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Alaska Fisheries Science Center

Studies of Harbor Seals Using Glacial Ice in Disenchantment Bay, Alaska, 2016-2017

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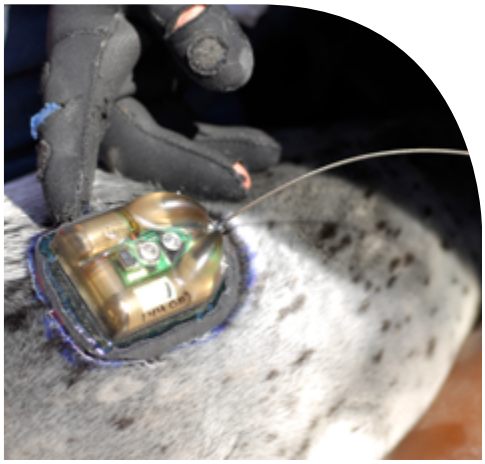
Goal of New Phase of Research

This summary will provide an update on NOAA-AFSC's latest research on seal-vessel interactions jointly conducted with the National Park Service. This research builds on studies since 2002 on ice-associated harbor seals in Disenchantment Bay which have focused on proximate effects such as when, where, and at what distances vessels were causing disturbance. By employing GPS satellite tracking (for both seals and ships), we aim to address broader population-level effects, and in particular to better understand how vessels entering glacial ice habitats may approach and alter the haul-out behavior of nursing pups, thus potentially increasing their energetic costs of thermoregulation in the water. There is concern that chronic disturbances could reduce body mass of pups at weaning and survival, and ultimately impact population stability.



Overview of Field Accomplishments and Next Steps

During two field deployments in June 2016 and 2017, scientists from NOAA's Marine Mammal Laboratory and NPS's Glacier Bay Field Office captured, sampled, and attached satellite-linked transmitters on 73 pup and 2 mother harbor seals hauled out on glacial ice. Vessel routes and speed upon entering the study area were tracked in both years using an AIS tracking station installed on Haenke Island. Coupling vessel AIS data with behavioral and spatial data from the seals' satellite tags will allow researchers to model seal and vessel movements to estimate the distance and time of closest approaches to seals by vessels, which will then be related to timelines of pup haul-out behavior (in/out of the water). Over the next year, analyses will focus on comparing the behavior of pups with and without ships present, and outside and within the path of vessels, to detect any differences in time spent submerged. Previous energetic models have shown that extra time in the ice-chilled water could compromise the capacity of pups to gain body mass (i.e., blubber) necessary to support them in the first months of independence. Findings will be submitted to peer-reviewed journals and presented directly to stakeholders via meetings.

Project Milestones

January 2012	MML and NPS scientists meet to discuss published results and local/historical concerns related to vessel disturbance of seals in Disenchantment Bay; NPS/MML commit to collaboration with NPS seeking funding to build on past findings to address possible population-level effects.
February 2013	NPS grant awarded for Disenchantment Bay study to examine pup haul-out behavior in relation to vessels.
Winter/Spring 2016	Began fieldwork planning; logistics; contracts; transporting equipment; funding support via grant from NOAA's Alaska Regional Office for AIS system, additional satellite-linked transmitters, and ARGOS satellite time.
May 2016	Conducted a Yakutat community meeting; also presented for CBY and Yakutat Tribe; presented hands-on activity (*Polar Detectives*) at Yakutat school; site visit to Haenke (Egg) Island to assess options for AIS station.
June 2016	Completed first field season to deploy 45 satellite tags on pups during 6 days on the *R/V Steller*; installed AIS station; hosted community members from Yakutat aboard ship.
August 2016	Circulated 2016 field season report.
Winter/Spring 2017	Field planning for second trip; logistics; contracts; transporting equipment.
June 2017	Completed second field season deploying 30 tags on pups (plus 2 moms) during 4 days on the *R/V Norseman* II; hosted community members aboard ship; gave a presentation for the Yakutat community after disembarking ship.
Sept/Oct 2017	Removed AIS station from Haenke (Egg) Island. Packaged and shipped for storage.
Fall 2017	Completed QA/QC of AIS and satellite tag data to make ready for analyses; conference call among partners to discuss structure of and prioritize analyses.
Winter 2018	Initiate preliminary movement modelling of vessel and seal spatial coordinates; working meeting planned to review progress on models and early results. Circulated final field season report.
Spring/Summer 2018	Develop state-dependent statistical model to test for differences in haul-out behavior under varying levels of vessel traffic, and spatial and temporal proximity of vessels to seals.
Fall 2018-Spring 2019	Anticipate completed analyses; submit for review to peer-reviewed journals.

