Cook Inlet Beluga Whale, *Delphinapterus leucas,* Observations near Anchorage, Alaska Between 2008 and 2011: Results from a Citizen Scientist Project

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Introduction

The endangered Cook Inlet beluga whale, *Delphinapterus leucas*, frequents the waters of the Anchorage Coastal Wildlife Refuge (ACWR) and has often been seen by observant local residents feeding near the Campbell Creek estuary (Carlson[1]). Belugas spend much of their time when the inlet is ice-free in relatively shallow waters near rivers in upper Cook Inlet where prey availability is high and the risk of predators is low (Moore et al., 2000). The proximity of the refuge to Anchorage, Alaska's largest city, increases use of the refuge and its natural resources for both public education and recreational enjoyment, making them vulnerable to human impact. Cook Inlet belugas have a tendency toward site fidelity in summer (Rugh et al., 2010), and with perilously low population numbers, this stock is at risk for loss of genetic diversity, which may impact the health of the species (Hobbs et al., 2015a; O'Corry-Crowe et al.[2, 3]).

Friends of the Anchorage Coastal Wildlife Refuge (FAR) is a 501(c)(3) nonprofit organization of citizens and professionals whose mission is "To preserve the integrity and biological diversity of the Anchorage Coastal Wildlife Refuge." Many mammals, fish, one amphibian, numerous species of invertebrates, and at least 220 species of birds visit or live in or near the ACWR. This refuge is part of a recognized Important Bird Area (IBA) of continental importance (National Audubon Society[4]). The refuge hosts a wide variety of flora providing for specific habitat requirements of wildlife (ADFG[5]). FAR believes that more collaboration between all researchers and resource managers will be useful in compiling data on vulnerable species, with the hope that the amassed information will help guide coastal

[1]Carlson, B. S. Friends of the Anchorage Coastal Wildlife Refuge (FAR), Alaska. Personal commun., 2011.

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[2]O'Corry-Crowe, G. M., C. Bonin, and A. Frey. 2007. Molecular genetic analysis of population structure, dispersal and gene flow of beluga whales, *Delphinapterus leucas*, in the western nearctic: new findings on the Cook Inlet population. Unpubl. rep. to Natl. Mar. Fish. Serv., Alaska Reg. Off., 25 p. Avail. from NMFS Alaska Reg. Off., Off. Protected Resour., 709 West 9th Street, Juneau, AK 99802-1668.

[3]O'Corry-Crowe, G. M., R. S. Suydam, R. Hobbs, L. Quakenbush, and B. Mahoney. 2008. Molecular genetic analysis of population structure, dispersal and gene flow of beluga whales, *Delphinapterus leucas*, in the western nearctic: new findings on the Cook Inlet population. *In* Alaska Mar. Sci. Symp., Jan. 20-23, 2008, Anchorage, AK, p. 136. (Retrieved 15 Mar. 2012 from http://doc.nprb.org/web/symposium/2008/Abstract%20Book%202008.pdf).

[4]National Audubon Society 2012. Important bird areas in the U.S. (accessed 11 Apr. 2012 from http://web4.audubon.org/bird/iba/).

[5]ADFG. 1991. Anchorage Coastal Wildlife Refuge Management Plan. Prep. by Div. Habitat Wildl. Conserv., 333 Raspberry Road, Anchorage, AK 99518-1599. (Avail. online at https://www.adfg.alaska.gov/static/lands/protectedareas/_management_plans/anch_coastal_management_plan.pdf).

ABSTRACT—The Anchorage Coastal Beluga Survey (ACBS) is an independent survey effort staffed by trained citizen scientists. It was developed and run by Friends of the Anchorage Coastal Wildlife Refuge (FAR), in collaboration with the NMFS Alaska Regional Office, National Marine Mammal Laboratory, Defenders of Wildlife, and the Alaska Center for the Environment. After consulting with key biologists, the survey was designed to help fill data gaps by prioritizing needs according to desired information, available resources, and selecting appropriate shore-based sites. Survey goals were to document the presence, absence, color, numbers, and behavior of beluga whales, Delphinapterus leucas, *and to create an archival record of beluga observations along the coast of Anchorage. Trained volunteers recorded information during daylight hours of ice-free months between 2008 and 2011, counting the number of whales in groups during survey shifts and did not identify individual belugas, so individuals were likely observed multiple times within and across seasons. Over 4 years and a total of 444 observation hours, the ACBS project documented 77 groups of belugas with a total of 507 beluga whale sightings, of which 31 included calves. Opportunistic reports made by ACBS volunteers during non-survey hours included an additional 29 groups of belugas with a total of 101 whales sighted, of which 12 sightings included calves. Volunteers documented the greatest number of sightings when FAR scheduled the survey to coincide with predicted fish runs and higher tides. During this scheduled survey the only other land-based beluga documentation projects in the given areas were a required observer project near Ship Creek for the Port of Anchorage work and, between August–November 2011 and April–July 2012, the Point Campbell overlook project for Cook Inlet Regional Incorporated's potential development of Fire Island. NMFS Alaska Regional Office has utilized the data and ACBS project information during permitting activities in the Anchorage area. This survey has helped increase public awareness and education and provided citizens with unique opportunities to actively contribute to the base of knowledge about Cook Inlet beluga whales.*

resource development and positively impact the recovery of the Cook Inlet beluga stock.

Between 2000 and 2012, FAR volunteers reported or helped with the logistics and labor regarding 26 dead marine mammals, most of which were beluga whales, washed up in the ACWR. In 2006, after 6 years of finding dead beluga whales stranded in the ACWR, FAR initiated a volunteer beluga monitoring study to document the presence of belugas along the Anchorage coastline and to provide scheduled scanning for strandings. The Anchorage Coastal Beluga Survey (ACBS, also referred to as "the survey") was developed as an independent land-based project staffed by trained citizen scientists. The survey was an outgrowth of relevant local knowledge and concern for Cook Inlet belugas shared by Anchorage residents based on their observations over the decade preceding the survey.

"Citizen Science" has been defined as nonprofessional persons engaging in scientific investigation that may be either hypothesis-driven, monitoring to be later used to test a hypothesis, or observations on natural history (Miller-Rushing et al., 2012). FAR volunteers, some of whom assisted National Marine Fisheries Service (NMFS) enforcement investigations, necropsies, and salvage for educational and scientific purposes, welcomed the formation of the survey. Citizen science programs such as the North American Breeding Bird Survey, North American Bird Phenology Program (part of the USA National Phenology Network), the U.S. National Weather Service's Cooperative Observer Program, and Izaak Walton League's Save Our Streams (water quality monitoring) have successfully collected data for use by professional scientists and used to shape policy and management decisions (Miller-Rushing et al., 2012). For survey volunteers, the opportunity to gather data that might contribute to policy decisions was important considering the Cook Inlet beluga was listed as "endangered" the year the survey began. Citizen science allows the use of more types of information for political decision-making and increases the opportunity for many perspectives to add their efforts to the collection of data for the support of policy decisions. (Freitag and Pfeffer, 2013).

The ACBS is a "co-created" collaborative citizen science project designed by interested FAR volunteers, with input from beluga and other scientists, to be conducted by public volunteers (Bonney et al.[6]). The data collected during the survey were chosen based on feedback FAR received from researchers and policy makers who wanted to fill data gaps on presence and absence of Cook Inlet belugas in coastal waters. The goals of FAR's survey were to monitor and document beluga activity in Anchorage coastal waters and to share the resulting information with NMFS, Alaska Department of Fish and Game (ADFG), and other parties interested in the science and well-being of Cook Inlet belugas. The survey gathered information on the occurrence, color, numbers, and behavior of belugas along the Anchorage coast, and created an archive of data for reference purposes.

As one objective supporting the goals, FAR also wanted to increase awareness of, and education about, Cook Inlet belugas and their habitat through educating volunteers who would then do public outreach. FAR knew that the presence of wildlife documentation crews posted along the coast would increase interest and curiosity about belugas by the public and believed that it would also make citizens more willing to consider how the actions of ordinary people might help enable this endangered population to recover. With trained citizen scientists on site collecting data and sharing information with other citizens to increase awareness, it was believed that the survey could also promote stewardship of the Cook Inlet beluga and the habitat upon which they depend. FAR's shared outreach highlighted specific actions, such as supporting clean waterways, avoiding motor boating near belugas, or paying more taxes for better waste water treatment, hoping that if citizens were more cognizant of the plight of the beluga they would be more willing to do what they could to help affect positive change. Finally, although the survey was designed to document real-time beluga sightings, an additional objective was training observers to scan for and report any live or dead strandings of marine mammals during scheduled shifts, thus providing oversight of these survey locations during the project.

In addition to sightings data collected, the survey database included incidental sightings reported by volunteers and the public that occurred outside of scheduled survey shifts. This paper covers the basic methods and results of the ACBS from 2008 through 2011.

