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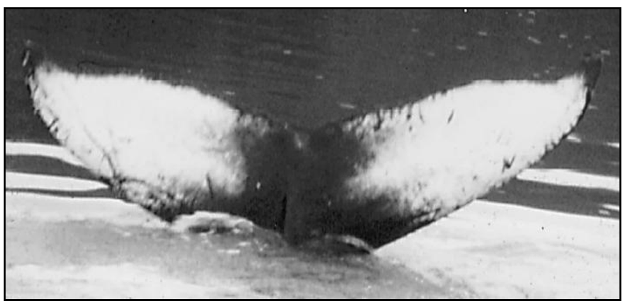
Humpback Whale Monitoring in Glacier Bay and Adjacent Waters 2014

Annual Progress Report

Natural Resource Report NPS/GLBA/NRR—2015/949



ON THE COVER

Humpback whale #516 “Garfunkle” as a calf in 1974 (left) and at age 40 in 2014 (right). Photographs courtesy of Sea Search Ltd. and Glacier Bay National Park and Preserve.

Humpback Whale Monitoring in Glacier Bay and Adjacent Waters 2014

Annual Progress Report

Natural Resource Report NPS/GLBA/NRR—2015/949

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Collins, Colorado

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

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 in digital format 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 endangered humpback whales (*Megaptera novaeangliae*) from the Central North Pacific stock use southeastern Alaska as summer feeding habitat, including the waters in and around Glacier Bay National Park and Preserve (GLBA). This report summarizes the findings of GLBA's humpback whale monitoring program in 2014, the thirtieth consecutive year of consistent data collection in Glacier Bay and Icy Strait (GB-IS). From June through August, the number of whales in GB-IS (n = 173) represented a 28% decline in abundance compared to 2013 and the largest inter-annual decline in whale numbers since monitoring began (1985-2014 inter-annual range: -28% to +37%). Compared to past years, fewer whales met our definition of 'resident' and a high proportion of whales (0.34) were identified on just one day. Between early August and late October, an unprecedented number of mothers (5 of 14) appeared to be missing their calves. We collected 15 sloughed skin samples, including samples from two calves, for genetic analysis. Similar to past years, we primarily detected capelin (*Mallotus villosus*) and sand lance (*Ammodytes hexapterus*) as whale prey. We documented several whale/human interactions, and whale #539 ("Max"), a well-known adult female who frequented GB-IS, was found dead from a ship strike in Chatham Strait.

In summary, all metrics by which we measure the local whale population noted a decline or anomaly in 2014. We discuss possible reasons why this was an unusual year for humpback whales in GB-IS, including oceanographic conditions of increased turbidity and temperature, and explore various explanations for the missing calves.

Acknowledgments

Whale sightings, behavioral observations and enthusiasm from Park staff and volunteers continue to play an important role in this long term study. In 2014, we were fortunate to have the excellent assistance of Kierstin Barlow; her hard work and attention to detail were integral to the success of our field season. We thank Bruce McDonough for keeping the *Sand Lance* running smoothly all these years. 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, Nat Drumheller, Todd Bruno and the crew of the NPS vessel *Serac*. We thank John Rodstrom, Katie Rayfield, Craig Murdoch and Mayumi Arimitsu for their help with fish identification. We extend our thanks to Nate Borson, Zach Brown, Gary Freitag, Don Holmes, Jim Johnson, Jim Kearns, Steve Lewis, Sean Neilson, Lewis Sharman, Zach Stenson, Doug Sturm, Suzie Teerlink and Jamie Womble for sharing their field observations. Thanks to Lewis Sharman for also sharing preliminary 2014 oceanographic data from the study area. We are grateful to Chris Sergeant for his help with Figure 5. We appreciate our long and fruitful collaboration with Jan Straley and Jennifer Cedarleaf at University of Alaska Southeast in Sitka. Thanks to Kaili Jackson, Aleria Jensen, Kate Savage and Ed Lyman [National Oceanic and Atmospheric Administration (NOAA)] for investigating, compiling and sharing data on humpback whale strandings and entanglements in Alaska. We are grateful to Kathy Burek-Huntington and Frances Gulland for leading large whale necropsies in Alaska to investigate ship strikes. We are also grateful to John Moran (NOAA) for sharing data and field observations with us. We thank Tania Lewis and Chris Sergeant for reviewing this report and providing valuable comments.

National Park Service (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 work was carried out under NOAA Fisheries Permit #15844.

