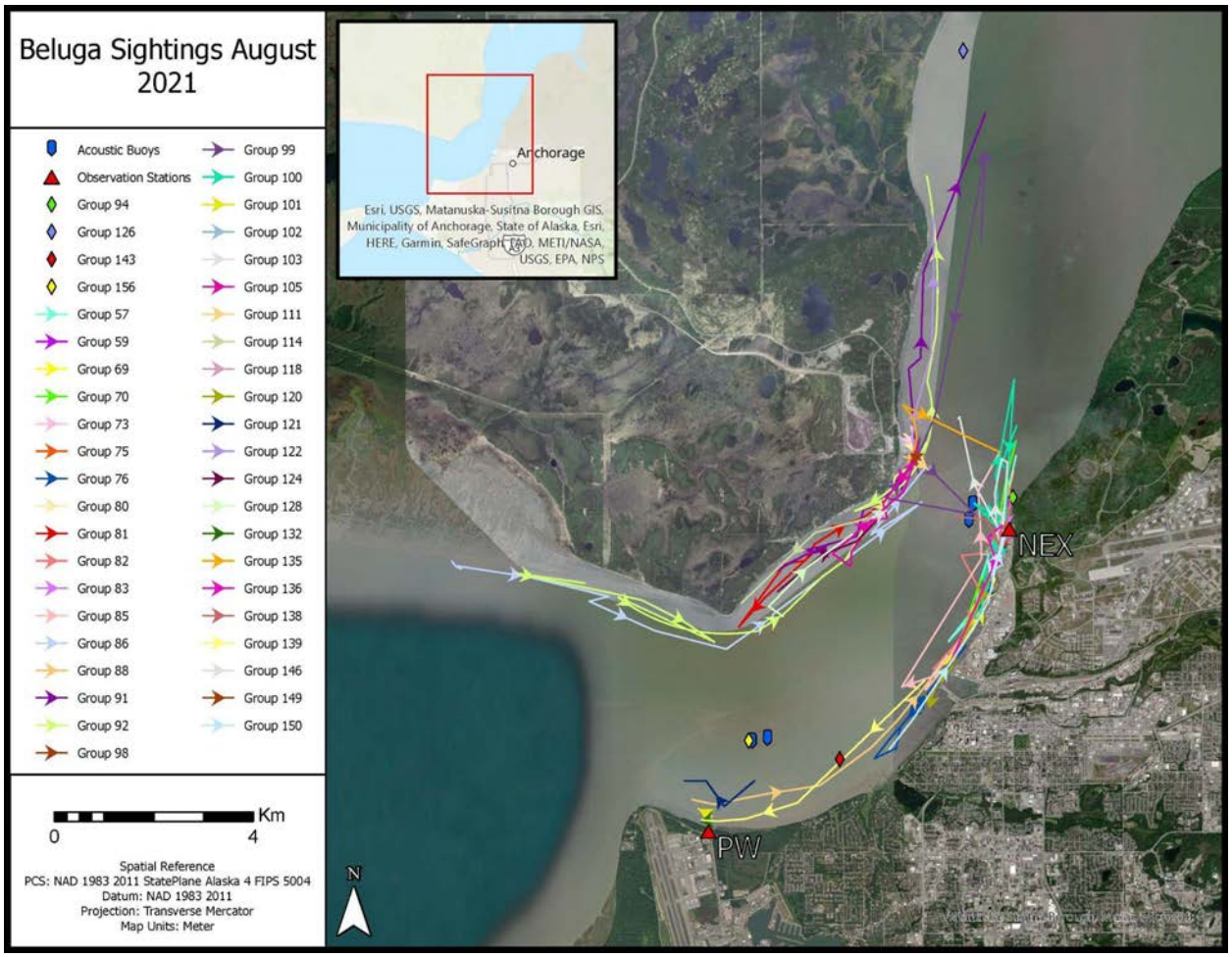


Figure A-4. August beluga whale sightings and tracklines

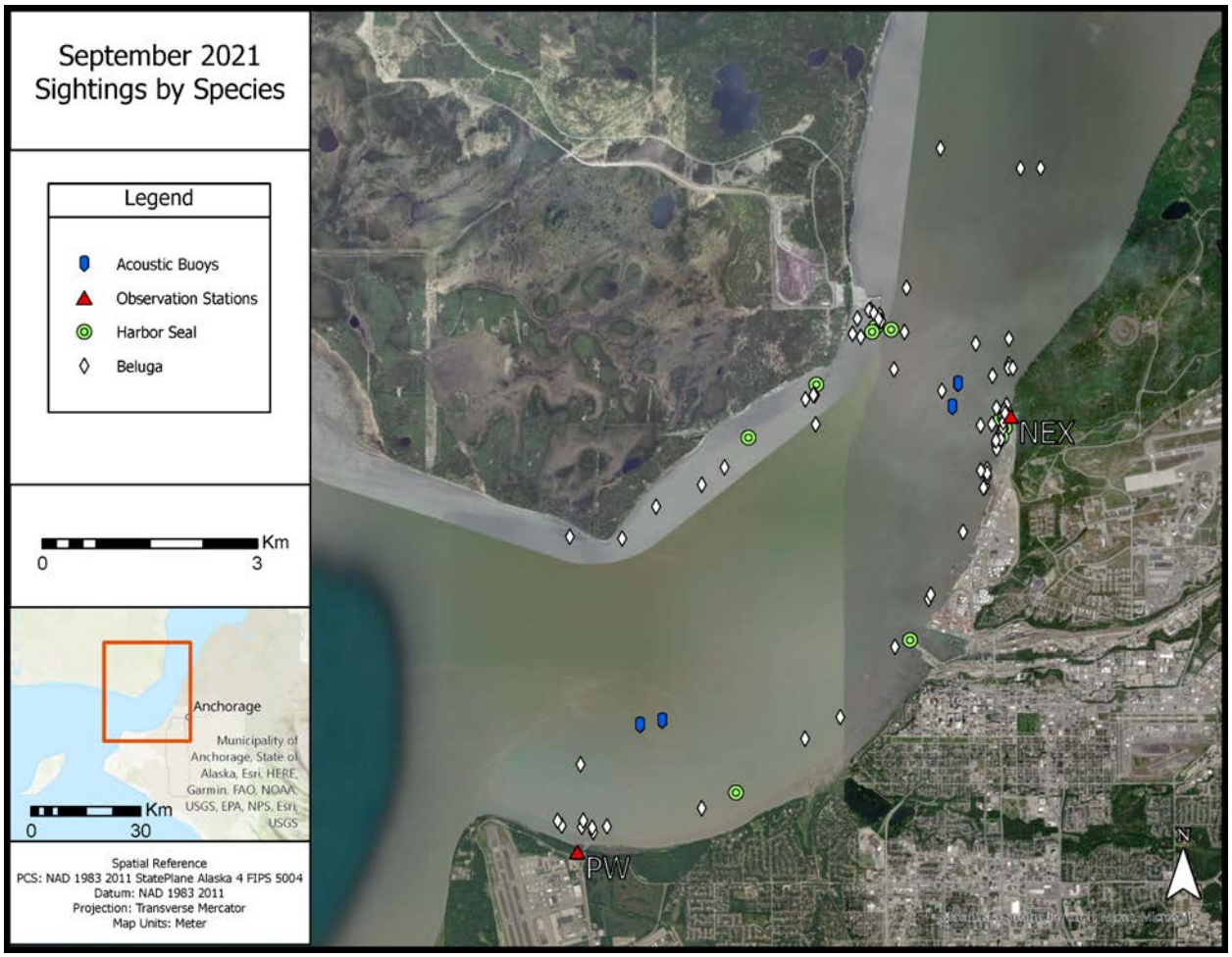


Figure A-5. September marine mammal sightings

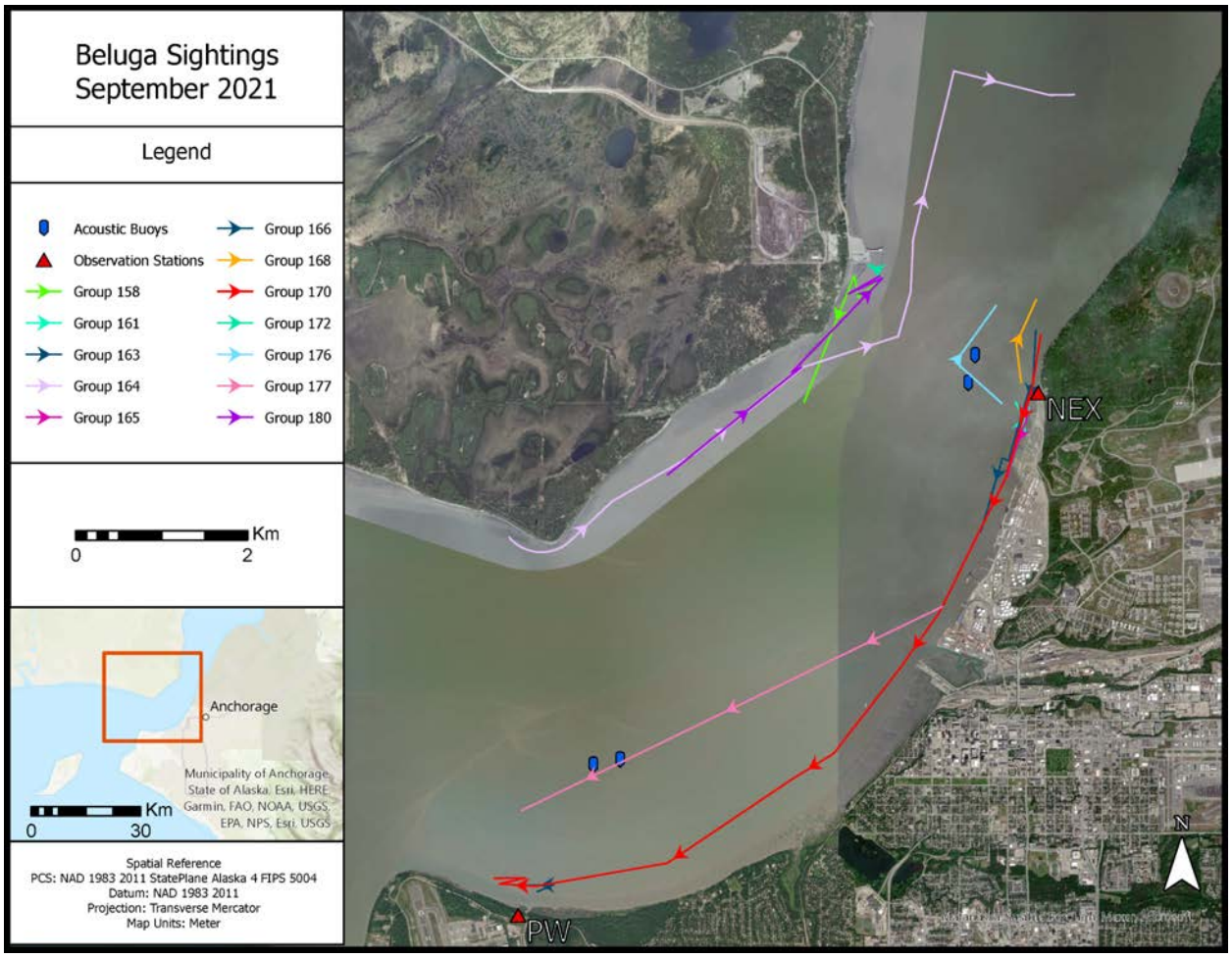