Methods

Survey Sites

Survey sites were selected based on Cook Inlet beluga data desired by research and management institutions, usefulness in helping meet project objectives, relevance to the lead organization's mission, and personnel available to meet staffing needs for each. Of 27 initial possible survey sites, 9 were selected. An additional 3 supplemental sites were selected to collect desired data, for a total of 12 sites. FAR also collected data from more than 20 localities of incidental sightings; some were project sites (between survey sites or off-survey time) and others were simply places where informants observed belugas and reported them to FAR. Figure 1 shows a list of dedicated and supplemental ACBS sites. Some sites were selected based on their proximity to creeks or rivers expected to draw belugas (Fig. 2). When developing a model for habitat use in a marine ecosystem, belugas

[6]Bonney, R., H. Ballard, R. Jordan, E. McCallie, T. Phillips, J. Shirk, and C. Wilderman. 2009. Public participation in scientific research: defining the field and assessing its potential for informal science education. A CAISE inquiry group report. Wash., D.C., Cent. Advance. Informal Sci. Educ. (CAISE). (Retrieved April 2014 from http://informalscience.org/images/research/PublicParticipationinScientificResearch.pdf).

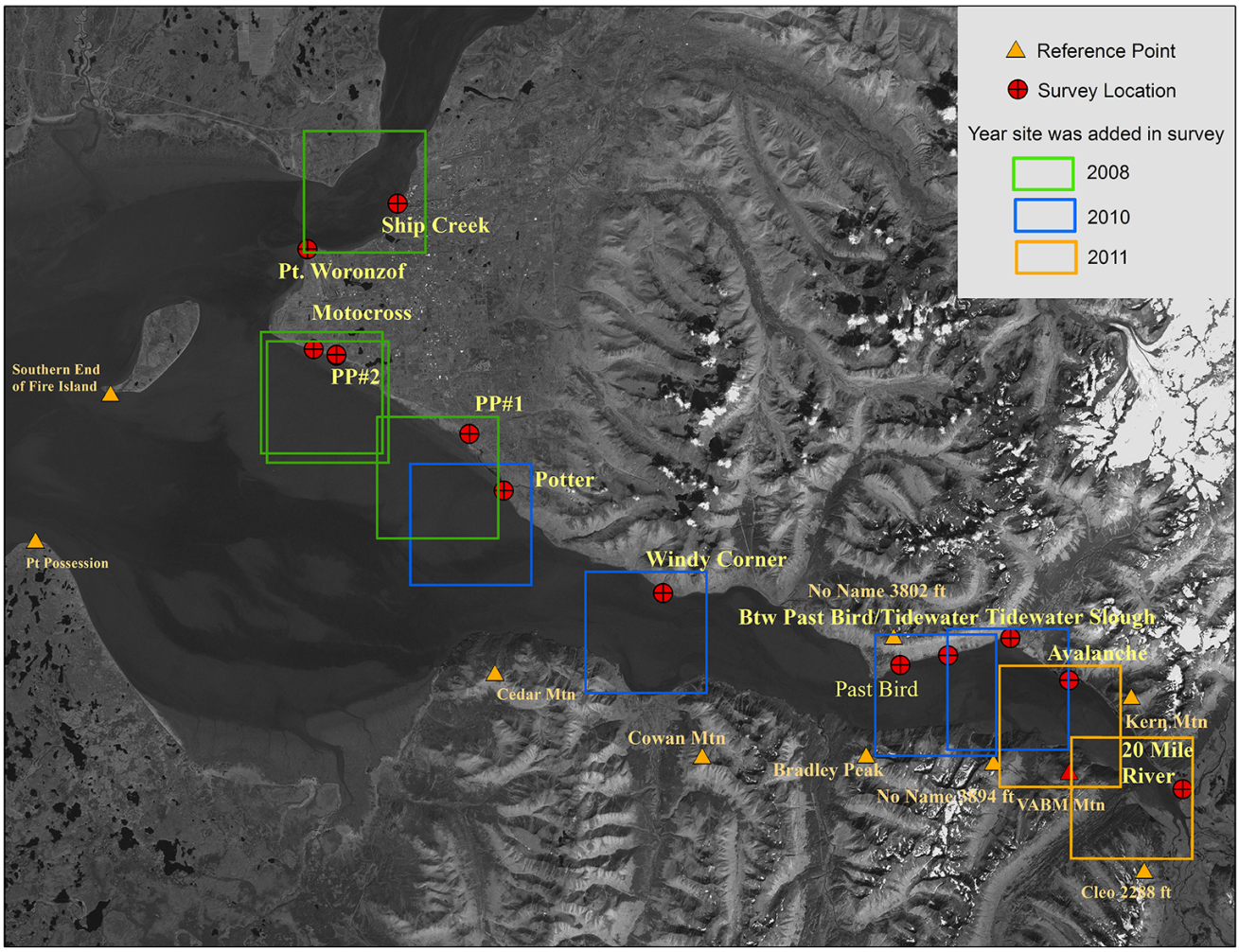

Figure 1.—Dedicated ACBS Sites: Ship Creek Boat Ramp (Ship Creek), Motocross (MotoX) Bluff, Private Property No. 1 (PP No. 1), Turnagain Arm (TA), Potter Section House (TA Potter), TA Windy Corner (TA Windy), TA first pull-out past Bird Point (TA Past Bird), TA Tidewater Slough (TA Tidewater), TA Avalanche, and TA Twenty-Mile River Boat Launch (TA 20-Mile). Supplemental ACBS Sites: Private Property No. 2 (PP No. 2), Point Woronzof Beach and Bluff (Woronzof Beach/Bluff), and Between Past Bird and Tidewater.

were found to favor medium to fast flowing rivers (Goetz et al., 2007).

Survey Scheduling

FAR scheduled surveys based on what particular data were desired, tides, daylight hours, and the number of trained volunteers available. In addition to crew leaders, two or three additional crew members were required to conduct a survey, and up to six total volunteers were allowed per shift to help individuals get survey experience. FAR sought to schedule surveys around high tides during predicted fish runs which would presumably bring belugas closer to shore and into nearby creeks and rivers where desired information could be recorded. The survey also focused on high tides because the vast majority of aerial surveys conducted by NMFS took place during low tides, so use of this near-shore area (covered with water during high tides) is less well documented (Shelden et al., 2013).

Schedules were created around daylight hours and made use of civil twilight[7] to extend observation time when days were short. This was necessary for safety and set up of equipment. Since fish availability was a consideration, site scheduling took into account neap tides for flatfish (yellowfin sole, *Limanda aspera,* and starry flounder, *Platichthys stellatus*) as well as the timing of anadromous fish runs such as eulachon (or "hooligan"), *Thaleichthys pacificus*, and Pacific salmon, *Oncorhynchus* spp.

Prior to scheduling for survey seasons, FAR reviewed the website host-

[7]Civil twilight is when the sun is between 0° and 6° below the horizon, before sunrise and after sunset, commonly known as dawn and dusk, when it is possible to see because there is sufficient light to see land features.

