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Humpback Whale Monitoring in Glacier Bay and Adjacent Waters 2015

Annual Progress Report

Natural Resource Report NPS/GLBA/NRR—2016/1354

ON THE COVER
Seventeen-year-old female humpback whale #1470 lunge feeds in Spokane Cove, August 2015.
Photograph courtesy of Glacier Bay National Park and Preserve.

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Natural Resource Report NPS/GLBA/NRR—2016/1354

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This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

This report is available from the Glacier Bay National Park and Preserve website (http://www.nps.gov/glba/naturescience/whale_acoustic_reports.htm) and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

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Abstract

Migratory humpback whales (*Megaptera novaeangliae*) use southeastern Alaska as summer feeding habitat, including the waters in and around Glacier Bay National Park and Preserve (GBNPP). This report summarizes GBNPP's humpback whale monitoring program in 2015, the thirty-first consecutive year of consistent data collection in Glacier Bay and Icy Strait (GB-IS). In June-August, we documented 166 unique whales in GB-IS, which represents our lowest count since 2008. Correcting for survey effort, which was lower than average in 2015, revealed an 8% increase in whales in GB-IS compared to 2014. However, by all metrics we have documented a decline in whale use of the GB-IS study area beginning in 2014 (22% decline) compared to 2009-2013, with this trend driven in large part by declines in Icy Strait. Possible reasons for these declines include possible shifts in whale prey and anomalously warm ocean temperatures in the northeastern Pacific. A majority (64%) of whales met our definition of 'resident' (remaining 20 or more days in the study area) but several historically resident whales were identified on just one day, indicating a break in their strong site fidelity to GB-IS. We documented five mother/calf pairs and the lowest crude birth rate (3.0%) since 1984. For the first time, we detected herring near whales feeding in Glacier Bay. In June, a humpback whale became briefly entangled but released itself from commercial longline gear in Glacier Bay. Our findings highlight the value of long-term monitoring in documenting the recovery of an endangered species.

Acknowledgments

This long-term study is greatly enriched by whale sightings, behavioral observations and enthusiasm from many Park staff and volunteers. In 2015, we extend our gratitude to Georgia Arnold, an undergraduate student volunteer from the University of Cumbria in England, who cheerfully assisted us from January through July with everything from data entry to map-making to cleaning whale bones. We also thank Student Conservation Association volunteer Thomas Nguyen, who helped us with data entry and fluke matching in September and October. We appreciate Lou Taylor-Thomas and the many hours she spent matching flukes and processing data. We are grateful to Bruce McDonough for his responsiveness and talent at resolving the *Sand Lance*'s mechanical issues. We are grateful to Park staff who reported whale sightings, and the Park's Visitor Information Station for recording them and passing them along to us. We especially appreciated the many sightings we received from Dena Matkin, Katja Mocnik, Jamie Womble, Linda Lieberman, Todd Bruno, Lewis Sharman and the crew of the National Park Service (NPS) vessel *Serac*. Thanks to Mayumi Arimitsu (U.S. Geological Survey Alaska Science Center) for her invaluable help with forage fish identification. We extend our thanks to Jim Kearns, Mike Halbert, Fred Sharpe (Alaska Whale Foundation), Gary Freitag (Alaska Sea Grant Marine Advisory Program) and John Moran [National Oceanic and Atmospheric Administration (NOAA)] for sharing their field observations. We thank Lewis Sharman and Seth Danielson (University of Alaska Fairbanks) for sharing oceanographic data and insights. We appreciate our long and fruitful collaboration with Jan Straley and Jennifer Cedarleaf at University of Alaska Southeast in Sitka. Thanks to NOAA staff Aleria Jensen, Kate Savage and Ed Lyman for investigating, compiling and sharing data on humpback whale strandings and entanglements in Alaska. We thank Chris Sergeant, Lou Taylor-Thomas and Lisa Etherington for reviewing this report and providing valuable comments.

We dedicate this report to the memory of interpretive park ranger Linda Lieberman, our most ardent reporter of whale sightings during her many years working at Glacier Bay National Park and Preserve.

NPS data from 1988 to 1990 were collected by Jan Straley. NPS data from 1985 to 1988 were collected by C. Scott Baker. This year's study was carried out under NOAA Fisheries Permit #15844-01.

Introduction

This report summarizes the findings of Glacier Bay National Park and Preserve's (GBNPP) humpback whale (*Megaptera novaeangliae*) monitoring program during the summer of 2015, the thirty-first consecutive year of consistent data collection in Glacier Bay and Icy Strait. The initial impetus for this program stemmed from concern in the late 1970s that increased vessel traffic in Glacier Bay may have caused a large proportion of the local whale population to abandon the bay (Jurasz and Palmer 1981). Beginning in 1973, humpback whales were listed as endangered under the U.S. Endangered Species Act (NOAA 2016), which afforded them increased federal protection and conservation concern. In addition, the National Park Service (NPS) is mandated to ensure that park management decisions do not negatively impact wildlife such as humpback whales [NPS Organic Act, 54 U.S.C. 100101(a)]. Therefore, each summer since 1985, Park biologists have documented the number of individual humpback whales in Glacier Bay and Icy Strait, as well as their residence times, spatial and temporal distribution, reproductive parameters and feeding behavior. These data are used as an index to monitor long-term trends in the population's abundance, distribution and reproduction. Residence times are valuable because they reflect site fidelity and habitat use. Long-term and consistent data collection in longitudinal studies is extremely rare and valuable in understanding the population parameters and recovery of an endangered species. A summary of whale/human interactions in the study area and elsewhere in Alaska has been included in this report since 2003 to document trends in ongoing whale conservation issues such as entanglements and vessel collisions. Photographic identification data are shared with other researchers studying North Pacific humpback whales. In addition, Park biologists use whale distribution data on a daily basis to make recommendations regarding when and where GBNPP 'whale waters' vessel course and speed restrictions should be implemented in Glacier Bay to reduce whale disturbance and collision risk.

Humpback whales that feed in southeastern Alaska (SEAK) in the summer spend the winter breeding season in the Hawaiian Islands, although a small proportion winters in Mexico (Baker *et al.* 1986; Perry *et al.* 1990; Calambokidis *et al.* 1997; Baker *et al.* 2013; Wade *et al.* 2016). In September 2016, NOAA reclassified the humpback whale globally into 14 distinct population segments (DPSs). The Hawaii DPS was one of 10 DPSs worldwide removed from the U.S. Endangered Species List, while the Mexico DPS remains listed as threatened (NOAA 2016). Humpback whales that summer in SEAK have been shown to exhibit strong maternally directed site fidelity (Baker *et al.* 1990; Straley 1994; Baker *et al.* 2013; Pierszalowski *et al.* 2016). In SEAK, the most recent population estimate was 1585 whales in 2008 (95% central probability interval: 1455, 1644) (Hendrix *et al.* 2012). This is considered the minimum population estimate for SEAK because no data were collected in southern SEAK. From 1985 to 2014, the number of unique whales documented annually in Glacier Bay and Icy Strait ranged from 41 to 241 whales, which closely matches population size estimates for this area derived from capture-recapture statistical analyses (Saracco *et al.* 2013). Overall the humpback whale population in the study area has been growing with an estimated 5.1% (95% CI = -1.3%, 11.9%) annual rate of increase from 1985-2014 and an accelerated rate of growth from 2002-2011 (11.1%/yr, 95% CI = 4.1%, 18.6%) (Gabriele *et al.* in press).

Humpback whale movement throughout SEAK is presumed to be linked with prey availability, which likely influences the number of whales in the study area (Baker *et al.* 1990; Krieger 1990; Straley 1994; Straley and Gabriele 1995). Whales in Glacier Bay and Icy Strait typically feed alone or in pairs (Gabriele *et al.* in press), primarily on small schooling fishes such as capelin (*Mallotus villosus*), juvenile walleye pollock (*Gadus chalcogrammus*), sand lance (*Ammodytes personatus*) and Pacific herring (*Clupea pallasi*) (Wing and Krieger 1983; Krieger and Wing 1984, 1986; NPS unpublished data). Notable exceptions are the large, stable 'core group' that commonly feeds at Point Adolphus in Icy Strait, although in recent years the group's size and stability have declined (Neilson *et al.* 2014, 2015). In addition, less consistent large aggregations of whales occasionally gather to feed at various locations in Glacier Bay and Icy Strait (NPS unpublished data).