Figure A-6. September beluga whale sightings and tracklines

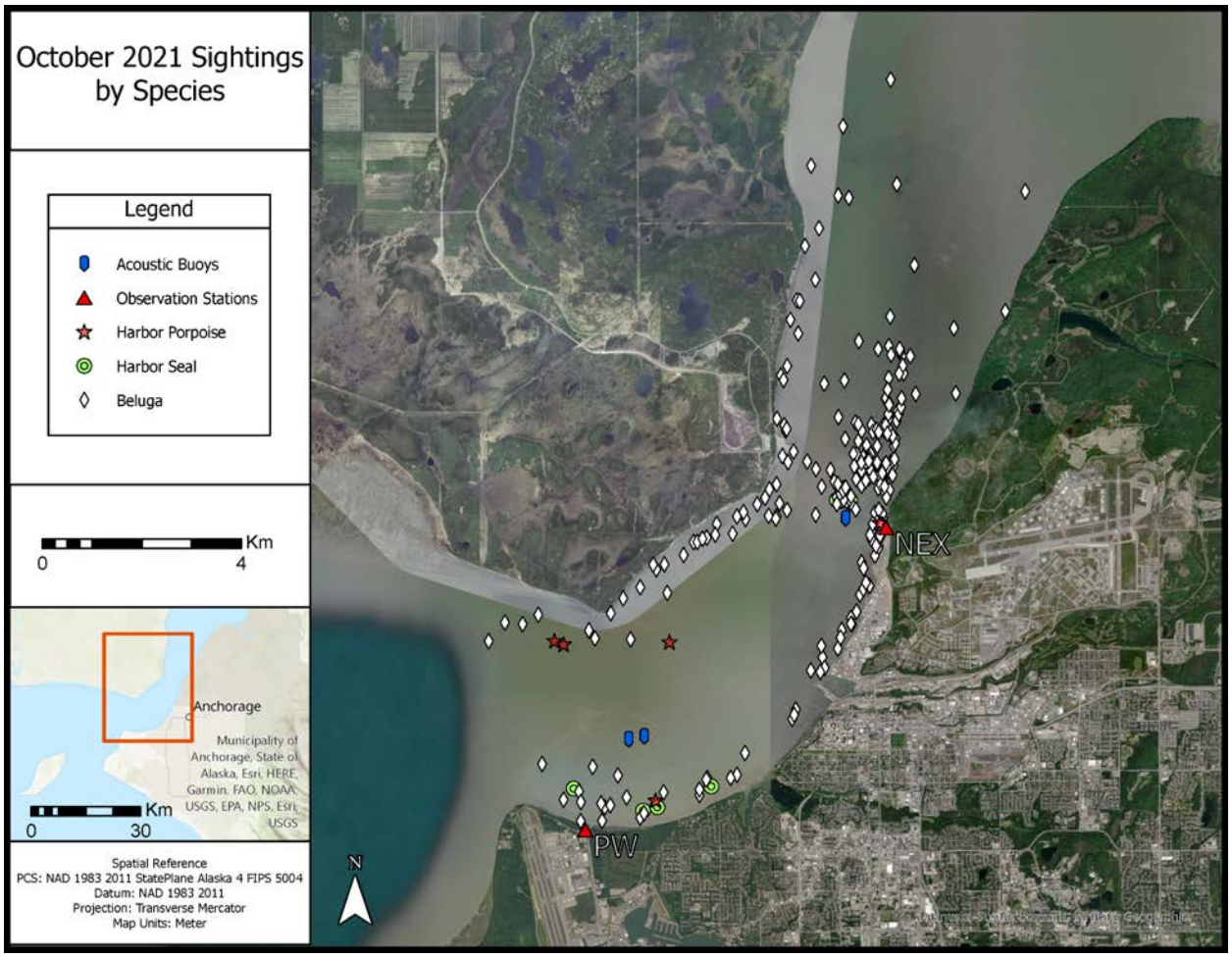


Figure A-7. October marine mammal sightings

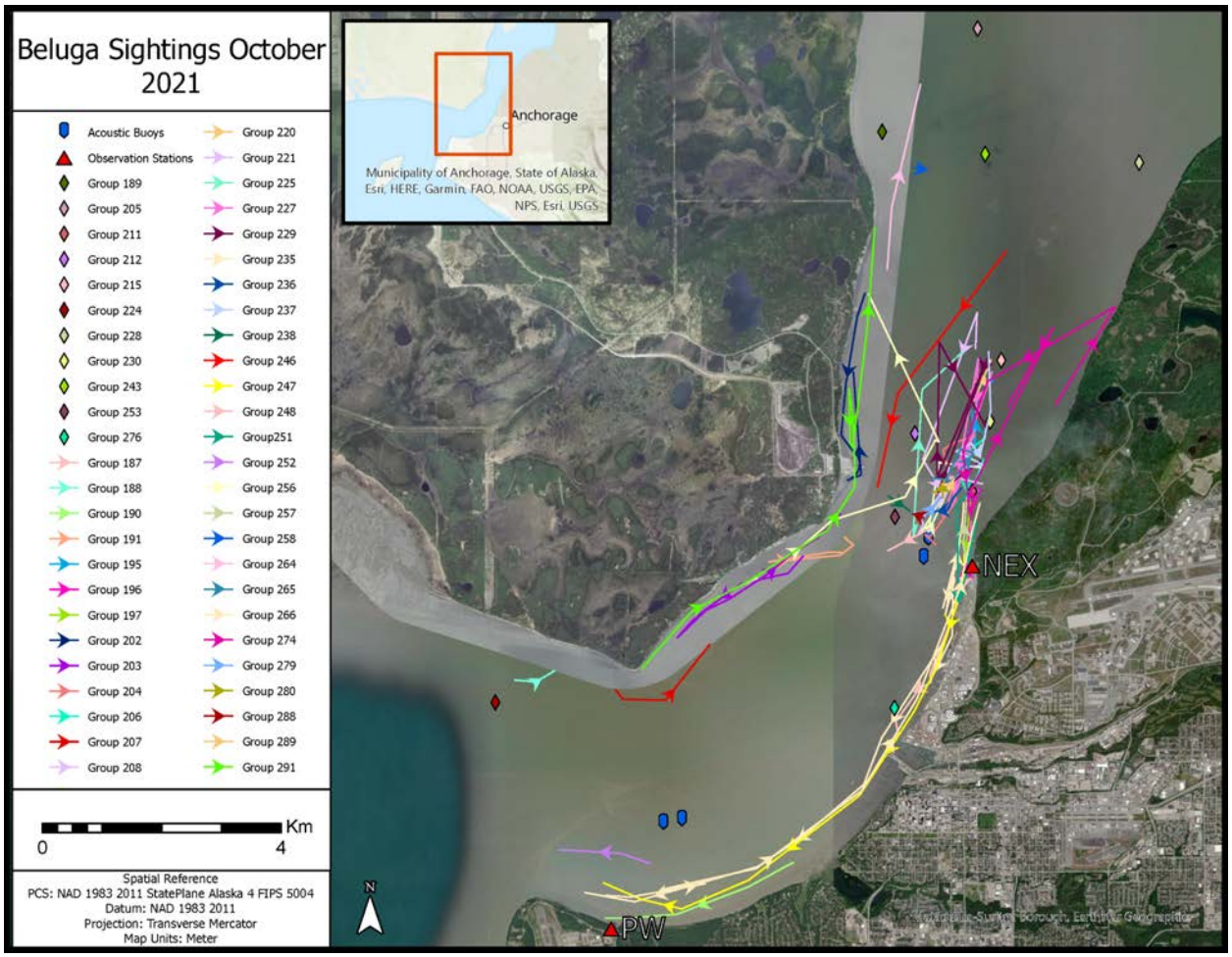


Figure A-8. October beluga whale sightings and tracklines

Appendix B

Observer Questionnaire

NMFS Port of Alaska Visual Monitoring Study NOAA Fisheries Alaska Region

October 2021

You are being asked to record up to 4 hours on your timesheet to answer the following questions. But please do not charge more than 40 hours a week, so you may need to spread your effort to answer these questions.

Please be as detailed and thorough as possible and consider including your knowledge and experience from all of your monitoring efforts near the POA. Outlining if there are differences in approach between POA monitoring and NMFS monitoring.