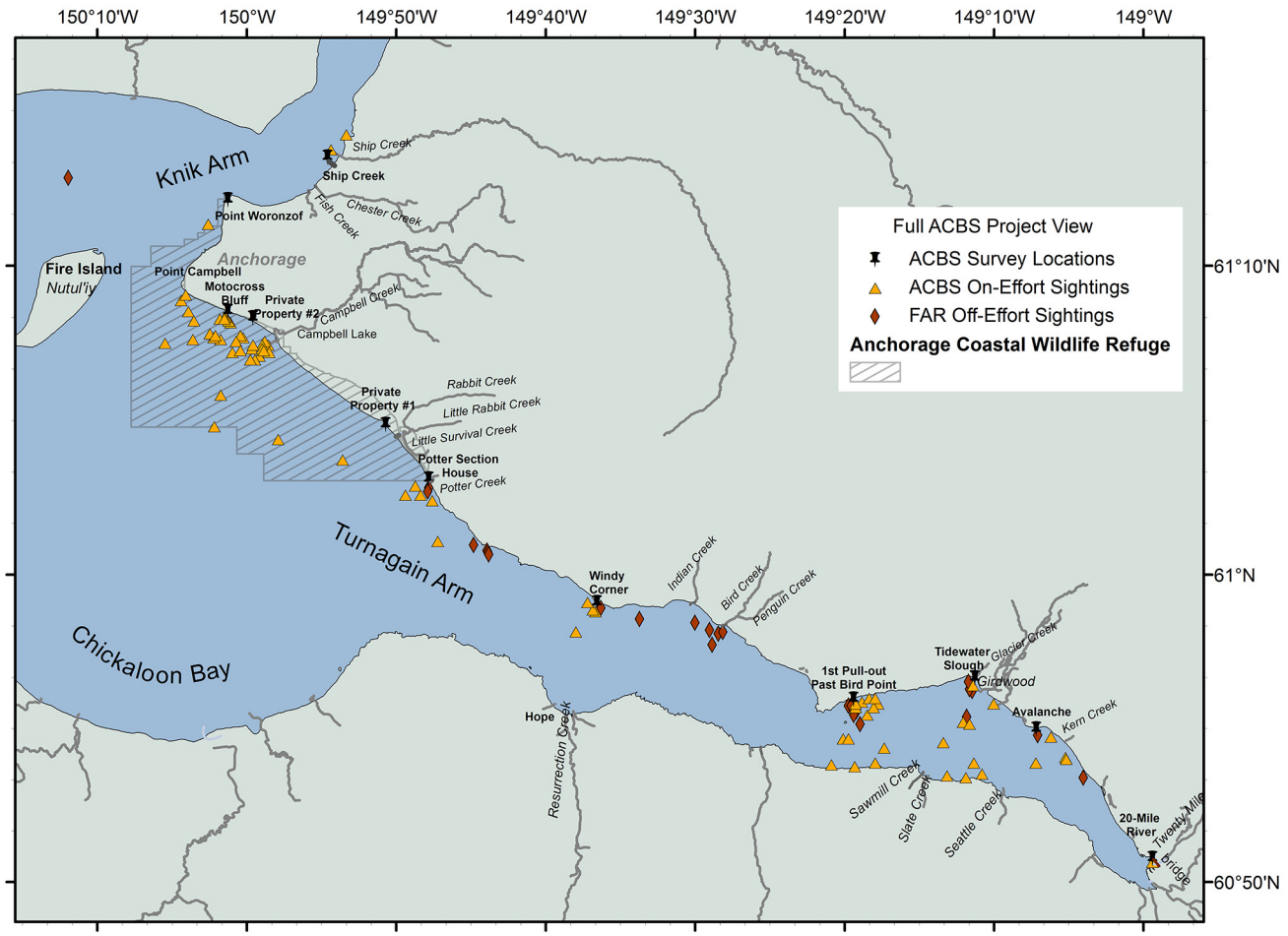

Figure 2.—Overview of Anchorage Coastal Beluga Survey study sites, dedicated, supplemental, and incidental beluga whale sightings, 2008–11.

ed by the Alaska Department of Fish and Game on Sport Fish Run Timing (ADFG[8]). More information on fish run timing was collected by emailing and/or speaking with Fish and Game department biologists regarding differences and clarifications about the project area for which few data are extant (Bosch et al.[9]). Project sites spanned from Ship Creek, near the Port of Anchorage, to Twenty-Mile River, past the town of Girdwood, and fish species, run timing (where applicable), and availability as prey differ somewhat from one site to the next. More on arrival times and places of specific species is given in Švarný Carlson and Brunner.[10]

Survey Gear

FAR minimized the amount of survey gear required so the project could be sustained at low monetary cost. After consulting with several marine mammal researchers, FAR elected to purchase equipment sturdy enough to survive weather and use by many volunteers, not be prohibitively expensive, and yet of high enough quality to meet project needs. Equipment included binoculars, spotting scope, tripod, data sheets, project maps, copy of the Beaufort Wind Scale (BF) showing both "on water" and "on land" effects, and GPS units. Field gear was stowed and maintained by the project lead and

[8]ADFG. Sport Fish Run Timing. (Anchorage, Matanuska-Susitna Fresh Water Run Timing, retrieved May 2010 from http://www.adfg.alaska.gov/index.cfm?adfg=PersonalUsebyAreaSouthcentralHerringandHooligan.regs and http://www.adfg.alaska.gov/index.cfm?adfg=fishingSportFishingInfoRuntiming.main).

[9]Bosch, D. E., M. Miller, and M. Willette. Alaska Dep. Fish Game biologists. Personal commun. with B. S. Carlson via telephone and email, spring and summer 2011.

[10]Švarný Carlson, B., and S. Brunner. 2012. Observations of Cook Inlet beluga whales, *Delphinapterus leucas*, along the Anchorage coast between 2008 and 2011. Unpubl. rep. submitted by Friends of the Anchorage Coastal Wildlife Refuge, P.O. Box 220196, Anchorage, AK 99522-0196 to Natl. Mar. Fish. Serv., Reg. Off., Anchorage, AK, p. i-227. (avail. online at http://alaskafisheries.noaa.gov/protectedresources/whales/beluga.htm).

checked out and in by crew leaders before and after each shift.

Training Citizen Scientists

Training for ACBS crews consisted of a minimum 2.5 h class, assigned reading of the Monitoring Instructions Handbook, and an orientation of survey sites and routes to assist volunteers in locating the designated sites. When possible, returning volunteers took the annual training class, otherwise they read the revisions and worked the first couple of shifts with a leader who had attended the current training session. The training presentation highlighted proper gear set-up including the use and break-down of the project spotting scope and important features of the marine binoculars. Instructors taught participants how to fill out each project form as well as how to use a compass and the Beaufort Wind Scale. For the purpose of the survey, FAR instructed volunteers to count belugas by counting only when they saw "skin" and taught methods of scanning for whales.[11]

Although volunteers were not "tested" while counting belugas, during the rigorous training sessions, participants practiced counting belugas, deciding relative sizes and colors of belugas, and documenting weather conditions shown on slides. As part of documenting beluga groups, FAR asked volunteers to watch for adults with calves and estimate the size of the calf and its proximity to the nearest adult (Litzky, 2001; Hobbs et al., 2015b). FAR also presented an overview of marine mammal species other than belugas that volunteers were most likely to encounter in upper Cook Inlet. On-site orientations were also provided at survey locations for volunteers to practice set up of equipment, familiarize themselves with the sites and landmarks referenced on project maps for optimal beluga placement, and practice scanning for belugas. Open communication with the Primary Investigator (PI) during surveys as well as a conservative approach to identifying whale groups helped increase data integrity, by repeatedly emphasizing the importance of recording as accurately as possible what was observed. Volunteers strove to achieve a consensus of numbers among observers before they recorded those data both to help increase precision and to avoid extreme high or low counts.

The Monitoring Instructions Handbook included a project summary, goals, objectives, the current season's sites, a description of the responsibility of volunteer positions, and a list of equipment required, along with detailed explanation of equipment care. The handbook provided examples of how to complete each form and discussed how to choose from a range of given responses and when to supply written but succinct descriptions. Instructions included an explanation of the scanning protocol (rotation of tasks, what the tasks entailed, a recommendation for how long a rotation should last, specific types of scans to use, and wrap-up tasks for the end of a shift).[11]

Additionally, the handbook provided a prioritized list of tasks should a stranded marine mammal be spotted (dead or alive) ensuring that observers scan purposefully during each shift for stranded marine mammals and be able to call and report the stranding to bring appropriate help to the location as soon as possible.

When scheduling crews and crew leaders, the goal was to have as many returning experienced volunteers as possible to balance crews with known attributes. The opportunity to work with experienced observers provided supervised hands-on training with the exacting tasks required for good data collection and documentation. Crew leaders used volunteers with leadership potential to help with management tasks for the crew, thus preparing volunteers for future roles in lead positions.

Data Collection

Scanning protocols directed observers to alternate scanning for belugas with spotting scope and the naked eye, or binoculars and the naked eye. Observers rotated scanning shifts every 10–15 min to limit observer fatigue and also rotated to data recording for a break, provided they had the requisite training and experience. Scanning methods could vary from scanning from left to right, moving further away from or closer to the horizon, or scanning up and down from the horizon to the shore while moving left to right. A minimum of two observers scanned at the same time during a shift.

Data collection protocols included recording specific start/end times, reporting environmental conditions during the shift, and documenting what observers saw at specific sites during the scheduled times. The shift form documented information that tied beluga sightings, the specific day, site location, time, crew, and environmental conditions (temperature in Celsius, BF, wind direction, precipitation, percentage of cloud coverage, sea conditions, and general viewing conditions); and whether live or stranded (dead or alive) belugas or if other marine mammals were seen during the shift. Volunteers also recorded the presence of other wildlife, human activity (such as dog walkers, motorized land vehicles, boats, and planes), and whether or not a formal oral history interview was conducted.

A beluga form and a map form were used to document each observed beluga group. The beluga form includes the specific site location, the date, the time belugas were observed, and which beluga group the form represents (first, second, third, etc., if more than one group of belugas was observed during that day's shift). The beluga form employed a grid number where the beluga group was spotted initially; and minimum, maximum, and best count of belugas (Funk et al.[12].), including colors,

[11]The ACBS handbook and forms are available in appendices 6.1 through 6.6 of Observations of Cook Inlet beluga whales, *Delphinapterus leucas*, along the Anchorage coast between 2008 and 2011(Švarný Carlson and Brunner, 2012), posted on the NOAA Protected Resources website. https://alaskafisheries.noaa.gov/sites/default/files/cibobservations_2008-2011.pdf.

[12]Funk, D. W., T. M. Markowitz, and R. J. Rodrigues (Editors). 2005. Baseline studies of beluga whale habitat use in Knik Arm, Upper

sizes, and proximity of calf to adult, when possible. Since Cook Inlet belugas are dark gray at birth and slowly change to lighter gray and to white as they mature, the color of individuals in a group can give information of the age classes present (Litzky, 2001; Hobbs et al., 2015a, b). Proximity of smaller dark whales to adult whales was also recorded because proximity of individuals may give insight into age classes (Krasnova et al., 2006; Hobbs et al., 2015a, b)

For data validation purposes, beluga groups were counted independently by separate observers. Although not technically a blind count, discussion of group numbers were usually reserved until all observers were able to count the beluga group multiple times. The final numbers for group size (minimum, maximum, and best) were determined by consensus between the 3–6 observers.