Introduction

This report summarizes the findings of Glacier Bay National Park and Preserve's (GLBA) humpback whale (*Megaptera novaeangliae*) monitoring program during the summer of 2014, the thirtieth 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). The federal government is mandated to ensure that park management decisions do not negatively impact endangered species such as humpback whales. Therefore, each summer Park biologists document 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. Residence times are valuable because they reflect site fidelity and habitat use. These data are used as an index to monitor long-term trends in the population's abundance, distribution and reproduction. Long term and consistent data collection in longitudinal studies is extremely rare and valuable in understanding the population parameters and trajectory 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 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 GLBA 'whale waters' vessel course and speed restrictions should be implemented in Glacier Bay.

The humpback whales in the study area are part of the southeastern Alaska (SEAK) feeding herd which is in turn a part of the central North Pacific stock. Humpback whales in this stock winter mainly in the Hawaiian Islands and migrate in the summer to feed in British Columbia, SEAK, the Gulf of Alaska and the Bering Sea/Aleutian Islands (Baker *et al.* 1990; Perry *et al.* 1990; Calambokidis *et al.* 1997, Calambokidis *et al.* 2008, Barlow *et al.* 2011), where they exhibit strong maternally directed site fidelity (Baker *et al.* 1990; Straley 1994; Baker *et al.* 2013; Pierszalowski 2014). 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 2013, the number of individual whales documented in Glacier Bay and Icy Strait ranged from 41 to 239 per year (Neilson *et al.* 2014), which closely matches population size estimates for this area derived from capture-recapture statistical analyses (Saracco *et al.* 2013). From 1985-2009, the average annual rate of population growth in Glacier Bay and Icy Strait was 4.4% (95% CI: 1.7%-7.0%) (Saracco *et al.* 2013).

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 and Gabriele 1995; Straley 1994). Whales in Glacier Bay and Icy Strait typically feed alone or in pairs, primarily on small schooling fishes such as capelin (*Mallotus villosus*), juvenile walleye pollock (*Theragra chalcogramma*), sand lance (*Ammodytes hexapterus*) and Pacific herring (*Clupea pallasi*) (Wing and Krieger 1983; Krieger and Wing 1984, 1986). Notable exceptions are the large, stable "core group" that commonly feeds at Point Adolphus in Icy Strait, and less consistent large aggregations of whales that gather to feed at various locations in Glacier Bay and Icy Strait (National Park Service (NPS) unpublished data).

Methods

The methods used for this annual monitoring program have been described in previous reports. The primary techniques have not changed significantly since 1985, allowing for comparison of data between years. The specific methods used in 2014 are outlined below.

Vessel Surveys

We conducted surveys in Glacier Bay and Icy Strait from May 5 through October 24, 2014. We 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. 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 included all of Glacier Bay and most of Icy Strait (Fig. 1) with a primary survey area covering the main body of Glacier Bay (roughly defined by four corners: Point Gustavus, Point Carolus, Geikie Inlet and Garforth Island) contiguous with a primary survey area in 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 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 GLBA 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 effort hours as only those hours that we spent actively surveying for whales (*i.e.*, transit time to/from Bartlett Cove was not counted). We defined a survey "day" as any day with survey effort hours in Glacier Bay or Icy Strait, thus we counted 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 five body lengths of each other, surfacing and diving in unison. We defined a shoal as a group of whales composed of subgroups that were within five 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. Starting this year, 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 activity (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.

We referred to many whales by a permanent identification number common to the combined catalogs of GLBA 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.*, 1298_calf_2014). 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 2014. We also printed and catalogued the best 2014 identification photograph (fluke or dorsal fin) of each individual.