Who Makes Up the Collaboration?

The following people from seven (7) agencies have been involved in project origination, logistical planning, analytical conceptualization, and/or field work:

John Jansen

Agency: Marine Mammal Laboratory, AFSC, NMFS, NOAA
Role: Co-Principal Investigator, Field Crew, Data Analyses, Write-Up

Jamie Womble

Agency: Glacier Bay Field Office, NPS
Role: Co-Principal Investigator, Field Crew, Data Analyses, Write-Up

Scott Gende

Agency: Glacier Bay Field Office, NPS
Role: Co-Principal Investigator, Field Crew, Data Analyses, Write-Up

Brett McClintock

Agency: Marine Mammal Laboratory, AFSC, NMFS, NOAA
Role: Statistician, Field Crew, Data Analysis, Write-Up

Heather Ziel

Agency: Marine Mammal Laboratory, AFSC, NMFS, NOAA
Role: Biological Sampling & Archival, Field Crew

Shawn Johnson, Sophie Whoriskey

Agency: Marine Mammal Center, Sausalito, CA
Role: Veterinary Support, Field Crew

Eric Veach, Judy Putera

Agency: Wrangell St Elias NP
Role: Field Crew

Leigh Welling

Agency: NPS Alaska Region
Role: Field Crew

Jed Harding

Agency: University of Alaska-Fairbanks
Role: Veterinary Intern, Field Crew

Nick Hatch

Agency: Marine Exchange, Inc.
Role: AIS support, Field Crew

Jim Capra

Agency: Yakutat Field Office, Glacier Bay NP
Role: Shore-based Field Support

What was the Impetus for the Study?

Studies on the effects of vessel traffic on glacier-ice associated harbor seals date back to the 1980's in Glacier Bay National Park, studies that were initiated due to increasing frequency of vessels in the Park. Early findings led the NPS to implement regulations to limit approach distances and establish space-time closures to protect seals in Johns Hopkins Inlet, the largest aggregation of glacial harbor seals in Alaska at that time. NOAA established a 100-yard, Alaska-wide guideline for approaches to marine mammals in the 1990's – which applied to harbor seals including those in glacial fjords.

In 2001, increases in the use of Disenchantment Bay by large vessels prompted the Yakutat Tlingit Tribe (YTT) to voice concerns to NOAA managers about the potential impacts of vessels to the seal population. Seals in Disenchantment Bay have been a source of traditional subsistence to Native people of the area likely since the earliest settlements in *ca*. 1300 AD. The Tribe's main concern was that vessels were disturbing adult females and pups and could be the cause of a perceived decline in seal abundance in the glacier-ice habitat of Disenchantment Bay. At about the same time, the Tribe passed a formal resolution requesting that large vessels approaching Disenchantment Bay to remain south of a demarcation line between Bancas Point and Calahonda Creek. In response, NOAA's Marine Mammal Laboratory (MML) established a new research program to study the potential impacts of tour vessels on harbor seals. As a first step, the MML implemented aerial surveys using new methodology and conducted behavioral observations of seals from cruise ships. These studies took place in 2002, 2004, and 2005, with continuing efforts since then to conduct annual surveys of seals in both Disenchantment and Icy bays to acquire a reliable estimate of abundance to assess population trends.