Some citizen science projects include procedures to test the accuracy of species identification and counts. For a Cook Inlet beluga survey, this would likely involve an aerial photograph to compare with a specific sighting count, neither of which was financially or logistically feasible for the survey. Without a way to ground-truth beluga sightings and group sizes, the more experienced or knowledgeable crew leader helped direct identification of species and determination of group size during consensus discussions.

Additionally, the PI made unannounced visits to crews on shifts to help assure data quality, during which time any errors of procedures were corrected on the spot, and notes were taken on issues with protocols. If the PI felt clarification was necessary to supplement the Monitoring Instruction Handbook, an ancillary teaching packet was developed so that the data would be accurately and consistently recorded.

When possible, whale behavioral information was recorded on the beluga form. Since Cook Inlet waters are turbid, any documented beluga behavior was limited to those visible above water. Categories of behavior included feeding (observed or suspected), traveling, diving, resting, milling, (Funk et al.[12]; McGuire and Kaplan[13]), body contact, spy hopping, tail waving, tail slapping, porpoising, vocalizing, and spouting. FAR rewrote descriptions and added to the Photo ID project (McGuire and Kaplan[13]) list of behaviors to meet ACBS needs (Švarný Carlson and Brunner[10]).

Validation of behavior data took place as survey crew members discussed observed surface activities before including detailed comments describing behaviors and surface activities. Behavioral comments also included notes on group composition. Behavior data was further validated when the PI reviewed behavioral comments and discussed any questions with the crew leader. When time permitted, human activities, in particular boat traffic, were also documented with increased emphasis starting in 2012; however; those data are not part of this paper and have yet to be analyzed.

Detailed maps referencing natural features visible from each project site were designed specifically for survey volunteers to plot beluga sightings within the study area accurately with minimal tools (Fig. 3). Reference points enabled observers to orient themselves and whales in the survey area for more precise placement of sightings on the map. This was important because the ACBS did not use a survey tool such as a theodolite to triangulate a beluga's location.

Outside of dedicated survey time, FAR also collected incidental observations of belugas from volunteers and the general public. Although these incidental sightings can add to what can be learned about belugas, incidental reports have incomplete sighting and environmental data and are analyzed separately from dedicated survey reports.

Data Management Post Survey

With help and support from the Alaska Fisheries Science Center's National Marine Mammal Laboratory (NMML) and volunteers, FAR designed, and now maintains, the FAR Fieldwork and Volunteer Database, which is a MS Access 2007[14] database. FAR crew leaders and data managers followed detailed data collection and data entry protocols to ensure data accuracy making the survey information valid and useful data. These procedures, complete with data forms, are given in Švarný Carlson and Brunner[10].

Results

Between 2008 and 2011, ACBS volunteers logged 444 h scanning for belugas on scheduled watches over a total of 348 survey shifts (Fig. 4). Data were collected during at least four different months at five of the project locations (Table 1): 1) Ship Creek (at the small boat launch); 2) MotoX (also known as Kincaid Motocross or Jodhpur bluff); 3) TA Potter (Potter Section House on Turnagain Arm); 4) TA Past Bird (first pull-out past Bird Point on Turnagain Arm); and 5) TA Tidewater (Tidewater Slough on Turnagain Arm).

Seven sites were staffed for less than 4 different months, primarily centered around months in summer and early fall. These included 1) Woronzof Beach/Bluff (at Point Woronzof); 2) PP No. 1 (Private Property No. 1, near the north end of Potter Marsh); 3) PP No. 2 (Private Property No. 2, near Campbell Creek); 4) TA Windy (Windy Corner on Turnagain Arm); 5) Between Past Bird and Tidewater; 6) TA Avalanche (on Turnagain Arm); and 7) TA 20-Mile (near Twenty-mile River on Turnagain Arm). Over the

Cook Inlet, Alaska: July 2004-July 2005. Report from LGL Alaska Res. Assoc., Inc., Anchorage, with HDR Alaska, Inc., Anchorage, for Knik Arm Bridge and Toll Authority, Anchorage, Dep. Transp. Public Facil., and Fed. Highway Admin., Juneau, Alaska, 232 p.

[13]McGuire, T. L., and C. C. Kaplan. 2009. Photo-identification of beluga whales in Upper Cook Inlet, Alaska. Final rep. field activities in 2008. Rep. prep. by LGL Alaska Research Assoc., Inc., Anchorage, AK, for Natl. Fish Wildl. Found., Chevron, and ConocoPhillips Alaska, Inc., 28 p.

[14]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

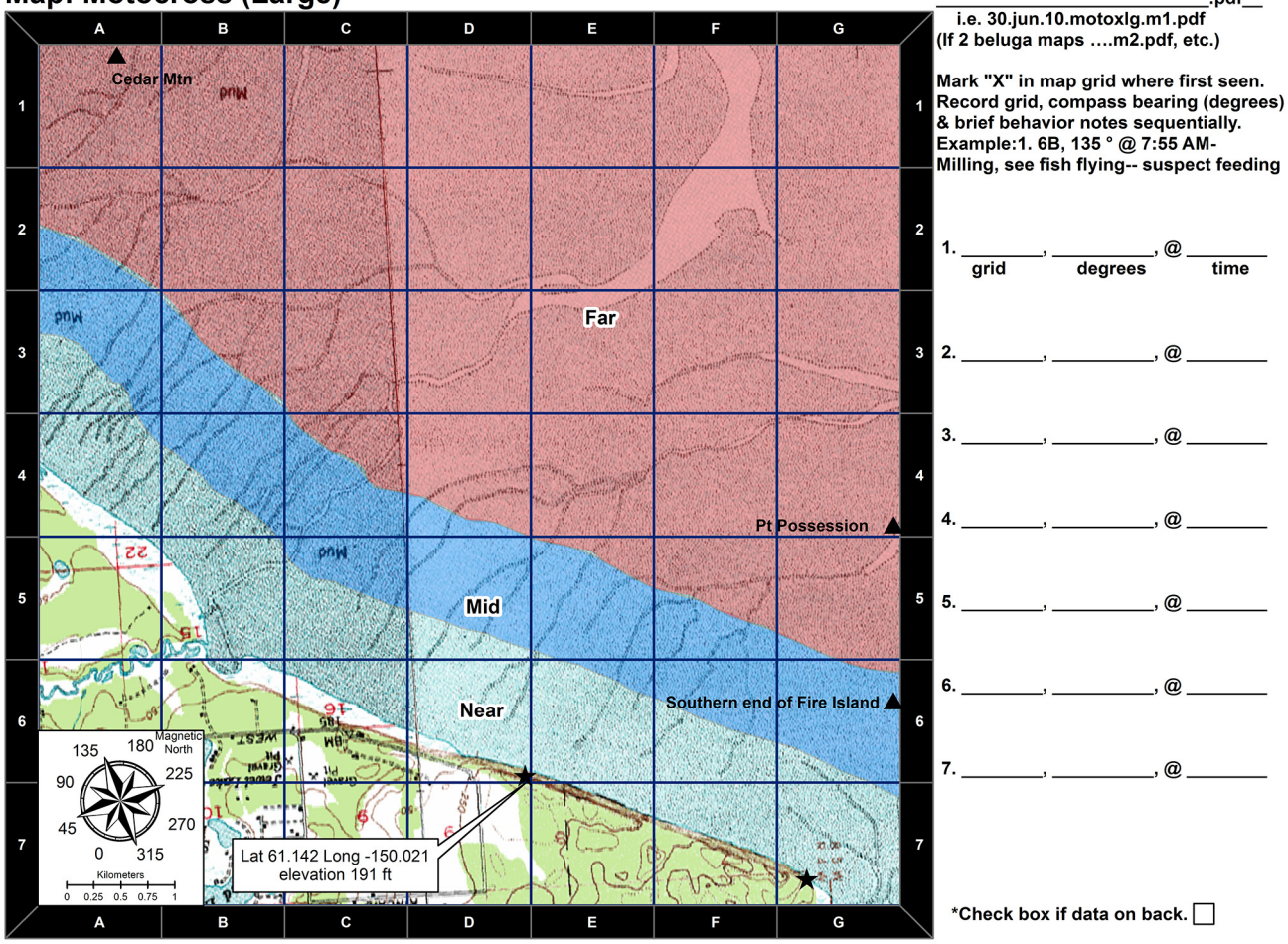

Figure 3.—One example of a map provided for each observation site showing survey area and nearest creeks with a 1 km (about 0.75 mile) grid overlay, and compass rose rotated to magnetic north. Shading divided the water into categories of near-shore, middle distance, and far distance, and showed prominent tidal guts and channels. Triangles on maps represented reference points of natural features viewed outside the map boundaries.

course of 4 years, surveys were scheduled for 175 days, of which 160 were completed; the remainder had been canceled due mostly to inclement weather and poor visibility (Table 2).

Observers counted the number of whales in groups during a survey shift and did not identify individual belugas, so individuals were likely observed multiple times within and across seasons. During the 4-yr project, 77 groups totaling 507 beluga whale sightings were documented; of these, 31 were identified as calves (Fig. 5).