Methods

The methods used for this annual monitoring program have been described in previous reports and publications (*e.g.*, Gabriele *et al.* in press). The primary techniques have not changed significantly since 1985, allowing for comparison of data between years. The specific methods used in 2015 are outlined below.

Vessel Surveys

We conducted vessel surveys in Glacier Bay and Icy Strait from May 5 through October 5, 2015. One to two observers primarily searched for, observed and photographed humpback whales from the *Sand Lance*, a 5.8-meter motorboat based in Bartlett Cove and equipped with a two-stroke Evinrude E-TEC 150 HP outboard engine. In addition, we conducted three surveys from the *Boomer*, a 6.7-meter motorboat equipped with a single two-stroke Yamaha 150 HP outboard engine and based in Bartlett Cove. To minimize the potential impact that monitoring efforts might have on whales, we typically did not conduct surveys in the same area on consecutive days.

The study area (1668 sq. km) included most of Glacier Bay and Icy Strait (Fig. 1) with a primary survey area (770 sq. km) covering the main body of Glacier Bay (roughly defined by four corners: Point Gustavus, Point Carolus, Geikie Inlet and Garforth Island) and central Icy Strait (roughly defined by four corners: Point Gustavus, Point Carolus, Pinta Cove and Mud Bay). Between June 1 and August 31, we surveyed the primary survey area in Glacier Bay 3-4 days per week, focusing the day's effort in a particular part of the study area. We surveyed the East Arm of Glacier Bay (generally only as far as the mouth of Adams Inlet) and the West Arm of Glacier Bay (generally only as far as Russell Island) infrequently. We did not conduct surveys in any Park designated non-motorized waters. We surveyed Icy Strait approximately once per week, with the greatest survey effort focused in the primary survey area. When whale numbers in Icy Strait were high and the weather allowed, we sometimes surveyed Icy Strait two or more times per week. Glacier Bay is the main area of NPS management concern with regard to whales, but descriptions of the whales' use of Icy Strait provide essential context for the Glacier Bay results because whales frequently move between these areas and because Park waters include portions of Icy Strait. Several Icy Strait surveys included the waters around Lemesurier and Pleasant Islands and the mouths of Dundas Bay and Idaho Inlet.

The intent of the survey protocol is to photographically identify as many whales as possible in the study area between June 1 and August 31 in a manner that is comparable between years. We use a mixed approach in which we go to 'hotspots' where whale sightings have been reported or are very probable, while also surveying outlying areas where whales may or may not be present. We strive for five surveys per week that cover the entire primary survey area (Fig. 1). Survey effort is only systematic to the extent that we aim to survey a particular portion of the study area on a given day and we generally do not survey the same area on consecutive days. However, where the whales are, and how many there are, dictates where the survey takes place and how much area we cover each day. Gathering life history data on individual whales is a secondary goal of the study, made possible by the whales' strong site fidelity to the study area and the high level of effort with which we cover the study area. The geographical distribution of whales is also of interest as it relates to vessel management in the Park (*e.g.,* whale waters), thus our effort is somewhat biased towards areas where vessel management is a concern. We limit our observations to good to fair ocean and visibility conditions [*e.g.,* in most cases, Beaufort ≤ 3, seas < 0.6 m (2 ft) and visibility > 0.8 km (0.5 mi)] and we make periodic stops to scan with 10x40 binoculars and listen for blows to keep our detection rate of whales high. This survey approach, combined with a high level of effort, approximates a census that identifies most of the whales in the study area in a given summer. In a recent study, capture-recapture statistical techniques were applied to GBNPP humpback whale monitoring data collected from 1985-2009 and revealed that our annual whale counts accurately capture about 90% of the non-calf whales in the study area (Saracco *et al.* 2013).

We defined 'survey hours' as the time we spent on the water in the study area each day (*i.e.,* from the time we departed the dock until the time we returned). This metric has been used since 1985. Beginning in 2005, we began recording 'effort hours' as the time we spent actively searching for whales each day (*i.e.,* not including transit time to/from the portion of the study area that was the day's focus). We also re-defined a survey 'day' from any day with survey hours in Glacier Bay or Icy Strait (1985-2004) (*i.e.,* some Glacier Bay 'days' were solely transits to/from Icy Strait) to only those days with survey effort hours in Glacier Bay or Icy Strait (2005-present). We count days in which there was survey effort in both Glacier Bay and Icy Strait as one Glacier Bay day and one Icy Strait day.

We defined a pod of whales as one or more whales within two to three body lengths of each other, surfacing and diving in unison (Baker 1985; Clapham 1993). We defined a shoal as a group of whales composed of subgroups that were within two to three body lengths of each other that were not necessarily surfacing and diving in unison and in which associations between individuals were fluid and ephemeral. Upon locating a pod or a shoal, we recorded the latitude and longitude coordinates of their initial location. We used a GPS-enabled iPad with Tap Forms software version 3.8.3 (Tap Zapp Software, Inc., Calgary, Canada), combined with custom datasheets, to record field data pertaining to the pod or shoal, including the initial location, number of whales, their behavior (feed, travel, surface active, rest, sleep, unknown), sketches of the markings on their tail flukes and dorsal fin, photographs taken, whale identity (if known), water depth, sea surface temperature and any prey patches observed on the depth sounder. If the whales were feeding we categorized their feeding behavior as subsurface, vertical lunge, lateral lunge, bubblenet, other bubble, flick or unknown (Jurasz and Jurasz 1979).

Individual Identification

The ventral surface of each whale's flukes has a distinct, stable black and white pigment pattern that allows for individual identification (Jurasz and Palmer 1981; Katona *et al.* 1979). For some whales, the shape and scarification of the dorsal fin also serve as unique identifiers (Blackmer *et al.* 2000). We took photographs of each whale's flukes and dorsal fin with a Nikon D90 digital camera equipped with a 100-300 mm zoom lens. We compared fluke and dorsal fin photographs to previous NPS photographs and to photographs of other humpback whales from SEAK (University of Alaska Southeast, unpublished data) to determine the identity and past sighting history of each whale.