The observational studies led by NOAA were structured to establish a proximate mechanism of disturbance (seals reacting to vessels and flushing into the water) and the distance at which this reaction occurred. These initial studies also looked for possible short-term changes in abundance or distribution in response to ships. Subsequent studies sought to determine the existence of a possible link between this altered behavior and population-level effects that could account for a decline in seal numbers, as reported by subsistence hunters of the YTT. Following the results of an energetic model suggesting increased vulnerability of pups to heat loss while submerged, and spatial analyses that estimated a significant fraction of seals being disturbed by vessels, the 2016-17 field studies focused on the biological significance of pups spending extra time in the water after being disturbed by vessels.

Findings to Date

Since NOAA's Marine Mammal Laboratory initiated studies in Disenchantment Bay, other agencies – including Alaska Department of Fish and Game (ADFG), the Alaska Sea Life Center (ASLC), and the National Park Service (NPS) – have implemented additional studies examining seal-vessel interactions in Alaskan glacial fjords. In general, these studies have progressed in scope from examining proximate effects (e.g., individual behaviors) to more ultimate impacts (e.g., population-level disturbance). Below is a summary of selected findings that helped formed the basis for the 2016-17 Disenchantment Bay studies, organized into three categories: 1) behavioral effects, 2) bio-energetic effects, and 3) population-wide effects (see references below).

Behavioral Effects

- Seals flush into the water when approached within 500 m (< ¼ mile) by cruise ships[1]; about 90% flush within 100 m (109 yards)[1]; reactions to cruise ships can occur out as far as 1000 meters (about ⅔ mile)[3]
- Seals are more likely to flush in response to cruise ships and kayaks than other vessel types, and when pups are present[4]
- Seals are 3.7 - 25 times more likely to enter the water when a vessel is within 100 m compared to 3-500 m [1,4]; seals are less likely to be hauled out and more likely to end a haul out in the presence of vessels[7]

Bio-energetic Effects

- Seal pups are disproportionately vulnerable to the energetic costs of spending more time submerged, potentially affecting survival[1]
- Elevated heart rates occur when hauled out seals are approached by vessels, suggesting added energetic costs even if they don't flush in the water[6]; seals hauling out following disturbance have elevated heart rates[6]

Population-Wide Effects

- A significant portion of the seals present on a given day (14%) can be disturbed in the water by a cruise ship[2]; up to 4 ships may visit Disenchantment Bay per day[1], and up to 7 (all vessel types) at other glacial sites[7]
- A majority of vessels (>75%) observed in Johns Hopkins Inlet (Glacier Bay) and Disenchantment Bay disturbed seals into the water [1,3]
- Vessel traffic to glacial habitats have risen 10-fold since the 1980's[1]
- The estimated proportion of pups at Disenchantment Bay (10%) appears to be lower on average compared to other less visited glacial sites (21-40%) [2]
- Population declines – including number of pups – at glacial sites with high levels of vessel tourism is concerning [5]; but greater knowledge and awareness about likely threats to seals can lead to reduced disturbance[8].

[1] Jansen et al. 2010; [2] Jansen et al. 2015; [3] Young et al. 2014; [4] Mathews et al. 2016; [5] Hoover-Miller et al. 2011; [6] Karpovich et al. 2016; [7] Blundell et al. 2015; [8]Hoover-Miller et al. 2013.

New Vessel Approach Guidelines

In response to these new findings – and after considering public and stakeholder input – NOAA Fisheries' Alaska Regional Office issued new voluntary guidelines in 2015 for vessels that operate in the vicinity of harbor seals in tidewater glacial fjord habitats. NOAA managers concurred with recent studies published by scientists at NOAA's Alaska Fisheries Science Center (AFSC) – and other researchers – that the previous voluntary guidelines to avoid approaching harbor seals within 100 yards were inadequate to protect seals from disturbance. In their decision to adopt more stringent, but still voluntary guidelines, they pointed to: 1) an increasing likelihood of seals flushing in the water (i.e., disturbance) with decreasing ship approach distances, with disturbance occurring as far out as 500-1000 yards; 2) a direct overlap of peak incidence of seals on ice and tour ships during midday hours; 3) a high prevalence of seal disturbance by vessels at the most frequented glacial sites in Alaska; and 4) the potential risk to pups of exhausting energy reserves after flushing in the ice-chilled water and having nursing bouts interrupted by vessels, both factors leading to reduced survival and likely impacts to the population.