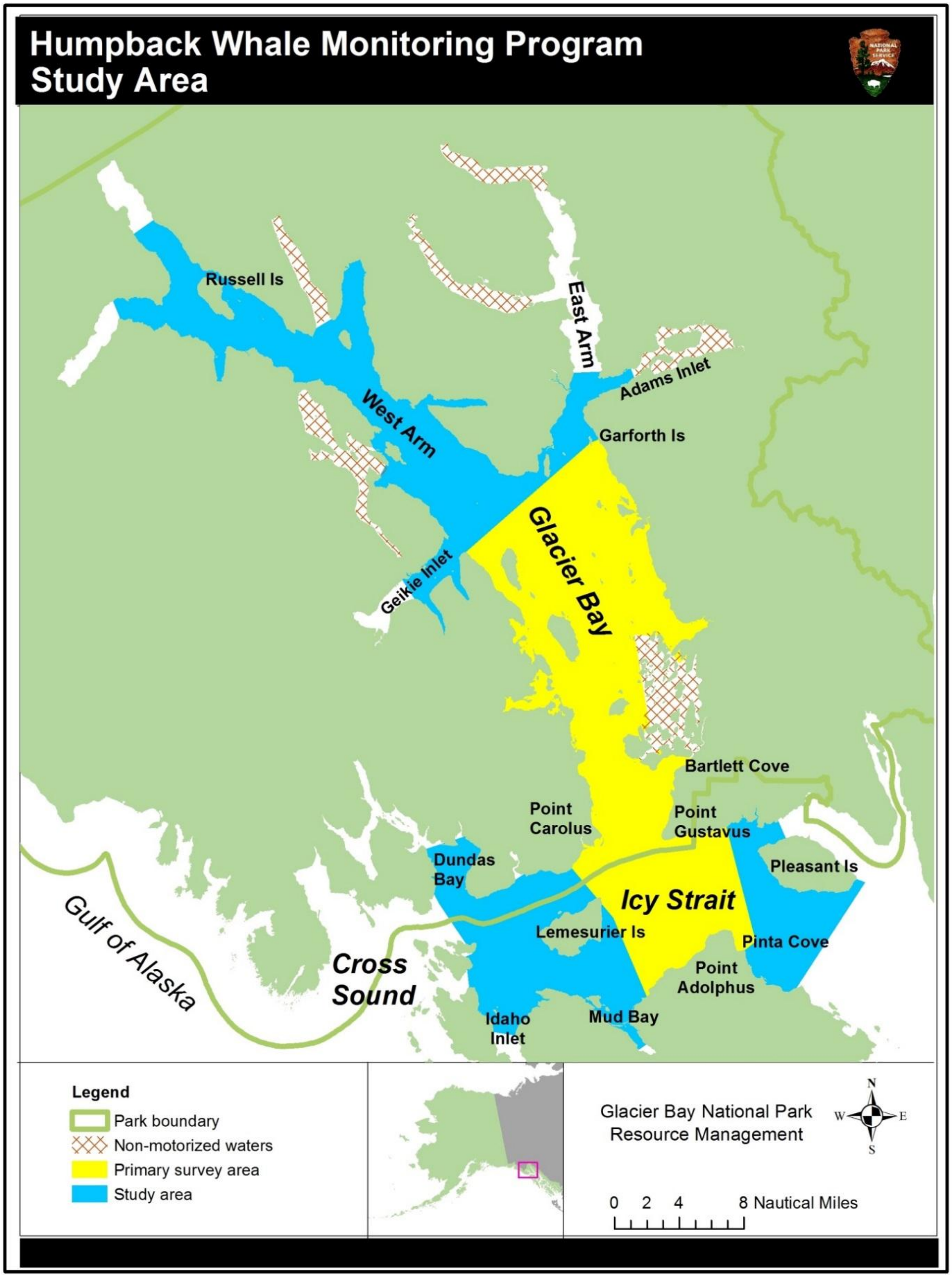

Figure 1. Study area in Glacier Bay and Icy Strait showing primary survey area and non-motorized waters.

Whale Counts

We examined the 2014 season's photographs to determine the number of distinct individual whales observed. We made separate counts of the number of individual 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" [found in Park regulations defining Glacier Bay (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). In a growing population, it is not valid to compare present abundance to the entire time series, so we compared our 2014 observations with recent years, which we defined as the five year period 2009-2013. We used Mann-Whitney *U* tests (StatView version 5.0, SAS Institute, Inc., Cary, NC) to test for significant differences in 1) the median number of whales we encountered per survey in June, July and August 2014 compared to data pooled by month from 2009-2013 and 2) the median water depths in which whales were found in 2014 compared to data pooled from 2009-2013. We used $\alpha = 0.05$ to determine significant differences.

Residency

We determined the number of whales that were 'resident' in the study area in 2014. We defined 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 (after Baker 1986). Under this definition, it is possible that 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 $\geq$ 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 (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 GLBA (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 with Dr. C. Scott Baker examining humpback whale population structure in southeastern Alaska.

Feeding Behavior and 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) 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, 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 document the number and types of whale/human interactions to the best of our ability.

Results and Discussion

Vessel Surveys

We conducted vessel surveys for humpback whales for a total of 287 hours in the combined Glacier Bay/Icy Strait study area (Table 1, Fig. 2). The number of hours we spent surveying in Glacier Bay (177 h) and the study area as a whole (287 h) was slightly below average (191 h and 294 h, respectively), while the number of hours we spent surveying in Icy Strait (110 h) was above average (102 h) compared to the average survey effort for 2005-2013. Compared to 2013, we spent less time surveying in Glacier Bay and more time surveying in Icy Strait because most of the whales were found there in 2014. 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).