1. What are your thoughts on the ability to detect belugas with 2 people at a monitoring station (compared to 3 per station for the POA monitoring effort; question 2 is related)?

2. What are your thoughts on the ability to detect belugas throughout lower Cook Inlet with 2 monitoring stations (compared to 4 stations for the POA monitoring)?

3. Given that there were 2 people, 2 stations and the equipment provided (i.e. big eyes, binoculars, naked eye), do you feel there was adequate coverage of the water (disregarding the blindspots)?

4. Have you seen any overall behavioral changes in movement or distribution during your monitoring efforts (e.g. between this year and last year, on a daily basis, throughout the season)?

5. Did you see any behavioral changes in movement or distribution when pile driving or other anthropogenic activities were occuring (i.e. cargo ship arriving)?

6. The following questions pertaining to theodolite fixes will help us understand any difference between the data and the actual location of the animals when analyzing the data.
    a. Please describe how fixes are taken and any time delay from when the position of the theodolite is secured and the fix is taken.

    b. Describe how accurate you think theodolite fixes are for animals that are at the following distances from the observation station in which the fix was taken from?
        i. 0 - 500 m
        ii. 501 m - 1 km

iii. 2 - 5 km
iv. > 6 km
v. Is there a distance at which you think the theodolite fixes are not very reliable, if you have not already indicated in a-d?

c. Describe the blindspots (e.g. platform posts) with the theodolites considering we are only utilizing two stations.

d. Describe determining which animal the fix should be taken on in the group. Describe any differences in the monitoring effort for the POA versus NMFS.

7. You gave us information on blindspots at the beginning of the season (provided below), do you have any additional comments or information on blindspots.

8. Please explain what influenced your decision to split or join groups (a distance, time).

9. Please share any other information you think is relevant when looking and interpreting the data set.

Blindspot Information Provided on July 11, 2021

Here are some visuals we put together to help highlight areas where the belugas seem to frequent, or mill, or become blind spots where we lose visual.

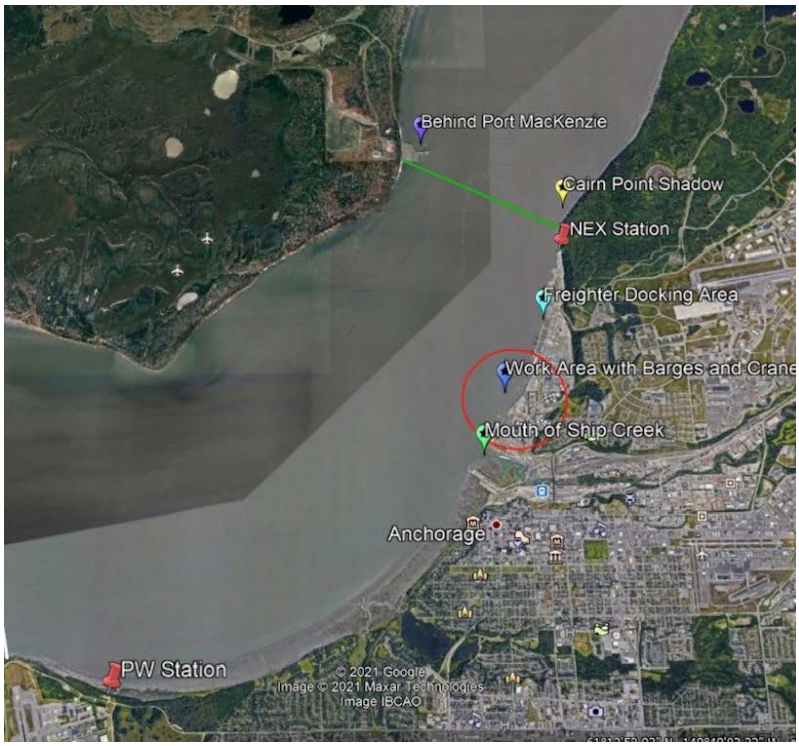
NE station cannot see past or around Cairn Point, and usually pick up a visual of belugas traveling south as soon as they round that corner-but PW station can see further into that area.