NOAA Fisheries sought to develop meaningful, voluntary guidelines that reflected the latest, most relevant scientific findings, while also considering the needs of vessel operators who have increasingly frequented these areas because of the growing popularity of tidewater glaciers as a tour destination. As these glaciers diminish with climate change, the popularity of these areas is expected to increase further. NOAA Fisheries convened the first meeting of the Harbor Seal Approach Guideline (HSAG) Working Group in Juneau (January 2017) to provide a forum for discussing topics related to the new guidelines and how they may be functionally implemented by different vessel types in tidewater glacial fjords. Subsequent stakeholder meetings were held in various Alaska communities where vessel-based tourism is important. Through a combination of a listserv, newsletters, and other communications, NOAA will foster communication within the HSAG Working Group so that any issues or questions can be addressed collaboratively.

Project Goals, Summary and Accomplishments

The primary objectives of this joint-funded NPS/NOAA project are to measure the activity budgets and haul-out behavior of harbor seal pups in relation to distance and varying levels of vessel traffic. Various metrics of ship and seal behavior will help determine if disturbance (i.e., pups entering the water prematurely) may be altering their energy balance, causing pups to spend more energy keeping warm and less on growth and development. Previous estimates of energetics and survival of seals in their first year of life suggest that the balance between energy consumed vs. required could be narrow, with little margin for perturbations such as vessel disturbance. The end result could be pups starting their first winter with less blubber to survive lean periods, and ultimately fewer resources to deal with a variable environment.

Given that vessel traffic has increased in areas used by harbor seals for pupping, especially in tidewater glacier fjords where large seasonal aggregations of seals occur, the potential for impacts to individual harbor seals via disruption of nursing, pup growth, and survival are of concern to managers. In Disenchantment Bay, the annual visitation by cruise ships has risen from fewer than a dozen in the late 1980's to over 170 in 2017, with as many as four vessels visiting in a given day. These changes have raised concern in nearby Yakutat, where the local Tlingit Tribe has used harbor seals as a subsistence resource for centuries. Recent NOAA studies revealed that adult seals (including nursing mothers) start flushing from the ice when vessels approach closer than 0.5 km (about ¼ mile), with the vast majority entering the water when vessels are closer than 100 meters (about 100 yards).

2016 Research Cruise

In the first field effort of this two-year study, a crew of 10 scientists, veterinarians, and university students from the National Park Service (NPS), NOAA Fisheries, University of Alaska Fairbanks, and The Marine Mammal Center were based on the *R/V Steller* in Yakutat and Disenchantment bays from 4-9 June 2016. The ship transited north from Juneau after being loaded with research gear and supplies, and returned there at the conclusion of pup captures.

Capture and tagging goals of the 2016 field study were achieved in less time than anticipated. Researchers used small inflatable boats to quietly approach mother-pup pairs resting on icebergs. Long-handled dip net poles (12 ft) were found to be indispensable for catching pups, usually providing a few seconds lead time before the pup could flush in the water. After some trial and error, up to 13 pups were captured in a single day. The first couple days were characterized by heavy rain and wind making captures more difficult owing to fewer seals hauled out with those being more alert. Captures increased thereafter as warmer, dry days made for calmer seals that were easier to approach more closely.