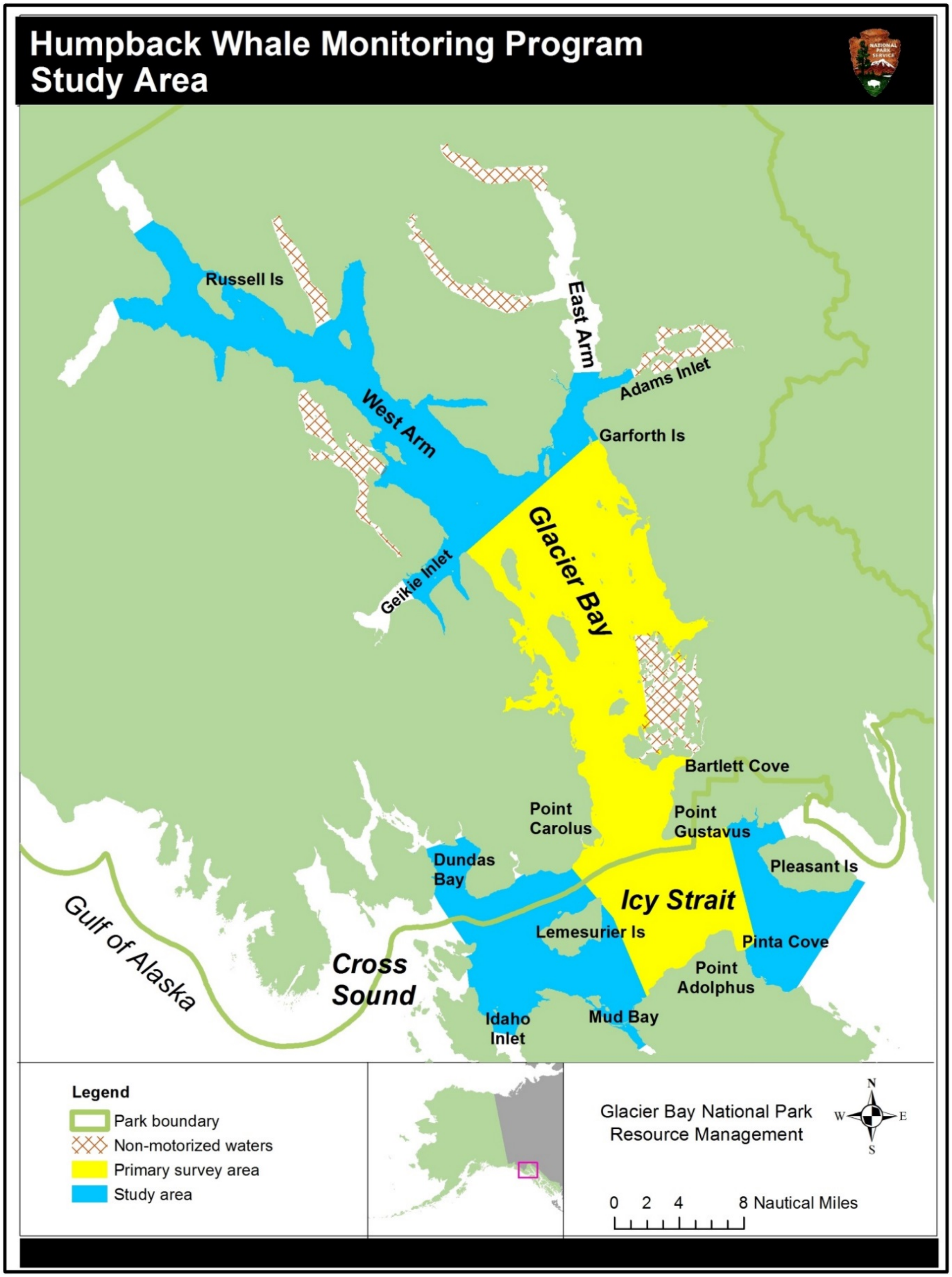

Figure 1. Study area in Glacier Bay and Icy Strait showing primary survey area and non-motorized waters.

We referred to many whales by a permanent identification number common to the combined catalogs of GBNPP and University of Alaska Southeast researcher Jan Straley (http://alaskahumpbacks.org/flukeIDcatalog.html). We also referred to those whales first photo-identified by Jurasz and Palmer (1981) by their nicknames. We only assigned calves a permanent identification number if we obtained at least one adequate photograph of the calf's flukes and the calf was sighted on more than one day. For calves that did not meet these criteria, we assigned a temporary unique identifier in the format "mother's identification number_calf_year" (*e.g.*, 1042_calf_2015). For non-calf whales that had not been previously identified in Glacier Bay and Icy Strait, we assigned temporary alphanumeric identification numbers. We replaced these temporary numbers with permanent identification numbers if we identified the whale on more than one day or if the whale was identified elsewhere by another researcher. Photographic and sighting data were added to a relational database containing Glacier Bay and Icy Strait whale sighting histories from 1977 to 2015. We also printed and catalogued the best 2015 identification photograph (flukes or dorsal fin) of each individual.

Whale Counts

We examined the 2015 season's photographs to determine the number of unique whales we observed. We defined annual whale counts as the number of unique whales identified per year. We made separate total counts of the number of unique whales that we sighted in Glacier Bay, Icy Strait and the combined GB-IS area for the dedicated monitoring period (June 1 - August 31) and for a 'standardized period' (July 9 - August 16) (after Perry *et al.* 1985). We used the "line drawn between Point Gustavus and Point Carolus" (Title 36 Code of Federal Regulations (CFR) Subpart N, 13.1102) to separate Glacier Bay and Icy Strait and assigned sightings north of the line to Glacier Bay and sightings south of the line to Icy Strait. Although the standardized period is substantially shorter than the current NPS monitoring period and the beginning and ending dates have no particular biological significance, we continue to use the standardized period because it provides the only valid means of comparing whale counts in 1982-1984 to later years (Gabriele *et al.* 1995).

Residency

We determined the number of whales that were 'resident' in the study area in 2015. We designated a whale as resident if it was photographically identified more than once in Glacier Bay and/or Icy Strait over a span of 20 or more days between June 1 - August 31 (after Baker 1986). Note that in some cases, an individual could leave Glacier Bay or Icy Strait in the interval between our sightings, then return, and be counted as a resident in the study area as long as 20 or more days had elapsed between two or more GB-IS sightings.

Reproduction and Juvenile Survival

We defined the following age classes: calves (less than one year old), juveniles (age 1-4 years, as determined by prior sighting history) and adults (age ≥ 5 years) (Chittleborough 1959). We monitor the reproductive histories of individual females and document the return and recruitment of these offspring into the population. We calculated crude birth rate as an index of reproduction by dividing the number of calves by the total whale count from June 1 - August 31. 'Known age' whales are non-calf whales whose birth year is known from photo-identification.

Tissue Sampling

We opportunistically collected sloughed skin on the sea surface with a small dip net when whales breached or performed other ‘surface active’ behavior (*e.g.*, breaches, tail slaps, etc.). We stored these sloughed skin samples in plastic vials filled with dry table salt (NaCl). We archived one-third of each skin sample at GBNPP (in dry salt) and sent one-third to be archived (frozen at -80° F) at the National Marine Fisheries Service Southwest Fisheries Science Center where they are available on request to other scientists studying a variety of topics. The remaining one-third of the sample is provided to the Cetacean Genomics Group at Oregon State University for use in our long-term collaboration examining humpback whale population structure in southeastern Alaska.

Prey Identification

We recorded instances when we observed probable whale prey such as small schooling fish in the vicinity of whales. In addition, we opportunistically collected anecdotal reports of whale prey in the study area. We used field guides (Smith and Johnson 1977; Pearse *et al.* 1987; Hart 1988; Mecklenburg *et al.* 2002; Johnson *et al.* 2015) and/or provided high resolution photographs to fish identification experts to taxonomically identify sample prey items that we collected opportunistically at the surface using a dip net.

Whale/Human Interactions

‘Whale waters’ are defined by NPS regulation as “any portion of Glacier Bay, designated by the superintendent, having a high probability of whale occupancy, based upon recent sighting and/or patterns of occurrence” (Title 36 CFR Subpart N, 13.1102). The whale observations from this study are used to make recommendations to the superintendent on where and when whale waters should be implemented. Vessel course and speed restrictions have long been used to reduce whale disturbance and collision risk in whale waters (Title 36 CFR Subpart N, 13.1174). Course restrictions require transiting vessels over 5.5 m (18 ft) to remain at least 1.9 km (1 nautical mile) from shore, or mid-channel in areas too narrow to maintain this course, to avoid the near shore areas most often used by feeding whales. Speed and course restrictions are both important aspects of whale protection because the increasing whale population combined with whales’ unpredictable distribution means that whales are often in mid-channel as well as near shore.

We summarized whale/human interactions (including strandings, vessel collisions and entanglements) in the study area and elsewhere in Alaska in 2015, based on our observations and those of other NPS staff, stranding data compiled by the NOAA Alaska Region Office of Protected Resources, the media and via anecdotal observations from the public. In addition, we opportunistically documented disturbance of whales by vessels and aircraft in the study area. While our reporting is likely not all-inclusive because under-reporting is known to occur, we attempted to characterize the number and types of whale/human interactions using the best available information.

Results and Discussion

Vessel Surveys

In the combined Glacier Bay/Icy Strait study area, survey hours totaled 332 h between June 1 and August 31 and effort hours totaled 251 h (Table 1). Effort hours in Icy Strait (63 h) and the study area as a whole (251 h) were below average compared to 2005-2014 (103.2 h and 292.8 h, respectively), while effort in Glacier Bay (188 h) was comparable to the average for 2005-2014 (189.6 h). Compared to 2014, we spent less time surveying in Icy Strait and more time surveying in Glacier Bay, primarily because most of the whales were found there in 2015. Interestingly, the number of survey days in Glacier Bay (n = 45 d) and Icy Strait (25 d) was above average compared to 2005-2014 (41.8 d and 23.0 d, respectively) (Table 2). This indicates that on average, our surveys were shorter in 2015, especially in Icy Strait. Indeed, from 2005-2014 average effort was 4.5 h/d in both Glacier Bay and Icy Strait. However, in 2015 average effort fell in both areas (GB = 4.2 h/d, IS = 2.5 h/d), most notably in Icy Strait. Overall in 2015, a combination of frequent high winds in Icy Strait and an overall lack of whales there caused us to bias our survey effort towards Glacier Bay. Although we strive to maintain a comparable level of overall survey effort each year, it inevitably fluctuates as a result of inter-annual variability in uncontrollable factors such as weather, availability of staff and the frequency of unexpected events that detract from our ability to conduct surveys (*e.g.*, mechanical difficulties and marine mammal strandings) (Table 1, Table 2).