Whale Counts

Between June 1 and August 31, 2014, we documented 173 humpback whales in Glacier Bay and Icy Strait (Fig. 3, Table 2). This count is the lowest since 2008 and represents a 28% decline in abundance compared to 2013, when we documented 239 whales in the study area, and the largest inter-annual decline in whale numbers since monitoring began (1985-2014 inter-annual range: -28% to +37%; median = +8%).

In Glacier Bay, the number of whales (n = 98) was 39% lower than the record high number of whales there in 2013 (n = 160) and represents our lowest count since 2008. Likewise, the number of whales in Icy Strait (n = 124) was 39% lower than the record high number of whales there in 2013 (n = 204) and represents our lowest count since 2006 (Table 2).

The standardized period counts (July 9 - August 16) reflect these same trends even more dramatically, with anomalously low numbers of whales in the study area as a whole (n = 119; 43% fewer than in 2013), Icy Strait (n = 60; 62% fewer than in 2013), and Glacier Bay (n = 76; 39% fewer than in 2013). The Icy Strait and Glacier Bay standardized counts were our lowest counts since 2005 and 2009, respectively (Table 2).

Compared to recent years (2009-2013), whale numbers were generally low throughout the summer, especially in August (Fig. 4). Although our survey effort in May is variable and therefore our results from year to year cannot be compared, the number of whales present in the study area in May 2014 appeared to be relatively high, but then declined beginning in June. Likewise, our survey effort in the fall is variable; however we did note an overall lack of whales in September and October compared to recent years.

The median number of whales that we encountered per survey in June 2014 was not significantly different compared to recent years (2009-2013) (Fig. 5) [June 2009-2013 (n = 88, median = 14.5) vs. June 2014 (n = 17, median = 13) ($p = 0.060$)]. However, in July and August the differences were significant [July 2009-2013 (n = 96, median = 18.5) vs. July 2014 (n = 20, median = 12.5) ($p = 0.005$); August 2009-2013 (n = 89, median = 12) vs. August 2014 (n = 17, median = 6) ($p < 0.0001$)], which was unexpected in a population that has been increasing (Saracco *et al.* 2013). In addition, in 2014 we documented very few (n = 2) large pods (≥10 whales) compared to recent years (2009, n = 8; 2010, n = 4; 2011, n = 7; 2012, n = 11; 2013, n = 15).

Table 1. Monthly & Annual Survey Effort, 1985-2014.

	MAY *# survey days*		**JUNE** *# survey days*		**JULY** *# survey days*		**AUG** *# survey days*		**SEPT** *# survey days*		**TOTAL # SURVEY DAYS** *(Jun 1 - Aug 31)*		**TOTAL # SURVEY HOURS** *(Jun 1 - Aug 31)*		
YEAR	**GB**	**IS**	**GB**	**IS**	**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**	234	92	**326**
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**	199	108	**307**
1989	3	1	17	6	14	6	16	7	1	4	**47**	**19**	231	123	**354**
1990	6	4	16	5	18	6	14	8	0	0	**48**	**19**	215	115	**330**
1991	7	3	14	7	17	6	13	4	6	3	**44**	**17**	256	100	**356**
1992	3	2	19	4	17	5	12	4	7	1	**48**	**13**	248	71	**319**
1993	2	1	10	3	13	3	7	5	1	1	**30**	**11**	192	62	**254**
1994	1	0	9	5	10	4	13	8	1	1	**32**	**17**	169	92	**261**
1995	3	2	10	4	11	4	10	7	2	2	**31**	**15**	167	90	**258**
1996	4	2	11	5	17	10	16	3	3	1	**44**	**18**	259	116	**374**
1997	5	2	17	4	21	7	19	6	9	4	**57**	**17**	327	90	**417**
1998	10	4	20	3	23	6	12	4	5	2	**55**	**13**	344	64	**408**
1999	4	1	16	4	18	6	18	3	5	1	**52**	**13**	318	64	**382**
2000	1	0	21	8	21	5	23	6	5	1	**65**	**19**	321	84	**405**
2001	3	1	17	6	14	5	20	5	6	2	**51**	**16**	236	76	**312**
2002	3	1	19	6	19	4	18	2	4	2	**56**	**12**	297	68	**365**
2003	5	0	20	7	19	5	16	5	3	1	**55**	**17**	283	101	**384**
2004	6	2	21	3	19	5	21	5	8	2	**61**	**13**	373	74	**447**
2005	1	0	16	5	17	3	12	3	4	3	**45**	**11**	216	56	**272**
2006	2	2	14	6	15	7	16	7	5	1	**45**	**20**	197	85	**282**
2007	4	2	15	10	14	7	14	6	5	2	**43**	**23**	206	117	**323**
2008	4	1	16	10	14	8	12	9	3	1	**42**	**27**	187	117	**304**
2009	6	5	12	10	16	9	10	5	5	4	**38**	**24**	179	107	**286**
2010	5	3	14	9	11	11	17	8	3	5	**42**	**28**	194	99	**293**
2011	3	1	13	10	14	6	13	7	5	3	**40**	**23**	189	110	**299**
2012	5	2	11	8	12	9	12	10	4	2	**35**	**27**	144	129	**273**
2013	7	4	13	7	16	12	19	7	5	1	**48**	**26**	208	102	**309**
2014	5	6	11	9	14	8	15	4	4	1	**40**	**21**	177	110	**287**
2005-2013 average survey effort:											42.0	23.2	191.0	102.4	293.5