Once captured, pups were kept in the small inflatables near the capture site to encourage interaction with the mothers who were generally attentive, either swimming around the boat or hauling out on a nearby iceberg. Pups were first measured and weighed prior to collecting biological samples, including whiskers, hair, and skin. Blubber sonography was conducted on more than half of the pups. Satellite-linked transmitters were attached using quick-setting adhesive, Forty-five (45) satellite tags were attached to pups ranging in size from about 13 to 25 kg (approx. 1-2 weeks of age). On average, pup handling time was 30 minutes. Prior to capturing pups, the automated identification system (AIS; for vessel tracking), was installed on Haenke (Egg) Island to monitor the distance of tagged pups to approaching vessels. Installation was assisted by a technician from Marine Exchange of Alaska, who then returned to Yakutat.

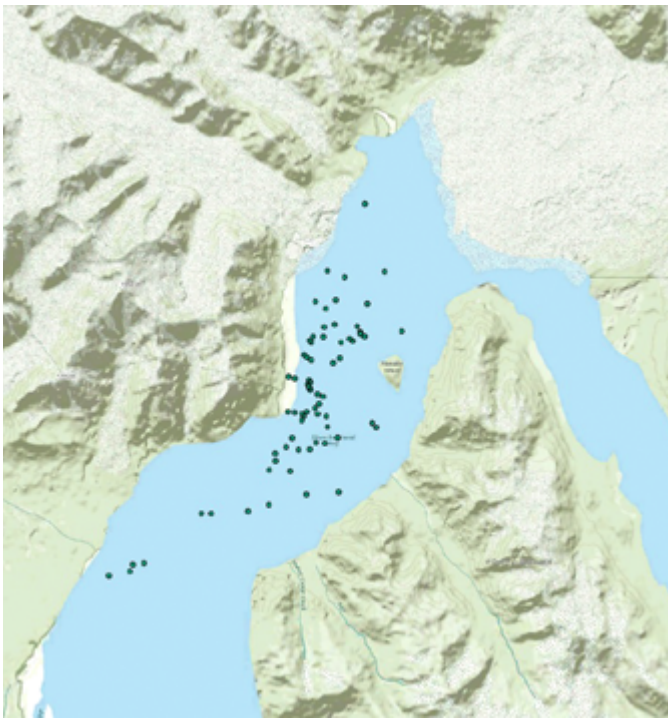


Figure 1. Map of tagging locations for 2016 and 2017 (N=75) in Disenchantment Bay, AK.

2017 Research Cruise

Due to reduced project funding, the second field effort comprised a smaller crew, fewer tags, and fewer days of capture and sampling work. A team of 6 researchers were based aboard the *R/V Norseman II* in Yakutat and Disenchantment Bays from 5-8 June 2017.

Having the benefit of our previous experience, and better weather, we were able to deploy more tags per day than in 2016 (7.5 vs 6.6) and reach our goal of 30 tags in the shorter window we had available. Using small inflatables and the same capture, tagging, and sampling methods as the previous year, we matched last year's daily maximum of 13 pups tagged. Similar to last year, tagged pups ranged in mass between 13 and 25 kg. Pup handling time was reduced compared to 2016, averaging 27 min despite conducting blubber sonography on nearly twice the proportion of pups (68 vs. 36%); most of the pups were released in the water directly to attendant moms.

To gain insights into the behavior of mothers during lactation, and specifically their likely role in influencing pup behavior, the last 4 tags were reserved for deployment on two mother-pup pairs. Adult seals are typically captured using larger tangle nets in the water, so it was uncertain if mother could be captured simultaneously with long-handled dip nets. Still, on the last day of capture operations two (2) mother-pup pairs were captured together on the ice; due to the size of the adult females, both animals were transferred back to the research ship for processing. The transfer, sampling, and tag attachment for each pair took about one (1) hour before the mother and pup were released together from the ship. Based on observations and tag locations both pairs were believed to remain together following release.

Before captures, the AIS vessel tracking system was repaired (after a bear damaged a cable) and then later removed from Haenke Island in October 2017. Preliminary assessment of the AIS data shows the system worked well and collected high-quality locations on vessel positions throughout both sampling periods in 2016 and 2017.