Whale Counts

Between June 1 and August 31, 2015, we documented 166 humpback whales in Glacier Bay and Icy Strait (Table 3, Fig. 2, Fig. 3) which represents our lowest annual whale count since 2008. Outside of the regular June through August monitoring period, we documented an additional 15 whales in the study area, for a grand total of 181 unique whales in 2015. We documented these whales in May (n = 6), September (n = 5) and October (n = 3). In addition, we documented one whale in both May and September. Seven of the whales that we documented in the study area in June, July and August (not including dependent calves) were considered “new” because they had not been sighted previously in Glacier Bay or Icy Strait. One more new whale was documented outside of the June through August monitoring period, for a grand total of eight new whales in 2015. Five of these whales appeared to be small to medium in body size which indicates that they may have been juveniles. Two whales (male #441 and female #193) had 44-year sighting histories (1972-2015).

The overall number of whales in the study area continued to decline, with a 5% decrease between 2014 and 2015 (Table 3, Fig. 3) following the dramatic decrease in total abundance that we documented between 2013 and 2014 (-27%) (Neilson *et al.* 2015). In 2015, the declining trend was driven by a 40% decrease in whale abundance in Icy Strait (n = 75) compared to 2014 (n = 125) (Fig. 4), when numbers were already low relative to recent years. The number of whales in Icy Strait represents our lowest annual whale count since 2004 (Table 3, Fig. 4). We documented a 26% increase in the number of whales in Glacier Bay in 2015 (n = 125) compared to 2014 (n = 99) (Fig. 5).

Table 1. Annual number of survey hours and effort hours in Glacier Bay, Icy Strait and the combined area, June 1 - August 31, 1985-2015. The dashed line highlights a change in the way survey effort was calculated beginning in 2005 (see Neilson and Gabriele 2007). Survey hours are not available for 1986 or 1987. For 2005-2015, survey hours are only available for the combined area (Glacier Bay-Icy Strait). Effort hours are not available prior to 2005.

	No. survey hours			**No. effort hours**		
Year	**GB**	**IS**	**GB-IS**	**GB**	**IS**	**GB-IS**
1985	234	92	326	-	-	-
1986	-	-	-	-	-	-
1987	-	-	-	-	-	-
1988	199	108	307	-	-	-
1989	231	123	354	-	-	-
1990	215	115	330	-	-	-
1991	256	100	356	-	-	-
1992	248	71	319	-	-	-
1993	192	62	254	-	-	-
1994	169	92	261	-	-	-
1995	167	90	258	-	-	-
1996	259	116	374	-	-	-
1997	327	90	417	-	-	-
1998	344	64	408	-	-	-
1999	318	64	382	-	-	-
2000	321	84	405	-	-	-
2001	236	76	312	-	-	-
2002	297	68	365	-	-	-
2003	283	101	384	-	-	-
2004	373	74	447	-	-	-
2005	-	-	357	216	56	272
2006	-	-	356	197	85	282
2007	-	-	393	206	117	323
2008	-	-	367	187	117	304
2009	-	-	357	179	107	286
2010	-	-	364	194	99	293
2011	-	-	379	189	110	299
2012	-	-	343	144	129	273
2013	-	-	401	208	102	309
2014	-	-	352	177	110	287
2015	-	-	332	188	63	251
			2005-2014 average:	*189.6*	*103.2*	*292.8*

Table 2. Monthly and annual number of survey days in Glacier Bay and Icy Strait, 1985-2015. The dedicated annual monitoring period (June 1 - August 31) is shaded. The dashed line highlights a change in the way survey effort was calculated beginning in 2005 (see Neilson and Gabriele 2007).

	May		**June**		**July**		**August**		**September**		**Jun 1 – Aug 31**	
Year	**GB**	**IS**	**GB**	**IS**	**GB**	**IS**	**GB**	**IS**	**GB**	**IS**	**GB**	**IS**
1985	0	0	10	7	11	4	10	3	0	1	**31**	**14**
1986	0	0	13	5	17	3	6	6	0	2	**36**	**14**
1987	3	2	12	5	12	7	5	7	1	2	**29**	**19**
1988	0	0	11	5	12	7	12	5	7	3	**35**	**17**
1989	3	1	17	6	14	6	16	7	1	4	**47**	**19**
1990	6	4	16	5	18	6	14	8	0	0	**48**	**19**
1991	7	3	14	7	17	6	13	4	6	3	**44**	**17**
1992	3	2	19	4	17	5	12	4	7	1	**48**	**13**
1993	2	1	10	3	13	3	7	5	1	1	**30**	**11**
1994	1	0	9	5	10	4	13	8	1	1	**32**	**17**
1995	3	2	10	4	11	4	10	7	2	2	**31**	**15**
1996	4	2	11	5	17	10	16	3	3	1	**44**	**18**
1997	5	2	17	4	21	7	19	6	9	4	**57**	**17**
1998	10	4	20	3	23	6	12	4	5	2	**55**	**13**
1999	4	1	16	4	18	6	18	3	5	1	**52**	**13**
2000	1	0	21	8	21	5	23	6	5	1	**65**	**19**
2001	3	1	17	6	14	5	20	5	6	2	**51**	**16**
2002	3	1	19	6	19	4	18	2	4	2	**56**	**12**
2003	5	0	20	7	19	5	16	5	3	1	**55**	**17**
2004	6	2	21	3	19	5	21	5	8	2	**61**	**13**
2005	1	0	16	5	17	3	12	3	4	3	**45**	**11**
2006	2	2	14	6	15	7	16	7	5	1	**45**	**20**
2007	4	2	15	10	14	7	14	6	5	2	**43**	**23**
2008	4	1	16	10	14	8	12	9	3	1	**42**	**27**
2009	6	5	12	10	16	9	10	5	5	4	**38**	**24**
2010	5	3	14	9	11	11	17	8	3	5	**42**	**28**
2011	3	1	13	10	14	6	13	7	5	3	**40**	**23**
2012	5	2	11	8	12	9	12	10	4	2	**35**	**27**
2013	7	4	13	7	16	12	19	7	5	1	**48**	**26**
2014	5	6	11	9	14	8	15	4	4	1	**40**	**21**
2015	5	2	16	4	15	6	14	15	5	1	**45**	**25**
2005-2014 average:			*13.5*	*8.4*	*14.3*	*8.0*	*14.0*	*6.6*			***41.8***	***23.0***

Table 3. Standardized (July 9 - August 16) and total (June 1 - August 31) annual whale counts, 1985-2015.

Year	GLACIER BAY		ICY STRAIT		GLACIER BAY & ICY STRAIT	
	Standardized whale count	**Total whale count**	**Standardized whale count**	**Total whale count**	**Standardized whale count**	**Total whale count**
1985	7	15	19	30	24	41
1986	26	32	20	29	37	46
1987	18	30	33	48	40	60
1988	19	41	29	36	40	54
1989	22	26	20	28	33	41
1990	16	25	24	33	36	49
1991	17	19	35	42	46	53
1992	27	34	35	51	50	66
1993	23	30	24	30	40	50
1994	17	29	29	42	44	60
1995	18	28	26	44	37	57
1996	37	44	44	60	65	78
1997	41	55	33	50	67	82
1998	47	63	27	50	68	92
1999	36	63	39	65	68	106
2000	44	59	26	58	62	90
2001	26	45	58	85	72	100
2002	28	44	35	61	57	85
2003	54	82	62	77	103	117
2004	85	112	38	64	110	139
2005	67	102	50	90	96	146
2006	68	84	99	122	132	151
2007	76	91	98	129	132	161
2008	56	86	98	139	126	160
2009	59	108	125	162	145	182
2010	78	131	97	145	141	193
2011	133	151	82	157	175	221
2012	87	125	144	177	176	209
2013	125	162	160	205	211	241
2014	77	99	60	125	120	175
2015	92	125	49	75	127	166
1985-2015 average:	*49.2*	*69.1*	*55.4*	*80.9*	*86.5*	*112.0*
95% CI:	*(37.7-60.7)*	*(54.2-83.9)*	*(41.9-69.0)*	*(63.2-98.6)*	*(66.8-104.1)*	*(90.9-133.1)*