The dashed line highlights a change in the way survey effort was calculated beginning in 2005 (Neilson and Gabriele 2007). Total # survey hours are not available for 1986 & 1987.

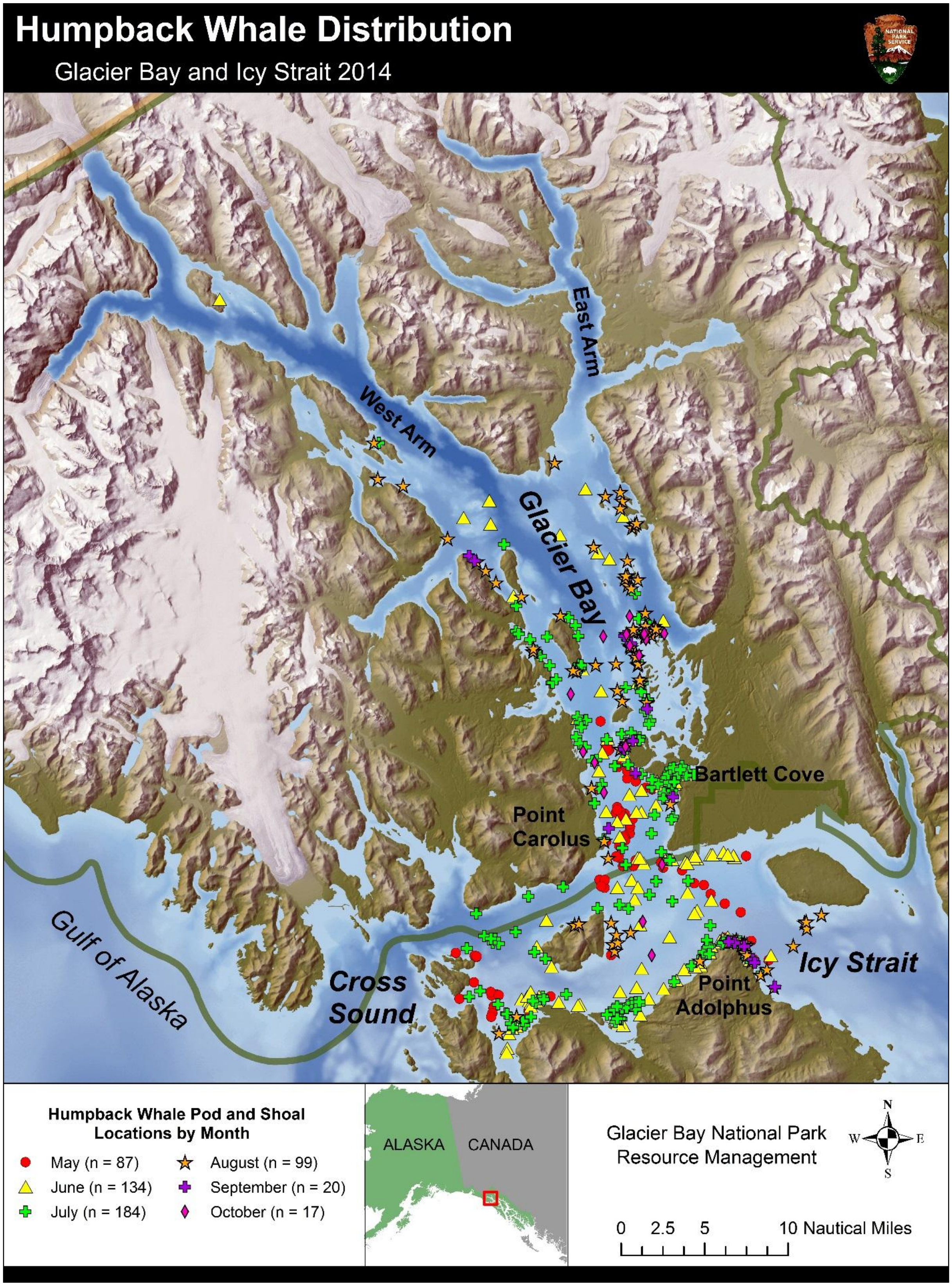

Figure 2. Study area in Glacier Bay and Icy Strait showing distribution of humpback whale pods and shoals in 2014. Each symbol represents a pod containing one or more whales.