Outreach

In addition to the two research trips in Disenchantment Bay, two members of the science team (J. Jansen and J. Womble) visited Yakutat on two occasions to meet with stakeholders, school kids, and the public. In May 2016, prior to the first field effort, separate presentations were given to the Yakutat Tlingit Tribe, the City Council, and to the community at-large to provide a summary of the research and allow for questions; a hands-on educational presentation was also given at the Yakutat School. Similarly, after the 2017 field trip, in June, another community talk was given in Yakutat to provide an update on accomplishments to date and answer any outstanding questions. During capture and tagging operations in both years, the scientific party hosted members from the Yakutat community aboard the research vessel to provide a more in-depth perspective on the project.

Preliminary Results

Analyses of the pup haul-out behavior in relation to vessel presence and distance is in the early stages, with the different data streams (i.e., pup behavior and locations, and ships' speed, bearing, and locations) being compiled and undergoing error checking prior to structuring models to test for effects.

Still, a preliminary inspection of pup locations from the satellite-linked transmitters revealed some interesting movements. In 2016, within 30 days of being tagged twenty (20) pups (45%) had ventured outside the shelter of Disenchantment and Yakutat bays, four of them travelling as far as Prince William Sound (PWS), two to Kayak Island, four to the Icy Straits area, and three near Lituya Bay (Fig. 2). The longest travelers to PWS had covered at least 500 km (about 300 miles), which appear to exceed typical pup journeys previously documented. Interestingly, four (4) pups ventured to nearby Icy Bay, another tidewater glacial fjord just to the northwest of Disenchantment Bay. In 2017, during the first 30 days, 16 pups (55%) had ventured outside the bay with two pups matching the distance of the 2016 longest trips (4 pups; >500 km or >300 miles) by traveling as far south as Baranof Island, south of Sitka. Interestingly, even though overall distances seemed similar between years, the movement patterns differed. In 2017, pups stayed in continental shelf waters to the southeast of Disenchantment Bay, whereas pups tagged in 2016 occasionally ventured off the shelf and traveled both to the northwest and southeast of the bay (Fig. 2).