Beluga behaviors were recorded at all sites with observers primarily charting general direction of movement and documenting behaviors listed on data sheets. Milling, porpoising, and spouting were the most commonly observed behaviors. Changes in surfacing behaviors were noted in association with boat traffic and the take-off of an F-15 jet at Ship Creek. Groups of belugas were observed moving in and out of Campbell Creek, exhibiting milling and diving behaviors that suggested feeding. Observers both at MotoX and PP No. 2 documented beluga groups possibly chasing prey, and included a repeated pattern of fast swimming in tidal guts, then movement back into a deeper part of the inlet. During one such observation, the belugas alternated energetic bouts with periods of apparent rest, where the whales would remain mostly submerged for several minutes, then begin spouting and fast swimming again.

Results for individual survey sites varied according to effort expended per location as well as seasonal and tidal scheduling (Fig. 2). The ascending order based on the total counts of belugas by effort hours was PP No. 1 (4.23 h/four belugas); Woronzof Beach/Bluff (low and high vantages) (1.20 h/five belugas, including one calf); Between Past Bird and Tidewater (0.22 h/nine belugas); TA 20-Mile

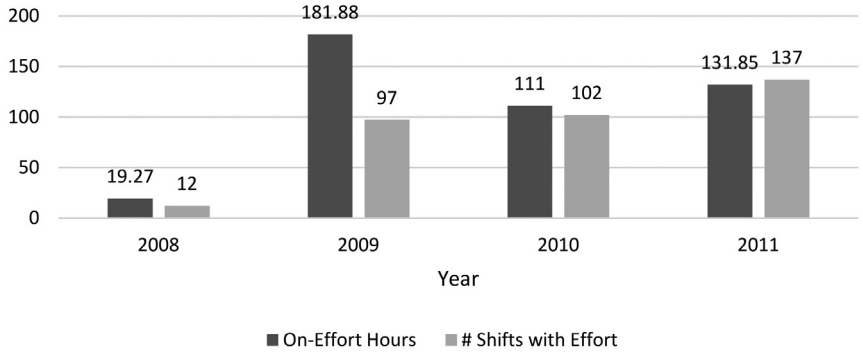

Figure 4.—Cumulative Anchorage Coastal Beluga Survey beluga-scanning effort and shifts, 2008–11.

Table 1.—List of survey sites with time ranges during each season. Although dedicated beluga data exists for PP No. 2, Woronzof Beach, and one site between Past Bird and Tidewater, they are not included in the time range table because those survey shifts, although complete, were additions to the schedule.

	Survey time span			
Survey site	2008	2009	2010	2011
MotoX	18–22 Oct.	10 June–30 Oct.	10–28 Aug. 5 Sept.–31 Oct.	13 Aug.–28 Sept. 1 Oct.–1 Nov.
PP#1	21–22 Oct.			
Ship Creek	12 Oct.–12 Nov.	9 June–30 Oct.		
TA Potter			5 Sept.–31 Oct.	8–22 May 13 Aug.–28 Sept.
TA Windy			5 Sept.–31 Oct.	8–22 May 13 Aug.–28 Sept.
TA Past Bird			5 Sept.–31 Oct.	8–22 May 13 Aug.–28 Sept. 1–31 Oct.
TA Tidewater			5 Sept.–31 Oct.	8–22 May 1–31 Oct.
TA Avalanche				8–22 May 1–31 Oct.
TA 20-Mile				8–22 May 1–31 Oct.

Table 2.—Number of days surveyed per season from each Project site. Table illustrates the number of days that ACBS crews completed shifts at each observation site per season; the number of shifts scheduled per site per season; the days scheduled for the survey per season; the days with complete shifts (that were not cancelled) per season; and totals.

ACBS Observation Site	Pre-survey	2008	2009	2010	2011[1]	Totals	Total seasons
PP#1	0	2				2	1
PP#2	ne[2]	ne	ne	ne	8	8	>4
MotoX	ne	5	50	29	22	106	>4
Ship Creek		5	42			47	2
TA Potter				18	22	40	2
TA Windy				18	22	40	2
TA Past Bird				18	29	47	2
Between PastBird/Tidewater				1	0	1	2
TA Tidewater				18	15	33	2
TA 20-Mile					7	7	1
TA Avalanche					8	8	1
Woronzof Beach/Bluff					1	1	1
Total complete ACBS shifts		12	92	102	134	340	
Number of shifts scheduled		12	105	106	150	373	
Days With Complete shift		10	81	28	41	160	
Days scheduled		10	89	30	46	175	

[1]Project lead spot data entered for 2011.
[2]ne=not entered.

(3.22 h/10 belugas, including one calf); Ship Creek (94.53 h/13 belugas); TA Windy (19.08 h/15 belugas, including two calves); TA Avalanche (6.32 h/23 belugas); TA Tidewater (20.03 h/26 belugas, including one calf); TA Potter (21.17 h/33 belugas, including three calves); PP No. 2 (9.30 h/83 belugas, including five calves); TA Past Bird (29.21 h/84 belugas, including two calves); and MotoX (260.18 h/202 belugas, including 16 calves) (Fig. 6). The number of whales seen within the ACWR was 36% higher than areas outside of the ACWR with 310 whales seen within the ACWR and 197 whales seen outside the refuge (Figs. 2, 6).

Human activity was documented on 209 shifts over the course of the survey period. Instructions for observers allowed leeway regarding what potential human impacts were documented, so that we did not miss something that might be important later that could impact the health or behavior of belugas. Volunteers were asked to look during surveys for pollution, trash, pet use and deposition of fecal matter, and loud noises and their sources. Documented human activity during surveys ranged from windsurfers to construction noise (Fig. 7). The MotoX site had 81 shifts documenting human activity out of a total of 106 shifts, most of which were dirt bike noises, airplane traffic from the nearby airports and lakes, as well as hunters or other people on foot. The Ship Creek site had 46 shifts (out of a total of 54) with human activity noted, most of which was fishing, boats, tugs, or dredges and construction activities near the Port of Anchorage. Turnagain Arm sites run along the road and had 78 shifts with human activity noted, most of which was vehicular traffic along with some roadside tourist activity, windsurfing, kayaking, and fishing activities.

The survey included a form to record germane oral histories, but managers found there was insufficient time for volunteers to follow through. Depending on the popularity of the survey site and the presence of other visitors, providing an opportunity to

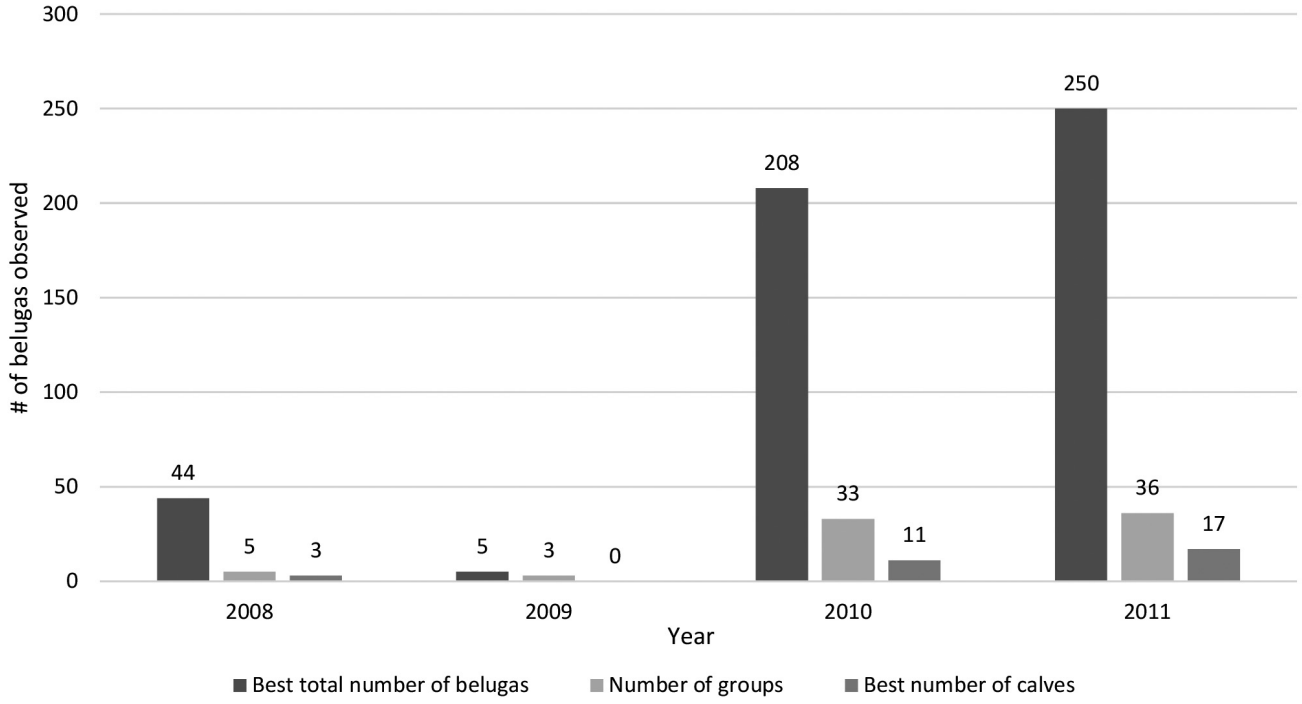

Figure 5.—Number of belugas observed on-effort by Anchorage Coastal Beluga Survey volunteers, 2008–11. Total individual dedicated and supplemental beluga sightings throughout project.

help educate the public as well as solicit local beluga knowledge at times would have taken time away from scanning and documenting belugas, if allowed. Crew leaders reminded volunteers of the priority order to scan and record data first, and usually there was no time to solicit oral history information. The interest in what might be learned from oral histories centering around belugas was significant enough to merit a separate project, which was undertaken by the Alaska Sealife Center for the Kenai Peninsula Borough, dedicated to Cook Inlet beluga work in that area (Dutton et al.[15]).