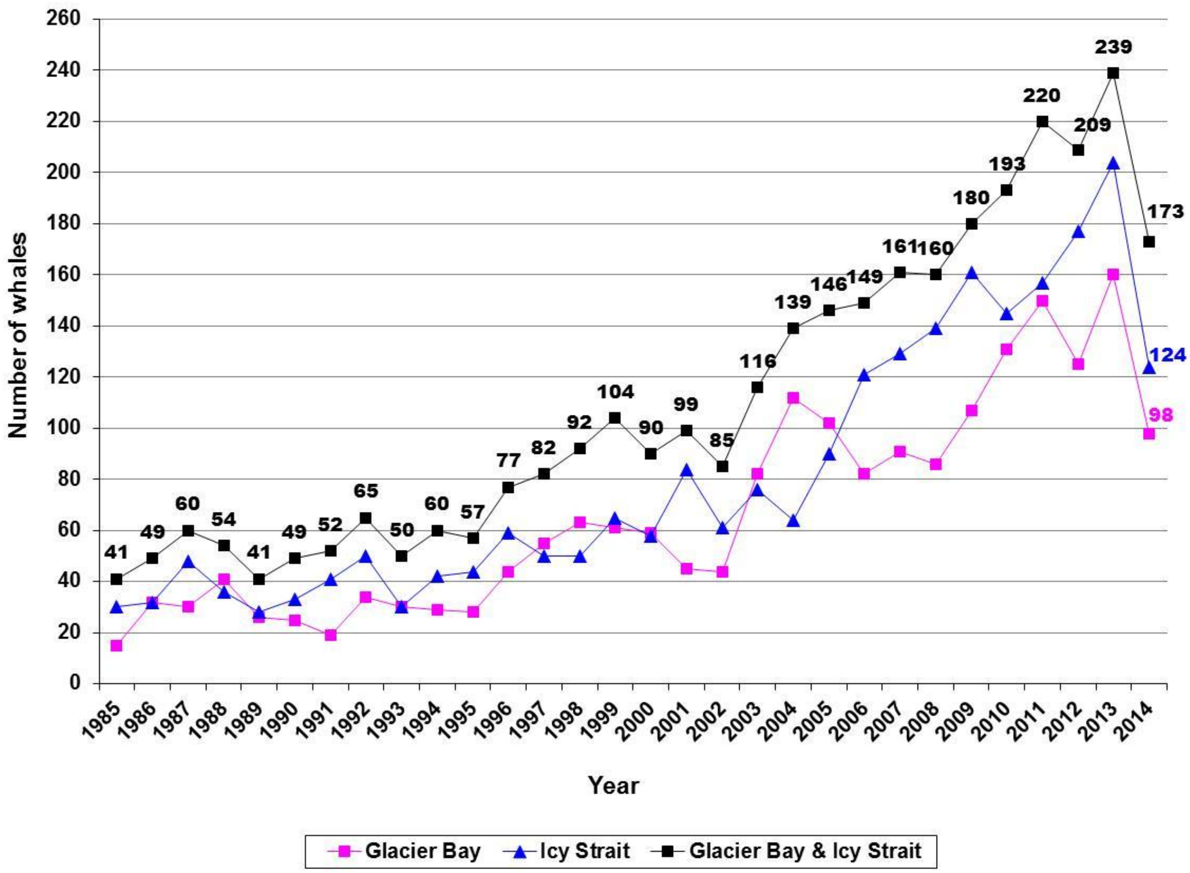

Figure 3. Number of individual whales documented in Glacier Bay and Icy Strait from June 1 through August 31, 1985-2014.

Table 2. Standardized (July 9 – August 16) and total (June 1 – August 31) whale counts, 1985-2014.