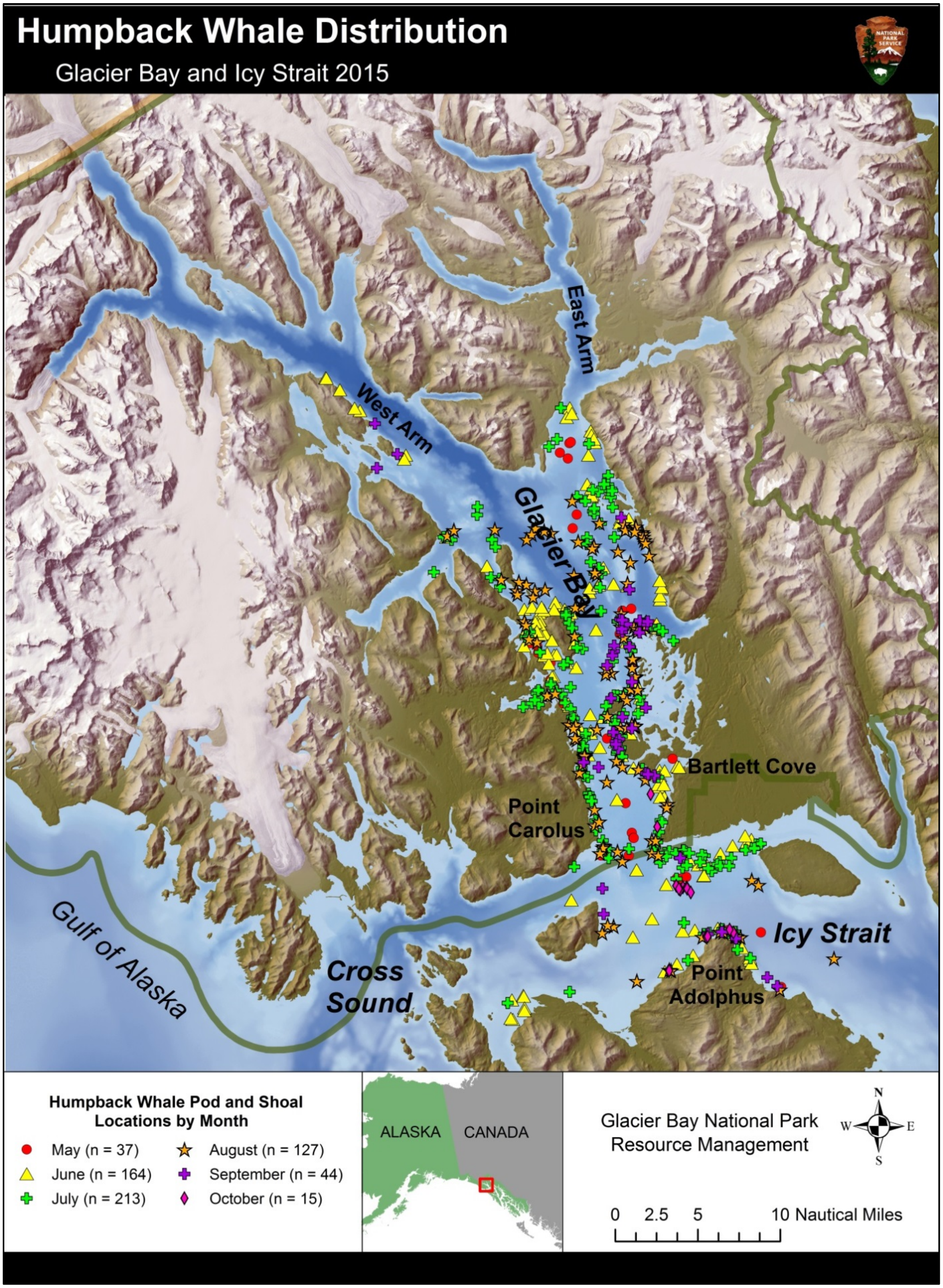

Figure 2. Study area in Glacier Bay and Icy Strait showing distribution of humpback whale pods and shoals in 2015. Each symbol represents a pod or shoal containing one or more whales.

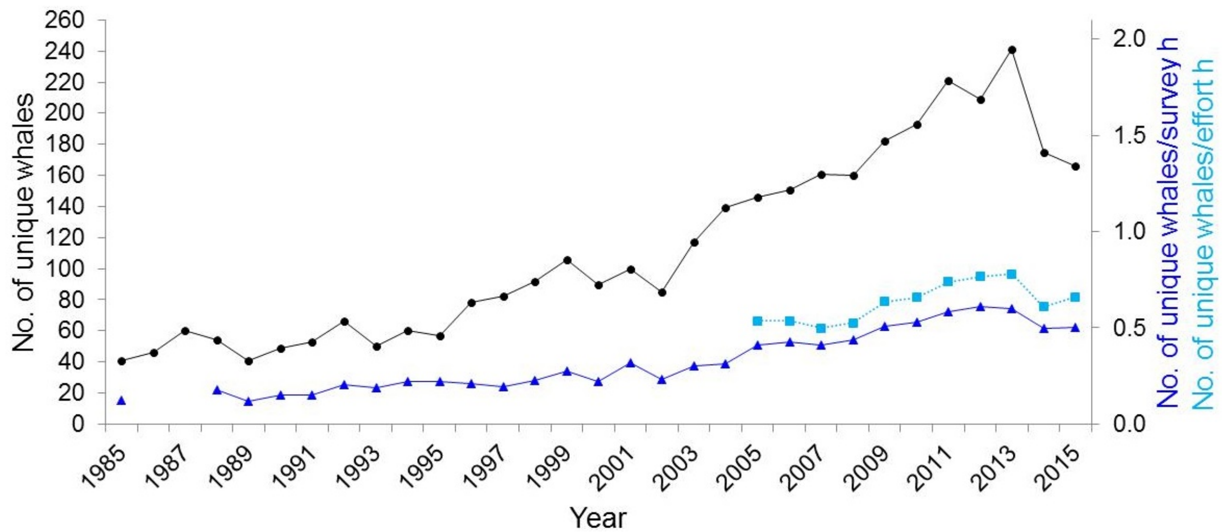

Figure 3. Annual whale counts (black), whales/survey h (dark blue) and whales/effort h (light blue) in Glacier Bay and Icy Strait from June 1- August 31, 1985-2015. Whales/survey h is not available for 1986-1987. Whales/effort h is not available for 1985-2004 because in these years we only recorded survey hours (see Neilson and Gabriele 2007).

Correcting whale counts for survey effort reveals some different trends. In contrast to the 5% decline in total whale counts in GB-IS since 2014, we found no change in whales/survey h in GB-IS in 2015 compared to 2014 (0.50 whales/survey h in both years) (Fig. 3). In contrast, we found that whales/effort h in GB-IS increased 8% compared to 2014 (0.61 whales/effort h in 2014 *vs.* 0.66 whales/effort h in 2015) (Fig. 3). We believe that whales/effort h is the most accurate metric to assess the population's trajectory because it controls for the amount of time we spent actively searching for whales.

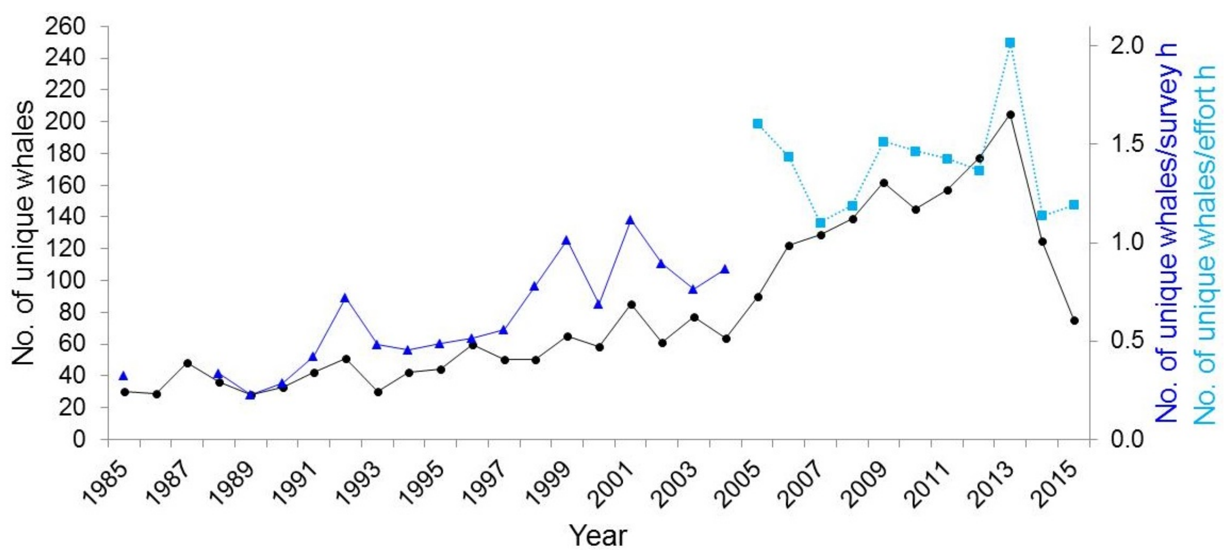

Figure 4. Annual whale counts (black), whales/survey h (dark blue) and whales/effort h (light blue) in Icy Strait from June 1- August 31, 1985-2015. Whales/survey h is not available for 1986-1987. Whales/effort h is not available for 1985-2004 because in these years we only recorded survey hours (see Neilson and Gabriele 2007).