Over the course of 4 yr, the numbers of volunteers increased annually (Fig. 8). Volunteers for the ACBS logged 444 observation hours at 12 survey sites along the Anchorage coastline. A combined total of FAR on-effort observations and incidental sightings over 4 yr yielded 680 beluga whale sightings, in 106 groups, of which 43 of the whales sighted were identified as calves. Throughout the study, FAR trained 208 volunteers of which 153 followed through to assist with gathering beluga data. There was a 59% increase in project personnel in 2009 after the first pilot study year in 2008 and then a 15% increase in volunteer personnel in 2010 and a 17% increase in 2011. A number of other residents responded with interest every year who were unable to participate because they could not make the training sessions.

In 2008, FAR and Defenders of Wildlife (DoW) trained 26 volunteers with 19 following through to staff shifts; this was the pilot year and 11 of those completed two or more shifts. In 2009 the partnership trained 50 volunteers with 44 following through to staff shifts; 33 of those helped with three or more shifts. In 2010 FAR trained 61 volunteers with 52 following through to staff shifts; 30 of those completed three or more shifts. For 2011, the last survey year included in this paper, FAR trained 71 volunteers with 58 following through to staff shifts; 44 of those helped with three or more shifts. Between 2008 and 2011 eight guests helped with minor survey tasks under supervision of trained volunteers. Over the course of the 4 years of the survey, the total number of shifts increased and the level of effort hours were maintained above 100+ h each season after the initial pilot survey season in 2008 due to the number of dedicated trained volunteers (Fig. 9).

Although new volunteers made up the base of the total number each year, a core group of returning volunteers helped round out the observer pool. Volunteers that attended training but were unable to participate in 3 or more survey shifts were counted separately from the main pool of volunteers but were included in the total number of

[15]Dutton, I. M., J. R. Klein, K. J. Cain, R. Deel, R. Federer, H. LeBail, and J. Hunt. 10 May, 2012. An oral history of habitat use by Cook Inlet belugas in waters of the Kenai Peninsula Borough. Final Rep. Prep. for the Kenai Peninsula Borough. http://www.alaskapublic.org/wp-content/uploads/2012/06/3-R0086-Oral-History-of-CIBW-Final-Report-FINAL-051012.pdf

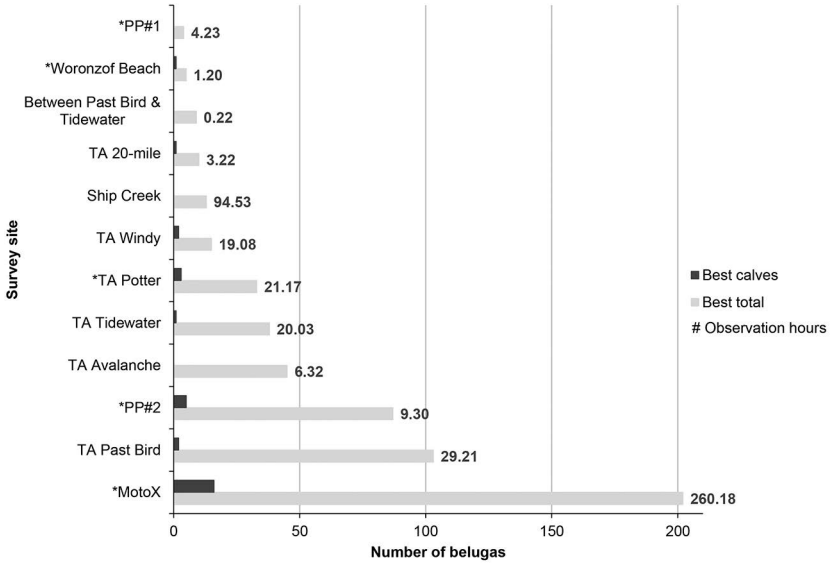

Figure 6.—Number of belugas observed at each Anchorage Coastal Beluga Survey project site 2008–11 (Numbers after bars indicate total observation hours for each survey site. Asterisk next to site name denotes sites located within the ACWR).

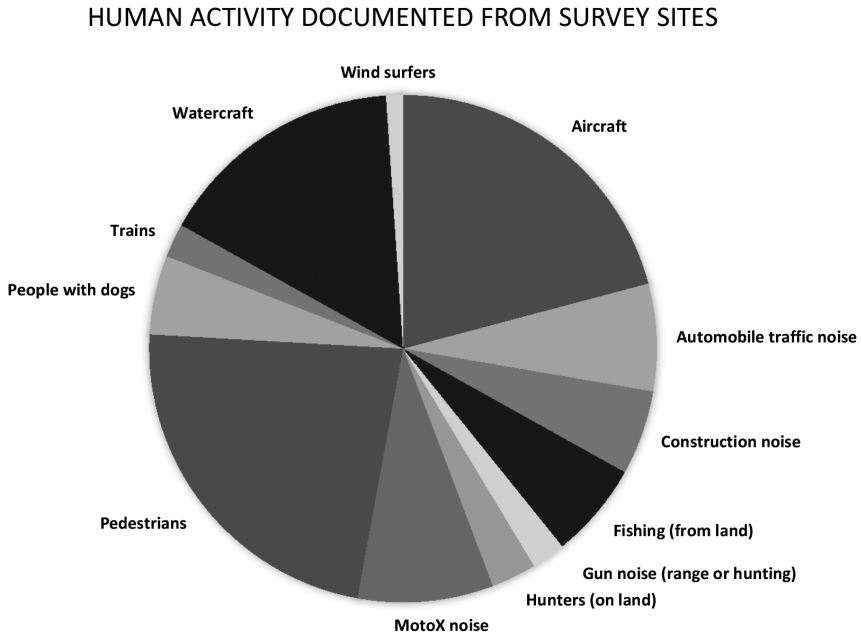

Figure 7.—Human activity documented from survey sites.

volunteers trained each season. The average number of shifts per volunteer was 1.7 shifts per volunteer in 2008, 6.5 shifts per volunteer in 2009, 3.9 shifts per volunteer in 2010, and 4.9 shifts per volunteer in 2011. Although many volunteers only worked one shift each year, a core group volunteered for 3 or more shifts with several individuals working 10 or more shifts in the 2009–2011 surveys (Fig. 9).

Discussion

Since FAR undertook no in-depth analysis of data collected during the ACBS, discussion will focus on interesting issues noted from the summarization of the data. In-depth analyses in collaboration with interested professional scientists are possible in the future.

The MotoX site was the only one surveyed all 4 yr, due to its importance as an overlook of the ACWR and its proximity to Campbell Creek, Fire Island, and the physical center of FAR's stewardship efforts. The MotoX site has also been used by the organization for several projects. Conversely, the Ship Creek site was only used during 2008–09 because FAR management believed that better data were being gathered by the well-funded port-monitoring project through Alaska Pacific University (Kendall and Cornick, 2015; Pinney and Cornick[16]; Cornick and Saxon[17]; Cornick et al.[18]). Further, the Ship Creek site manager was

[16]Pinney. L. and L. Cornick. Assessing relationships between beluga whale habitat use, prey availability, and hydrodynamics in the Knik Arm of Cook Inlet, Alaska, unpubl. manuscr.

[17]Cornick, L. A., and K. L. Saxon. 2008. Distribution, habitat use, and behavior of Cook Inlet beluga whales in Knik Arm, fall 2007. Unpubl. rep. to Integrated Concepts and Research Corp., Anchorage, 28 p. Avail. at Integrated Concepts and Research Corporation, 421 West First Avenue, Suite 200, Anchorage, AK 99501 (retrieved 15 Mar. 2012 from http://www.fakr.noaa.gov/protectedresources/whales/beluga/development/portofanc/apu_cib_habitat_07.pdf).

[18]Cornick, L. A., L. S. Kendall, and L. C. Pinney. 2010. Distribution, habitat use and behavior of the Cook Inlet beluga whales and other marine mammals at the Port of Anchorage Marine Terminal Redevelopment Project, May-November 2009. Scientific Marine Mammal Monitoring Program 2009 Annual Report. Prep. for U.S. Dep. Transportation Marit. Admin., Port of Anchorage and Integrated Concepts and Re-

no longer available to help, other partner organizations declined, and the additional administrative load for FAR was unwieldy, making it an easy decision to focus efforts on other locations. The addition of more Turnagain Arm survey sites in 2010 added a new challenge to scheduling, but the new locations gave much-needed insights into use of Turnagain Arm by belugas, with over 200 whales sighted.