	GLACIER BAY		**ICY STRAIT**		**GLACIER BAY & ICY STRAIT**	
Year	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	22	32	39	49
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	34	41	45	52
1992	27	34	34	50	49	65
1993	23	30	24	30	40	50
1994	17	29	29	42	44	60
1995	18	28	26	44	37	57
1996	37	44	43	59	64	77
1997	41	55	33	50	67	82
1998	46	63	27	50	68	92
1999	36	61	39	65	68	104
2000	44	59	26	58	62	90
2001	26	45	58	84	72	99
2002	28	44	34	61	56	85
2003	53	82	61	76	102	116
2004	85	112	38	64	110	139
2005	66	102	50	90	95	146
2006	66	82	98	121	130	149
2007	76	91	98	129	132	161
2008	56	86	98	139	126	160
2009	59	107	124	161	144	180
2010	78	131	97	145	141	193
2011	132	150	82	157	174	220
2012	87	125	144	177	176	209
2013	124	160	159	204	210	239
2014	76	98	60	124	119	173
average:	**47.5**	**66.9**	**55.4**	**80.9**	**84.8**	**109.7**
95% CI:	**(36.1, 59.0)**	**(52.1, 81.6)**	**(41.5, 69.4)**	**(62.7, 99.1)**	**(66.8, 102.8)**	**(88.4, 131.1)**

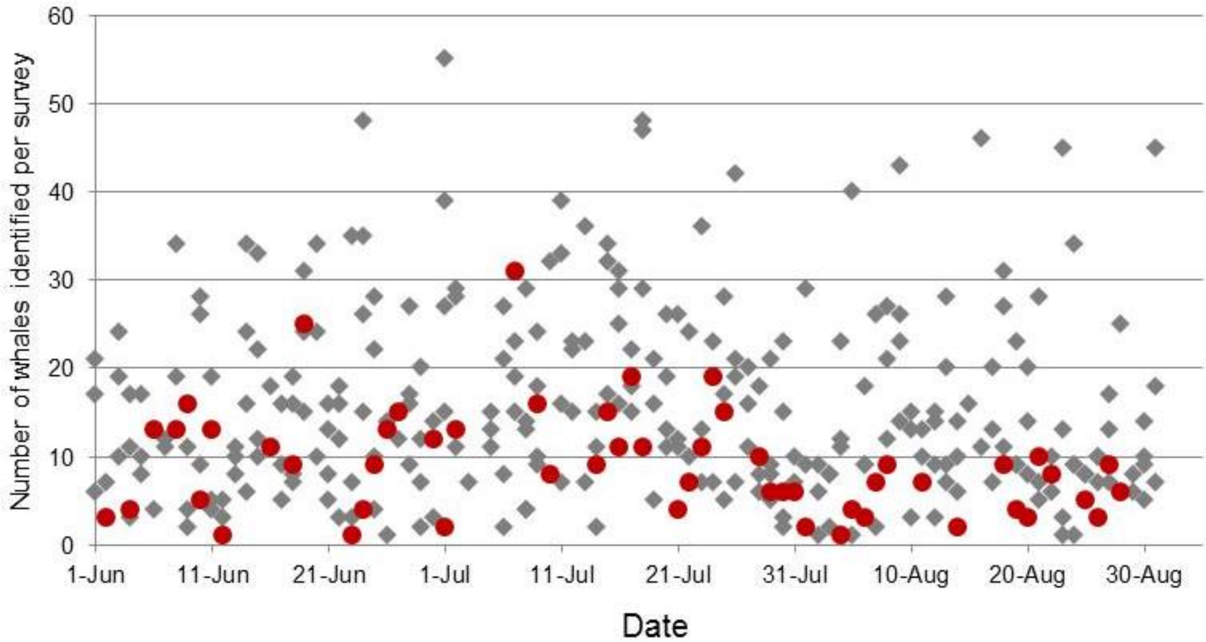

Figure 4. Number of whales identified per survey from June 1 through August 31 in Glacier Bay and Icy Strait for all observations collected from 2009-2013 (◆) versus 2014 (●).