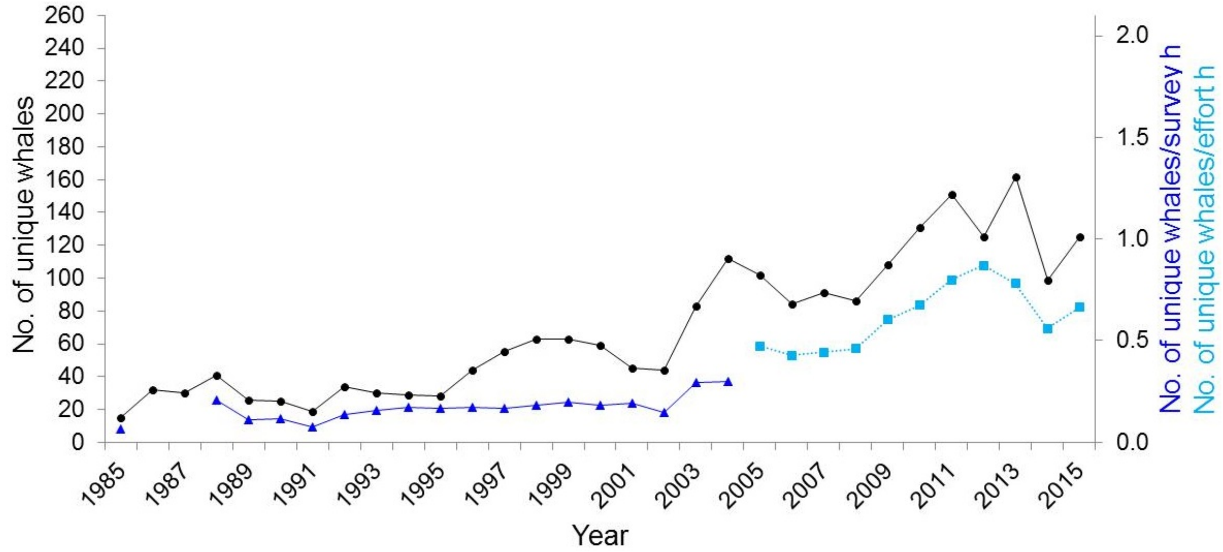

Figure 5. Annual whale counts (black), whales/survey h (dark blue) and whales/effort h (light blue) in Glacier Bay from June 1- August 31, 1985-2015. Whales/survey h is not available for 1986-1987. Whales/effort h is not available for 1985-2004 because in these years we only recorded survey hours (see Neilson and Gabriele 2007).

There appears to be an overall declining trend in the Icy Strait whale population since 2009, excluding 2013, when numbers spiked at 2.02 whales/effort h (Fig 4). In Icy Strait, total whale counts represented a 40% decline compared to 2014, although whales/effort h were similar in both years.

In Glacier Bay, we found a 19% increase in whales/effort h since 2014 (0.56 whales/effort h in 2014 *vs.* 0.66 whales/effort h in 2015) (Fig. 5), which is similar to the trend in total whale counts (+26% between 2014 and 2015). Still, this value is lower than in 2010-2013, when whales/effort h in Glacier Bay peaked at 0.87 whales/effort.

After many years of increase, the number of whales in the study area is undergoing a marked change. Although the whale counts, whales per survey hour and whales per effort hour reveal some differing trends, by all metrics we have documented an overall decline in whale use of the GB-IS study area beginning in 2014 compared to 2009-2013 (Fig. 3), with this trend driven in large part by declines in Icy Strait (Fig. 4). We presume that prey availability is the primary driver of whale movement in southeastern Alaska, thus this decline is most likely the result of a shift in prey availability. There are no other areas in Alaska with consistent levels of humpback whale monitoring effort comparable to GB-IS, so it is impossible to determine over what geographic scale these changes may have occurred or to quantify how humpback whales may have shifted their distribution within summer feeding areas in response to potential changes in prey or other factors.

The potential cause(s) of a shift in whale prey in the study area over the past two years are unknown but could include local over-browsing by whales, human over-fishing of whale prey species, changing oceanographic conditions and/or other factors. If the Hawaii DPS of humpback whales is approaching historical abundance in some parts of its range (Wade *et al.* 2016), competition among whales or other vertebrate predators could cause local depletion of prey resources, however there are no quantitative data on forage fish distribution and abundance in the study area. Alaska Department of Fish and Game surveys that monitor herring biomass at nine spawning areas in SEAK (the closest to the study area being Tenakee Inlet, approximately 75 km from the study area by water) show a period of high regional productivity from about 2005-2011, followed by a declining trend for herring in SEAK through 2014 (Hebert and Dressel 2015). Anecdotal observations of a decrease in herring in Icy Strait in 2014 and 2015, especially around Point Adolphus, are consistent with declines in whales/effort h in Icy Strait in 2014-2015 compared to 2009-2013.

Humpback whales have long been known to utilize more than one area within SEAK during their feeding season, with whales tending to move from GB-IS to the Frederick Sound-Seymour Canal area in mid-summer to fall (Straley 1994). Anecdotal evidence suggests that during summer 2015, higher than average numbers of humpback whales were found in several areas in SEAK and northern British Columbia. In early to mid-July, high numbers of whales were reported in Frederick Sound by the Alaska Whale Foundation and by cruise ship bridge teams (F. Sharpe, pers. comm.; NOAA unpublished data). In addition, throughout most of the summer, very high numbers of whales were reported by cruise ship bridge teams in lower Chatham Strait, lower Stephens Passage and around the mouth of Seymour Canal (NOAA unpublished data). In early July, unusually large groups of whales were reported around Annette Island, south of Ketchikan, by cruise ship bridge teams (NOAA unpublished data) and in early August we received similar anecdotal reports from this area (G. Freitag, pers. comm.). Earlier in the summer, very high numbers of humpback whales were reported in British Columbia (E. Lyman, pers. comm.). For several weeks in September, many (~30) humpback whales were reported near Juneau, along with unusually high numbers of euphausiids, whereas herring are more typical whale prey in this area (J. Moran, pers. comm.).

It is notable that in 2014 and 2015, anomalously high sea surface temperatures persisted in the northeastern Pacific Ocean, including in the Gulf of Alaska. The effect of this persistent, so-called warm water “blob” on humpback whale abundance and distribution in the study area is unknown, but unusually warm waters were implicated in a wide variety of cascading effects on the marine ecosystem (Bond *et al.* 2015; Miller 2016). Preliminary analysis of oceanographic data collected in Icy Strait in July 2014 and 2015 indicates that in 2015 the water column may have been more stratified and that water temperatures may have been slightly warmer than normal, however data collected at a station in mid-Glacier Bay show no apparent stratification or warming trends in 2014 or 2015 (NPS unpublished data). Glacier Bay’s oceanography is unique due to the cooling influence that meltwater from warming tidewater glaciers may have on surface ocean waters, which may effectively buffer Glacier Bay from regional ocean warming trends (S. Danielson, pers. comm.). Even if oceanographic conditions in the study area were unchanged in 2014 and 2015, it is plausible that the anomalously warm waters in some parts of the northeastern Pacific through which humpback whales migrate affected their abundance, distribution and prey availability in GB-IS beginning in 2014.

In summary, by all metrics we have documented an overall decline in whale use of the GB-IS study area beginning in 2014 compared to 2009-2013, with this trend driven in large part by declines in Icy

Strait, and there is reason to believe that a number of factors, including possible changes in the availability of whale prey in the study area and the presence of unusual oceanographic conditions in the northeastern Pacific Ocean, may have played a role in shifting whale distribution away from the GB-IS study area.