The number of beluga sightings recorded at MotoX during 2009 were significantly below those seen in subsequent years. No whales were documented at the site during surveys in June, July, and October, despite logging over 55 h of observation time. One variable of note was that during July through October, NMML requested that FAR schedule blindly, regardless of neap tides or conditions that would increase the chance of seeing belugas (Hobbs[19]). Another variable related to the fact that the number of days in which boat traffic was documented at the MotoX site was greatest during 2009, with 6 days recorded as having boat traffic present, twice the number recorded for years 2010 and 2011 combined. Other than the 2009 blind scheduling (regardless of neap tide cycle) at MotoX, and where Ship Creek was scheduled around low tide, the 2008, 2010, and 2011 surveys were scheduled based on high tides when belugas were expected to be in the area.

The Ship Creek observation site ranked second highest in number of effort hours (94.52 h), but it had the fifth lowest ranking in whales sighted (13 whales). Again, during 2009 July through October, as at the MotoX site, FAR scheduled Ship Creek surveys regardless of the neap tidal cycle. At Ship Creek, in 2008, there was one beluga group of 15 whales sighted at high tide in comparison to the 2009 sighting of one whale during low tide. Ship Creek observers recorded significantly greater boat traffic at this site compared to other observation sites. However, because the 2009 survey times at the Ship Creek site were centered around low tide, as requested by T. McGuire[20], further study would be required during high tide when we expect belugas to be present, to ensure a better measure of beluga occurrence for that site and if boat activity was having any impact.

With ongoing development around Fire Island, FAR management understands that it would be particularly useful to have more data on belugas traversing the narrow passage of water between the northern tip of Fire Island and Point Woronzof Beach/Bluff and Point Campbell (Mahoney[21]). Observations from both PP No. 2 and the MotoX survey sites provided some data near Fire Island, including instances of belugas apparently chasing abundant prey, for example eulachon or salmon into the tidal guts repeatedly. Point Campbell is a high bluff, clos-

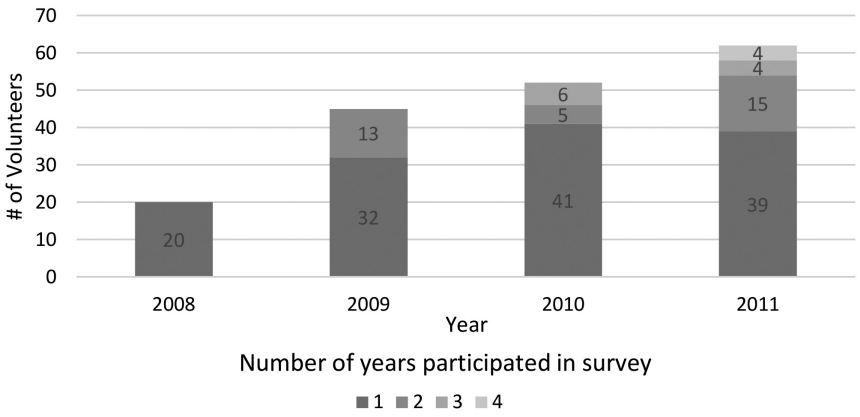

Figure 8.—Number of volunteer observers each year color shaded based on number of years assisting in the survey.

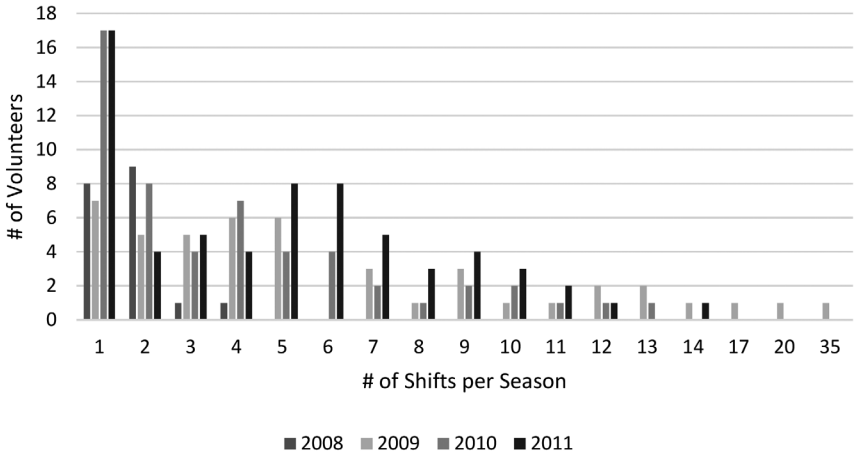

Figure 9.—Number of shifts per volunteer each year.

search Corporation. Prep. by Alaska Pac. Univ.. Anchorage.

[19]Personal commun. between Rod Hobbs (NMML) and B. S. Carlson, June 2009.

[20]Personal commun. between Tamara McGuire (LGL) and B. S. Carlson, April 2009.

[21]Personal commun. between Barbara Mahoney (NMFS Alaska Reg. Off.) and B. S. Carlson, May 2010.

er to Fire Island, and a better site from which to document beluga use of the Fire Island area. The Point Campbell site was used to survey the waters between Fire Island and the Kincaid area for nearly 8 mo by 61 North Consulting, LLC, for Cook Inlet Region, Inc. (CIRI). A report was recently released via the NMFS Protected Resources website documenting the study of belugas between ACBS sites just east of the Point Campbell site, an area with many tidal guts (Brueggeman et al.[22]). More observation at Point Campbell documenting belugas from the high vantage location, with more powerful optics than the CIRI survey team had available could provide valuable insight into beluga activities in the vicinity.

FAR reduced the potential for observer bias by the use of experienced leaders, through extensive training, the use of multiple individual counts, followed by consensus determining the final group size count, and descriptions of belugas observed. There was little emphasis on color because project leads recognize that the variation in light would make describing beluga colors unreliable. Training sessions utilized the use of photograph slides of belugas taken from land at a distance, from different angles, in different sea states, and in different lighting. Instructors emphasized the difficulty and the importance in making a quick assessment of what one observed so that it could be documented. This required when belugas were sighted that as many crew members as possible focus on counting the belugas multiple times before comparing notes for consensus, in order to reduce the likelihood of biases.

Further study of the occurrence of belugas may be warranted in areas undergoing significant development. With increasing development, there is concern that increases in human activity, such as increased number and size of vessels and increased amounts of construction activity, may have a negative impact on habitat use by the Cook Inlet belugas (Kendall et al., 2013; Norman et al., 2015). Increased human activity could also increase the amount of background noise that may mask acoustic signals and inhibit the capacity of marine mammals to communicate, forage, navigate, and avoid predators (Miller et al., 2000; Croll et al., 2001; Foote et al., 2004; Norman[23]). Noise could also have implications on breeding and social cohesion and in response to noise, marine mammals have been observed to decrease or cease vocalizations for weeks or months (Weilgart, 2007). Kendall et al. (2013) observed a decreasing trend in the hourly click rates of Cook Inlet belugas at the Port of Anchorage Marine Terminal Redevelopment site, between times without and with construction activity, a possible indication of disturbance. Additionally, an increase in noise levels has the potential to damage marine mammal hearing temporarily and permanently (Schlundt et al., 2000).

Many animals produce louder, longer, or more repetitious vocalizations to compensate for increases in environmental noise (Parks et al., 2011; Holt et al., 2015). Further, Holt et al. (2015) found that an increase in vocal effort between captive common bottlenose dolphins, *Tursiops truncatus*, created an increase in metabolic rate and oxygen consumption over a resting period that followed sound production in both animals, and that the metabolic cost may add up over time when the individuals must compensate for chronic background noise. A similar metabolic effect may be of concern for Cook Inlet belugas, particularly with an increase in ambient noise levels due to increases in shipping and construction activity.

Lusseau et al. (2009) found that vessel traffic may have contributed to southern resident killer whales, *Orcinus orca,* becoming endangered, by causing changes in behavior including a reduction in time spent foraging. Results from studies in Glacier Bay, Alaska, show four documented incidents of humpback whales, *Megaptera novaeangliae*, being awakened by cruise ship wakes (Neilson et al., 2013). In all cases, the whales dove, but it is critical to note that whales may not always wake up when a boat approaches and sometimes may be hit and injured or killed (Neilson et al., 2013). During observations of Cook Inlet belugas, Stewart[24] documented that small boats, such as inflatable, skiff, and hovercraft, caused belugas to respond (e.g., diving, speeding transit, leaving area) depending on proximity of said watercraft, how long they were near belugas, and activity. Stewart[22] also suggested that mouths of rivers and creeks may be important for belugas regrouping and socializing as they seem to vocalize there and that recreational or commercial boat noise could disrupt these important beluga transit activities. The effect of boat traffic on beluga whales in and around areas they inhabit may benefit from further study, particularly if there is a possibility that critical beluga behaviors are being negatively impacted by boat traffic (Norman et al., 2015), such as may be the case in Cook Inlet.