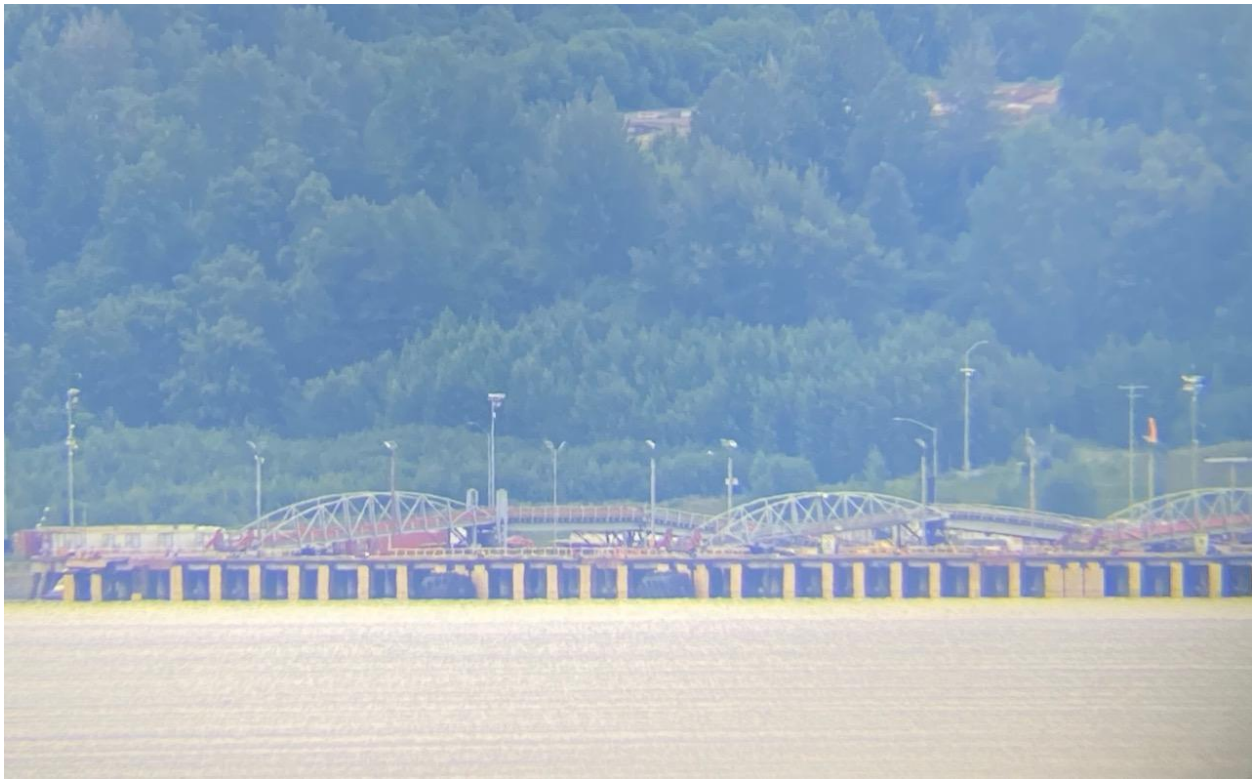
The area behind Port Mackenzie is an area where the belugas frequently mill, and NE station can usually maintain visual of them in that area.

The Freighter Docking area is where we consistently lose visual of belugas. Usually whales traveling south past NE heading into the POA area will tuck in there and we aren't able to track them for periods of time.

The area directly in front of the construction zone where pile installation is occurring is another area where we have a tendency to lose sight of belugas temporarily. With the amount of vessels moving around and the maze of piles, they are difficult to track within that area.

Lastly, the belugas seem to frequent the mouth of Ship Creek. They exhibited that preference last year, and have continued to appear there this year-so it's definitely a hot spot area.





Freighter Dock

South Freighter Dock

POA PCT Dock Construction