Residency

The historically high rate of residency in the study area highlights the importance of the Glacier Bay-Icy Strait region as a summer feeding ground for many humpback whales. Furthermore, monitoring results over many years have shown that while some whales are exclusive residents to Glacier Bay or Icy Strait, many move frequently between the two areas, demonstrating that the Glacier Bay-Icy Strait ecosystem is a single contiguous habitat (*e.g.*, Neilson *et al.* 2012). In 2015, 106 of the 166 whales (64%) that we documented in the study area between June 1 and August 31, including three mother/calf pairs, remained 20 or more days, meeting our definition of resident. This proportion is similar to historic values (1985-2014 mean = 0.62, SD = 0.08) and notably higher than in 2014, when the residency rate dropped to 49% (Neilson *et al.* 2015).

In contrast to residents, 42 (27%) of the whales that we documented between June 1 and August 31, including two mother/calf pairs, were identified on just one day (20 in Glacier Bay and 24 in Icy Strait). Six of these whales, including one mother/calf pair, were documented in Icy Strait on June 9; otherwise the sightings occurred over a broad range of dates and locations. The proportion of whales sighted on one day varies widely each year (1985-2014 range = 0.17-0.42, mean = 0.26, SD = 0.07).

Several historically resident whales (adult male #221, adult male #875, 28-year-old female #1042 and 21-year-old male #1293) were identified on just one day between June 1 and August 31, 2015. Some of these individuals were also present in May, outside of the regular monitoring period, but their near absence between June 1 and August 31 indicates an apparent break in these whales' historically strong summer site fidelity to GB-IS. In addition, 23-year-old female #1304, also a resident of the study area in many past years, was identified in the study area on just one day in early May. Some of these same typically resident whales appeared to exhibit a similar lack of site fidelity to GB-IS in 2014. We presume that this represents a shift away from GB-IS as opposed to mortality, but we are not aware of any sightings of these individuals elsewhere in SEAK in 2014 or 2015.

Reproduction and Juvenile Survival

We identified five mother/calf pairs in 2015 (Table 4) with the lowest crude birth rate (3.0%) recorded since 1984, although this is a highly variable parameter (3.0%-18.2%) (Table 5). Whale #1651 (sex previously unknown) was documented with her first known calf.

Table 4. Mother-calf pairs documented in 2015 (GB = Glacier Bay, IS = Icy Strait).

Mother ID#	Mother's age (years)	No. of previous calves documented	Calf skin collected?	Calf ID#	Documented in
397	unk	7	Yes	397_calf_2015	IS
1018	unk	6	No	2599	GB & IS
1042	28	5	No	1042_calf_2015	IS
1233	29	2	No	1233_calf_2015	GB
1651	unk	0	No	1651_calf_2015	GB

We identified two three-year-old whales that had not been documented in SEAK since they were calves in the study area. We did not identify any of the five "missing" calves from 2014 (Neilson *et al.* 2015) that would have been yearlings in 2015 although we documented all five of the mothers of the missing calves in the study area, confirming their survival. The mean age at which calves return to the study area is 3.2 years (Gabriele *et al.* in press), thus the fate of the five missing calves is unknown.

The value of the longevity of this study is highlighted by the fact that 40% (n = 65) of the non-calf whales that we identified in 2015 (n = 161) were of known age, primarily from previous sightings in the study area. This means that our dataset is increasingly useful for estimating life history parameters such as age at first reproduction in females.

Tissue Samples

In 2015 we collected 17 sloughed skin samples from 16 unique whales, including one calf. Since 1996, we have collected 314 sloughed skin samples in the study area. Genetic analysis of these samples allows sex determination, definition of mitochondrial DNA haplotype and nuclear DNA genotyping and these results have contributed to several humpback whale genetic studies (*e.g.,* Baker *et al.* 2013, Pierszalowski *et al.* 2016).

Prey Identification

Similar to past years, in 2015 capelin was the most common prey species that we detected opportunistically near feeding humpback whales (Table 6). In some years we have detected capelin in Icy Strait, but in 2015 all of our confirmed and suspected observations of capelin occurred in Glacier Bay. Between mid-May and late July, we collected five capelin samples near whales feeding between northern Rush Point and upper Whidbey Passage and one sample near whales in Bartlett Cove. In addition, on July 20 a local charter vessel captain reported seeing dense aggregations of capelin in the Point Gustavus reef near several feeding whales (J. Kearns, pers. comm.).

We made one confirmed detection of sand lance in Glacier Bay in 2015 (Table 6); however, it is possible that some of the unidentified forage fish that we observed were sand lance based on their shape and coloration.

Table 5. Reproduction and known age whales in Glacier Bay and Icy Strait, 1982-2015. Number of calves photo ID'd is the number of calves with fluke photos (*vs.* dorsal fin only photos). Calf photo ID rate is a percentage computed by no. calves photo ID'd / no. of calves. Crude Birth Rate (CBR) is a percentage computed by no. calves / total whale count. CBRs for 1982 and 1983 could not be calculated because total whale counts for these years are not available. Number of known age whales does not include calves of the year. These data are not available for 1982-1984.

Year	No. of calves	No. of calves photo ID'd	Calf photo ID rate (%)	Crude Birth Rate (%)	No. of known age whales	Total whale count
1982	6	3	50	-	-	-
1983	0	0	0	-	-	-
1984	7	5	71	17.9	-	39
1985	2	1	50	4.9	3	41
1986	8	5	63	17.4	2	46
1987	4	3	75	6.7	5	60
1988	8	5	63	14.8	4	54
1989	5	3	60	12.2	5	41
1990	6	6	100	12.2	8	49
1991	4	4	100	7.5	8	53
1992	12	10	83	18.2	8	66
1993	3	3	100	6.0	13	50
1994	9	5	56	15.0	12	60
1995	3	2	67	5.3	11	57
1996	6	3	50	7.7	21	78
1997	9	7	78	11.0	19	82
1998	8	7	88	8.7	22	92
1999	9	5	56	8.5	29	106
2000	3	2	67	3.3	26	90
2001	12	9	75	12.0	30	100
2002	11	6	55	12.9	28	85
2003	7	5	71	6.0	31	117
2004	16	12	75	11.5	39	139
2005	10	5	50	6.8	41	146
2006	13	8	62	8.6	45	151
2007	17	12	71	10.6	46	161
2008	15	12	80	9.4	55	160
2009	12	10	83	6.6	59	182
2010	21	15	71	10.9	58	193
2011	11	8	73	5.0	69	221
2012	16	14	88	7.7	63	209
2013	10	9	90	4.1	81	241
2014	14	6	43	8.0	64	175
2015	5	1	20	3.0	65	166
1985-2014 average:	*9.5*	*6.7*	*71.3*	*9.3*	*31.3*	*110.2*

Table 6. Prey species observed near humpback whales in 2015.

Method	Prey species (# of cases)						
	capelin	*capelin?*	*Pacific herring*	*Pacific herring?*	*sand lance*	*walleye pollock*	*unknown forage fish spp.*
Collected specimen with dip net	6		2		1		
'Cucumber' smell in air		9					
Fish observed near surface		1					2
Prey observed on sonar				1			
Seabirds observed eating fish						1	6

In past years, we have detected Pacific herring near feeding whales in Icy Strait, especially around Point Adolphus, but in 2015 we only had one possible observation of herring at Point Adolphus (based on a sonar image near a group of feeding whales) (Table 6). Our observations were consistent with those of a local charter fishing vessel captain, who reported in late July that herring were notably absent in Icy Strait compared to past years, while myctophids appeared to be unusually abundant, although in August he observed some herring (M. Halbert, pers. comm.). This was also the third summer in a row that we have documented relatively low numbers of whales around Point Adolphus, which was a consistent hot spot for high numbers of whales from 1985-2012. We observed a small version of the 'core group' (7-9 whales) around Point Adolphus for part of the summer, but after mid-August we did not see the group. We have documented myctophids several times near feeding whales in past years (Neilson *et al.* 2015), although previous studies in Icy Strait have found them to be relatively rare compared to more typical humpback whale prey species such as capelin and walleye pollock (Abookire *et al.* 2002).