The ACBS has increased public awareness of Cook Inlet belugas and their habitat through educating volunteers and, in turn, the trained volunteers educating the public, friends, and family. The increased outreach by FAR, Alaska Center for the Environment, and DoW expanded the number

[22]Brueggeman, J., D. Lenz, and M. Wahl. 2013. Beluga whale and other marine mammal occurrence in upper Cook Inlet between Point Campbell and Fire Island, Alaska August–November 2011 and April–July 2012 (retrieved 23 March 2016 from https://alaskafisheries.noaa.gov/sites/default/files/2013_cib_monitorsurvey.pdf).

[23]Norman, S. A. 2011. Anthropogenic and environmental stressors in Cook Inlet beluga whales (*Delphinapterus leucas*). Literature review and assessment. Rep. prep. for Natl. Mar. Fish. Serv., NOAA, Anchorage, Alaska. NMFS contract no. HA133F-10-SE-3639 (retrieved 15 Mar. 2012 from http://marine-med.com/studies/publications/Norman-2011-Anthropogenic-Environmental-Stressors-Cook-Inlet-Beluga-Whales.pdf).

[24]Stewart, B. S. 2010. Interactions between beluga whales (*Delphinapterus leucas*) and boats in Lower Knik Arm, Alaska: behavior and bioacoustics. *In* NMFS 2010. Cook Inlet beluga whale science conference: agenda and abstracts, p. 10–11. (1 Aug.–14 Sept. 2008) (retrieved 15 Mar. 2012 from http://alaskafisheries.noaa.gov/protectedresources/whales/beluga/acoustics/hswri_techrpt_boats_belugas2012.pdf).

of volunteers who wanted to participate in the survey. Over the 4 years of this portion of the survey FAR and associates trained 208 volunteers, 153 of them helped log 444 observation hours at 12 survey sites along the Anchorage coast. This effort provided an oversight for marine mammal strandings, the documentation of belugas, and scheduled citizen scientists visibly located at selected overlooks. The survey provided a noticeable stewardship presence. During the last 2 years of the survey, the PI would occasionally get phone calls and emails from people saying that they saw FAR's beluga survey volunteers out along Turnagain Arm, often with interested passers-by. FAR, DoW, and NMFS receive notes of interest about belugas from as far away as Colorado and Belgium.

Over the years, citizen science has grown to address ecological questions on scales that are either too large a scale to be addressed only by professional scientists or on smaller local scales that are too restricted for professional scientists (Miller-Rushing et al., 2012). Dickinson et al. (2012) lists various uses for citizen science by professional ecologists ranging from areas of research such as landscape ecology and climate change to finding rare organisms, tracking movements, and detecting species declines.

The FAR beluga survey focused on documenting beluga activities along the Anchorage coastline and compiling data as a reference source for other professional science users. Beluga sighting information with numbers, locations, and data from the ACBS are being used in Section 7 consultations for Seward Highway MP 75–90 repairs and construction and other projects around Turnagain (under the U.S. Endangered Species Act) by permitting offices at the NMFS Alaska Regional Office. Additionally, if NMFS considers a biopsy study of Cook Inlet belugas in Turnagain, the survey data will be used, along with LGL sightings, to help schedule timing of the new study. For any permitted activities that would occur in Turnagain Arm up to Point Woronzof, where an ESA consult is needed, survey data that is not >10 yr old will be used.

Once the survey data is added to the Alaska Ocean Observing System database, it will be made available to others as projects, seasons, timing, and locations are designed. NMFS will continue to use the survey data along with additional data provided by NMML, as using multiple sources of sightings yields more information on Cook Inlet beluga presence (Mahoney[25]). ACBS data were used by the Cook Inlet Beluga Photo-ID project, which looked at seasonal and spatial patterns of beluga sightings documented to see if the sightings matched with the patterns that the Photo-ID project had demonstrated and to make sure that project planners were not missing any hotspots when planning surveys (McGuire[26]).

Conclusions

People have long observed beluga whales offshore along the 16-mi ACWR, usually during the ice-free months of the year (Carlson[27]). Adult and young whales move freely along the shore and up into some nearby rivers and creeks, and feed near the Campbell Creek estuary (Carlson[28]). The proximity of the refuge to Anchorage, Alaska's largest city, makes it an important place for public education and enjoyment, but it also makes the refuge, and its wildlife, vulnerable to the effects of habitat degradation and disturbance. The sharing of relevant local knowledge and concern for the wellbeing of belugas by observant citizens helped create the initiative for the survey.

Volunteers from Anchorage and surrounding towns demonstrated great interest in the status of the beluga whale through their willingness to dedicate time to training, staffing survey shifts, managing project gear, survey associated travel, and helping with both data entry and data checking. Even those who did not participate in the survey itself gained knowledge after attending training sessions and FAR believes this exposure added to an increased constituency for the endangered Cook Inlet beluga whale.

Public engagement with the ACBS made citizens more cognizant of the Cook Inlet beluga status, and more aware of actions that may impact the recovery of this distinct genetic population of belugas. Citizens concerned with the status of Cook Inlet belugas and the health of their habitat may be more willing to participate in conservation measures such as paying more taxes to help upgrade wastewater sewage treatment, conserving natural resources, limiting use of household chemicals that might be contributing to the pollution of Cook Inlet waters, and dumping less pet waste into local creeks and streams that empty into Cook Inlet.

While it may be coincidental that few or no belugas were observed when boats were seen, it is possible that certain boat activity and/or noise affects the presence, numbers, or surfacing behavior of belugas in the same vicinity. It is equally possible that when belugas were being documented, observers were distracted from noticing and recording the presence of boats in the areas. Further accumulation of boat and beluga data, and subsequent analyses, may shed light on this phenomenon. In 2012 FAR changed its protocols to ensure that both belugas and boats in the project area are carefully monitored, but, for 2008-11 we do not have sufficient data to make a statement.

FAR and its partners have worked steadily towards the goal of gathering information on the occurrence, presence, absence, color, numbers, and behavior of belugas along the Anchorage coast, and creating an archive of data for reference purposes by professional scientists. Additionally, data have included information on relative size of calf to adult beluga, when pos-

[25]Personal commun. between Barbara Mahoney (NMFS Alaska Reg. Off.) and B. S. Carlson, Apr. 2014, Aug. 2015, and Dec. 2015.

[26]Personal commun. between Tamara McGuire (LGL) and B. S. Carlson, Apr. 2014.

[27]Carlson, B. S. (FAR), Personal commun., 2011.

[28]Carlson, B. S. (FAR), Personal observ., 2011.

sible. Through this survey, FAR has been able to collect vital information on Cook Inlet belugas and share it with NMFS, ADFG, and others interested in the science and conservation of Cook Inlet beluga whales.

Through the survey, FAR strove to collect the best information about belugas along the Anchorage coast, while creating an engaging and rewarding experience for participating citizen scientists. Sustaining volunteer participation is critical to the success of the survey and must be considered when planning further survey seasons. FAR continually assesses the needs of the refuge that they steward and hopes to be able to include opportunities for citizens to contribute to the Cook Inlet beluga science database again in the future.

The 2012 data has not yet been analyzed, and while FAR is interested in continuing to collect beluga data, the necessary volunteer effort required to start up and manage the survey represents a huge endeavor for such a small organization. If agency and volunteer interest remains high, FAR may seek funds and partners to build on our survey efforts and continue to collect and move forward with a more in-depth analysis. To continue with the survey, FAR will need partners who are willing to work closely with FAR and be able to, competently and diligently, help with higher-level needs, such as site management, scheduling, equipment management and care, and data quality assurance. Alternately, FAR might be willing to advise others seriously interested in taking on a similar project.

Acknowledgments

We are grateful to the many people who contributed to the success of this project. Partial funding for this wildlife survey came from National Marine Fisheries Service Community Outreach through NMFS Enforcement, FAR, Defenders of Wildlife, and Alaska Center for the Environment. We especially thank Roderick Hobbs and staff at the National Marine Mammal Laboratory in Seattle, Les Cockreham with the NMFS Enforcement Division, and Barbara Mahoney and staff with NMFS Alaska Regional Office. Together they have been invaluable in helping Friends of the Anchorage Coastal Wildlife Refuge to connect with appropriate colleagues and manage the data we gather.

We are indebted to the 150 volunteers who came from Chugiak, Eagle River, Palmer, Girdwood, Indian, and Anchorage to staff shifts and perform other project tasks. In addition to the FAR Board, we thank partners Karla Dutton, with Defenders of Wildlife; Toby Smith, formerly with the Alaska Center for the Environment; and the Center's GIS specialist, Doug Tosa; and Michael Carlson, with McCool/Carlson/Green, Architects, Inc. We thank Kim Shelden at NMML for her dedication and expertise with reviews to hone this paper. We also thank the many professionals from whom FAR sought and received collaborative help at the conception of the survey design, some already mentioned above. We are grateful to all of these and other early cooperating and/or supportive individuals, organizations, and agencies and a complete list of acknowledgements and participants can be found in Švarný Carlson and Brunner[10].

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