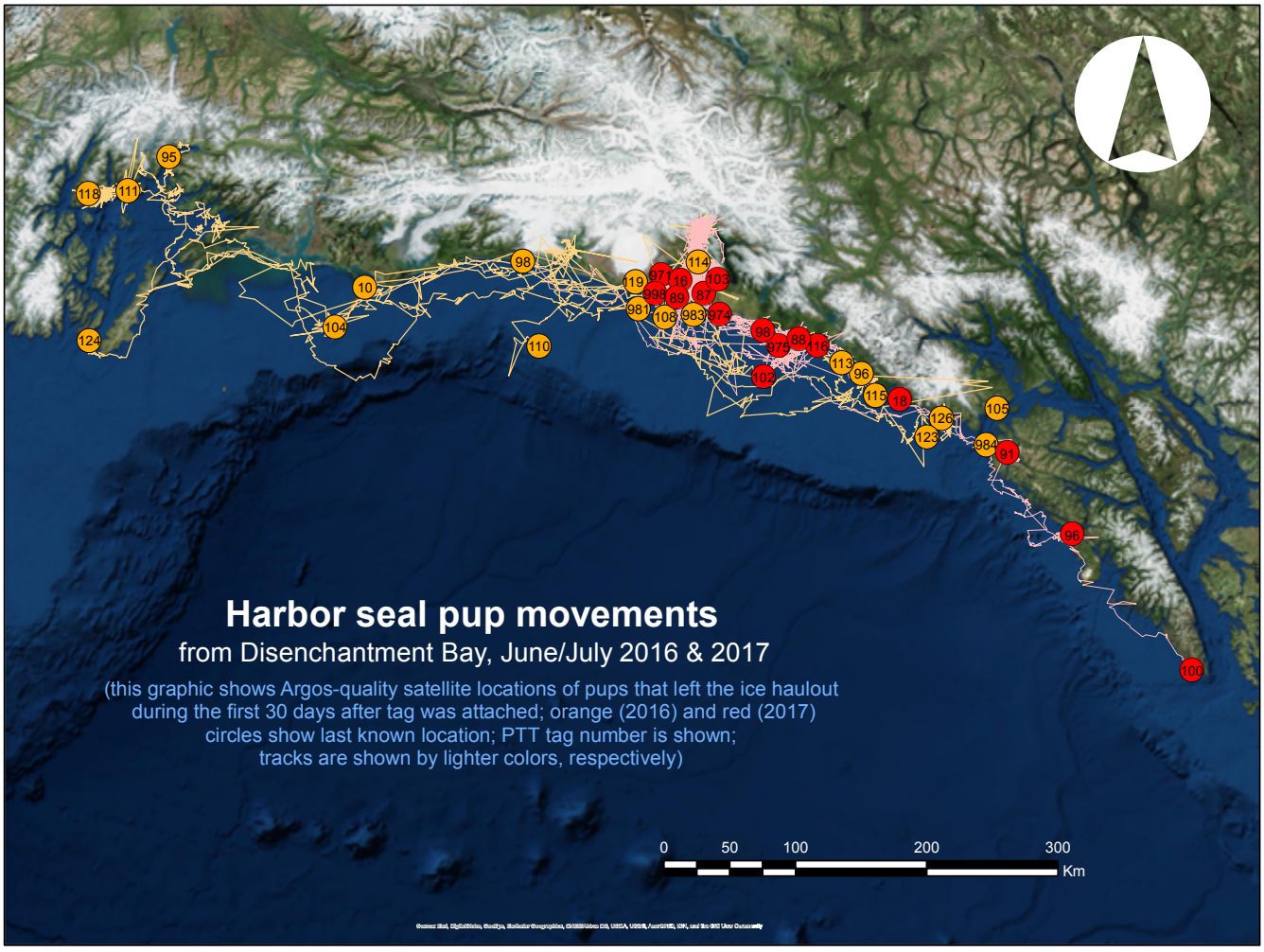
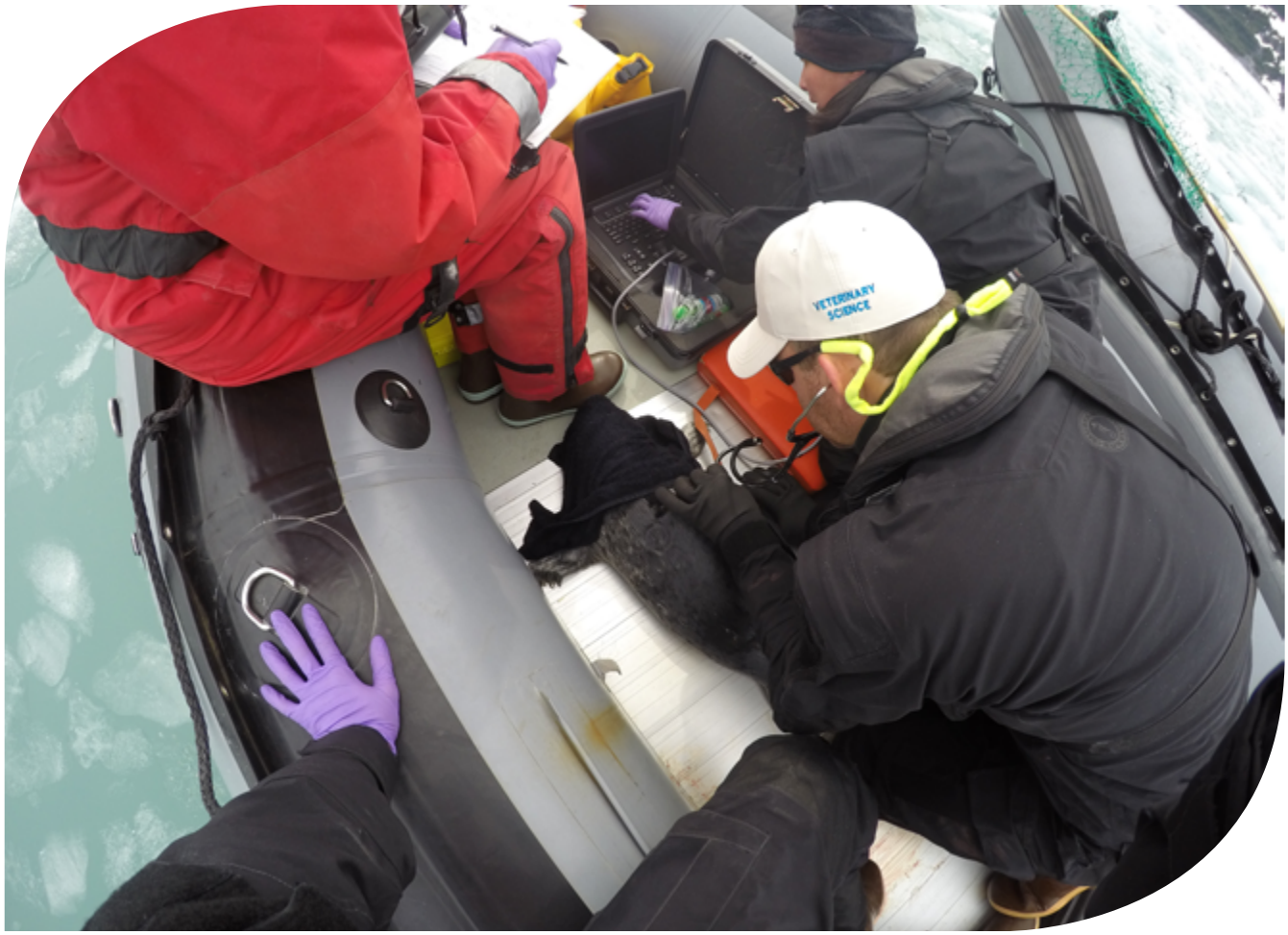