In 2015 we detected herring in Glacier Bay for the first time (Table 6). On August 25, we observed a single whale lunge feeding near South Sandy Cove in association with many gulls, murrelets and common murres (*Uria aalge*). We used a dip-net to collect a nearby sample of herring (M. Arimitsu, pers. comm.). A few weeks before, on August 7, a local charter vessel captain had reported catching small herring [~1.5 in (3.8 cm) long] in a similar area (Spokane Cove) (J. Kearns, pers. comm.). On August 3, we collected young-of-the-year and adult (age 2+) herring (M. Arimitsu, pers. comm.) from two dense surface schools that we observed in Bartlett Cove, although we did not observe any whales in the immediate vicinity (thus, these samples are not included in Table 6). In mid-September, the same charter vessel captain reported catching herring about ~4 in long (10.2 cm) west of Flapjack Island (J. Kearns, pers. comm.). On September 21, we collected several herring near a single whale that was lunge feeding just outside of Bartlett Cove. Previous studies have documented herring in Glacier Bay, although in relatively lower overall abundance than other forage fish such as capelin, walleye pollock and sand lance (Arimitsu *et al.* 2007; Renner 2012). Our increased observation of herring may indicate that they were more numerous in Glacier Bay.

Whale/Human Interactions

Whale Waters

In 2015, a 13-knot vessel speed limit was implemented in lower Glacier Bay whale waters for 104 days. In recent years similarly long duration whale waters have become typical (2007-2013 range = 92 - 143 days). Compared to 2013 and 2014, when whale activity in lower Glacier Bay fluctuated greatly within the season, in 2015 whale use of the lower bay was relatively consistent in June, July and August.

Beginning in early June, we documented high numbers of whales in lower Whidbey Passage, Berg Bay, Fingers Bay and around Willoughby Island with as many as 21 whales observed in a single survey (June 26). Temporary whale waters were designated in this area from June 4-July 28 (55 days). By late July, the number of whales that we observed in this area had declined but many whales continued to feed in and around Berg Bay, where temporary whale waters remained in place from July 28-August 18 (22 days).

At the end of June, at least 10 whales feeding in the vicinity of Garforth Island near one of the designated camper drop-off sites prompted the park to issue a whale 'advisory' for this area, in which we recommended a maximum vessel speed limit of 13 knots to protect whales from collision and disturbance. Under this non-regulatory approach we worked directly with the only motorized vessel known to regularly transit through the area, Glacier Bay Lodge's day tour boat, the 22-m catamaran *Baranof Wind*. This advisory, the second of its kind (we issued a similar advisory in 2012 for Sundew Cove; Neilson *et al.* 2013), was well received and this targeted conservation approach appeared to be successful, with no collisions or close calls reported in this area by NPS rangers or crew onboard the *Baranof Wind*.

From August 18-27 (10 days), a 13-knot vessel speed limit was designated in the middle of Glacier Bay (between Lone Island, Sebree Island, South Marble Island and Willoughby Island) to protect numerous whales that appeared to be feeding on a deep layer of prey in this area. These whales were moving erratically and diving for long periods of time ($\geq$ 8-10 min), with several incidents in which whales surfaced unexpectedly in close proximity to transiting vessels.

This was the second year in a row since 2004 that whale numbers in park waters around Point Carolus were not high enough to warrant designating temporary whale waters in this area.

Vessel Collisions

No whale-vessel collisions were reported in the study area in 2015. Elsewhere in SEAK, five collisions involving humpbacks were reported, including a collision involving a U.S. Navy submarine transiting at 10 knots at the surface of Behm Canal (NOAA Alaska Region unpublished data). The fate of the whales involved in these collisions is unknown. However, a dead whale found in Frederick Sound on August 26 may have been the result of a collision reported by the 124 m-Alaska state ferry *Matanuska* on August 5 in lower Stephens Passage (see below, Dead Whales).

Elsewhere in Alaska, no other whale-vessel collisions were reported in 2015 (NOAA Alaska Region unpublished data).

Dead Whales

No dead humpback whales were found in the study area in 2015 but elsewhere in SEAK, three dead humpbacks were reported (NOAA Alaska Region unpublished data).

On April 23, the carcass of a small (8.2 m) humpback whale was found on a beach in Carroll Inlet near Ketchikan. A few samples were collected, but no necropsy was conducted, and the cause of death was undetermined (NOAA Alaska Region unpublished data). Based on the animal's length and the date on which it was found, we suspect that this whale was either a large calf or a small yearling because humpback whales typically grow to 7-8 m in length by late summer and attain body lengths of 8-10m at independence (Straley 1994; Clapham *et al.* 1999).

On May 4, an airplane pilot spotted a dead humpback whale on a remote beach near Cape Yakataga, approximately 150 km northwest of Yakutat. No samples were collected and the cause of death was undetermined (NOAA Alaska Region unpublished data).

On August 26, a dead humpback whale was reported on East Brothers Island in Frederick Sound. A necropsy conducted on September 1 found that the subadult female (9.2 m in length) had blunt trauma injuries consistent with a vessel collision. Based on the nature of the whale's injuries, the level of decomposition and the location of the carcass, it is plausible that this is the same whale reported to have been struck by the Alaska state ferry *Matanuska* approximately 30 km to the north in Stephen's Passage on August 5 (NOAA Alaska Region unpublished data).

In August 2015, NOAA declared an Unusual Mortality Event (UME) for large whales in the western Gulf of Alaska, sparked by a marked increase in the number of dead fin whales found in this area beginning in May 2015. Humpback whales were included in the UME investigation based on 26 reports of dead humpbacks in the region in 2015 (this tally does not include the Bering Sea, Arctic Ocean or inside waters of SEAK) (NOAA Alaska Region unpublished data). Several dead humpback whales were also reported in British Columbia in 2015, however the geographic scope of the UME, as well as the species involved and the cause(s) of the UME remain under investigation (K. Savage, pers. comm.).

Entangled Whales

On June 2, two passengers on the cruise ship *Westerdam* alerted a Glacier Bay National Park ranger onboard the ship that there was an entangled whale near Willoughby Island in Glacier Bay. As the ship transited south approximately one mile (1.7 km) away, the ranger and passengers saw what appeared to be an adult-sized humpback whale "thrashing" with two orange buoys visible. The whale did not appear to be moving in any direction and no gear besides the buoys was visible. We mobilized the Park's trained whale disentanglement team in Bartlett Cove while the ranger from the cruise ship was transferred to the NPS vessel *Serac*. While we prepared to respond, the *Serac* headed to the area to try to re-locate the entangled whale. They observed several whales exhibiting normal feeding behavior and spotted a pair of orange buoys near shore. Upon further investigation, they determined that the buoys were floating free and that the end of the line was frayed as it if had parted under great force (*e.g.*, a thrashing whale). With this information, we concluded that the whale had self-released and the disentanglement effort was demobilized. The buoys and line were identified as commercial longline gear that had been set near Willoughby Island approximately two hours before the whale was reported entangled and the gear was returned to the owner. On June 3, we conducted a survey around Willoughby Island and documented several whales, but none had any visible entanglement injuries. The identity of the whale involved in this incident is unknown.

However, on June 19, we documented a significant injury on the left fluke blade of adult male humpback whale #1083 in Glacier Bay (Fig. 6). Both of his flukes were intact when last photographed on August 27, 2014. We speculate that the incision to this whale's fluke may be attributable to an entanglement or a vessel collision. Based on the red and yellow color of the tissue around the wound, the injury appeared to be recent. Therefore, we hypothesized that #1083 may have been the "adult-sized" humpback whale reported entangled on June 2. Although we did not photograph #1083 in the area before the reported entanglement, he was documented very close to where the entanglement occurred on July 9. Because the caudal peduncle is a part of the body commonly involved in large whale entanglements (Heyning and Lewis 1990; Kraus 1990; Johnson *et al.* 2005), we compared the scars on #1083's caudal peduncle before and after he acquired the incision; however, no new entanglement scars were apparent. While the fluke wound is not typical of an entanglement, according to scientists familiar with entanglement scarring (E. Lyman and J. Neilson), it seems possible that this brief entanglement might have produced a unique set of wounds. We first documented whale #1083 as an adult in 1993, making him at least 23 years old in 2015.

Figure 6. Whale #1083 on June 29 (left) and August 3, 2015 (middle and right) showing new incision in left fluke.

No other entangled whales were reported in Glacier Bay or Icy Strait in 2015. Elsewhere in SEAK, 12 humpback whales were reported entangled, although some of these reports may have been re-sights of the same individuals. Elsewhere in Alaska, eight more humpback whales were reported entangled, including a whale near Dutch Harbor assessed to have a life threatening entanglement that was later found dead (NOAA Alaska Region unpublished data).

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