Figure 2 Harbor Seal pup movements from Disenchantment Bay, June 2016 & 2017

It is unknown to what extent mothers may be accompanying pups on these migrations, but in phocid seals maternal investment is generally thought to end when pups wean at the natal site. Remarkably, one of the two mother-pup pairs tagged in 2017 ventured together out of the ice, into the Gulf of Alaska; this may be the longest trip documented for a mother and pup harbor seal travelling together at sea. The trip lasted just a couple days before the pair returned in tandem to the ice of Disenchantment Bay; the mother left shortly thereafter without her pup, not to return, while the pup stayed in the bay for several days. Tags equipped with diving recorders have revealed that pups that were still in the glacial ice habitat, as well as those that ventured out, were regularly diving to depths of 50-75 meters (apx. 150-250 feet) with many dives reaching 150 meters (almost 500 feet). This early look at the pups' diving behavior – but supported by earlier studies – seems to show a progression from shallow to deeper diving with age as they adapt physiologically. Many of the areas that these first-time foragers traveled to after leaving the glacial ice are similar to those along the Yakutat Forelands, Prince William Sound, and Icy Strait that were used by tagged seals from Johns Hopkins Inlet in Glacier Bay. Little is known about seals that use glacial ice habitats so any new information adds greatly to the knowledge about them, with details of movements and genetic data being important for further understanding stock structure of harbor seals in Alaska.

Though these early results of movement after pups are weaned are interesting and will add much to our knowledge about how glacial seals juggle the constraints of growing to adulthood, the real emphasis of this study will be the pups' behavior *before* they leave the tidewater glacial fjord habitat – while they are still dependent on mom – and whether vessel disturbance then represents a significant threat to their survival.



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