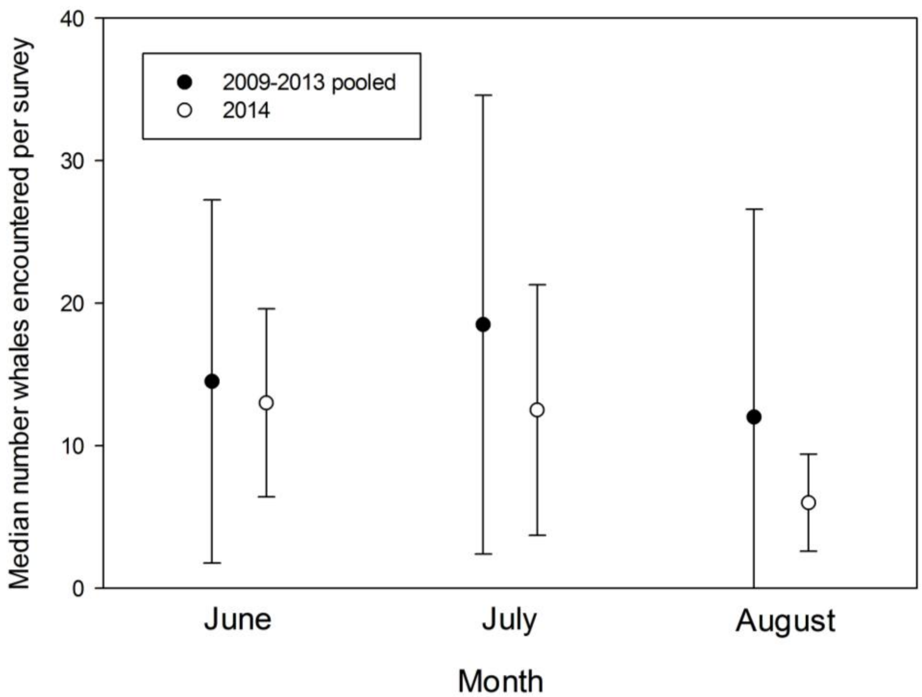

Figure 5. Median number of whales encountered per survey in June, July and August 2014 compared to data pooled by month from 2009-2013. Error bars represent ± SD. There were significant differences between pairs in July and August based on Mann-Whitney *U* tests.

We observed an additional 20 whales only outside of the regular June through August monitoring period, for a grand total of 193 individual whales in the study area in 2014. We documented 17 of these 20 whales in May and three in September.

For the first time since monitoring began in 1985, all of the whales that we encountered in June, July and August had been sighted in previous years in Glacier Bay or Icy Strait (not including dependent calves). In other words, we did not document any “new” whales in the study area in 2014. For comparison, from 1985 through 2013, on average 12% of the non-calf whales that we documented were considered new to the study area, which equates to approximately 12 new individuals per year (mean 11.9, SD = 7.4). In May 2014 we documented four new whales but none of these whales were observed again in subsequent months and none matched any of the individuals in the SEAK fluke catalog (University of Alaska Southeast, unpublished data). Two of these new whales appeared to be small in body size which indicates that they may have been juveniles.

Overall the humpback whale population in the study area has been growing with an estimated 4.4% annual rate of increase between 1985 and 2009 and an even greater rate of increase from 2002 to 2009 (approximately 7.7% per year) (Saracco *et al*. 2013). It is difficult to explain the dramatic decline in whale numbers that we documented in 2014. Although survey effort in the study area as a whole was slightly below average, effort in Icy Strait (where higher numbers of whales are generally observed compared to Glacier Bay) was above average, therefore we do not believe that variation in our survey effort in 2014 accounts for the observed low whale counts. The most likely explanation is a temporary shift in whale distribution related to prey availability or other factors. However there are no quantitative data on forage fish distribution and abundance in the study area to test this hypothesis. Moreover, there are no other areas in Alaska with a level 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.

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). There is anecdotal evidence suggesting that higher than average numbers of humpback whales in SEAK may have shifted their distribution to Frederick Sound and lower Stephens Passage/Seymour Canal during summer 2014. While we received anecdotal reports indicating lower than average numbers of humpback whales near Tenakee Inlet (S. Lewis, pers. comm.) and Ketchikan (G. Freitag, pers. comm.), summer whale numbers appeared to be above average in Frederick Sound (D. Holmes, pers. comm.). Very high numbers of whales in lower Stephens Passage and around the mouth of Seymour Canal were reported by cruise ship bridge teams throughout most of the summer (NPS unpublished data). In addition, in June at least 30-40 whales were reported in lower Chatham Strait for several weeks in June (D. Sturm, pers. comm.). During the last two weeks of August and first week of September, when whale numbers were especially low in GB-IS, we received a report of extremely high numbers of humpback whales feeding in a concentrated area near Kake in Frederick Sound (Z. Stenson, pers. comm.)

It is worth noting two unusual phenomena that occurred in 2014 that may have affected humpback whale abundance and distribution in the study area: 1) anomalously warm seawater temperatures in the North Pacific and 2) a large earthquake near the study area on July 25.

In 2014, a pattern of unusually high sea surface temperatures persisted in the North Pacific, with unknown cascading effects on the marine food web (Milstein 2014). These temperature anomalies were especially pronounced in the Gulf of Alaska, where by fall 2014, sea surface temperatures were up to 3ºC above normal. These are the highest water temperatures ever recorded in the Gulf of Alaska in 17 years of monitoring (Rosen 2014). It is unknown if a similar warming pattern was occurring in nearshore waters in GB-IS. NPS oceanographic data collected in the study area in 2014 are still being analyzed. The sea surface temperatures that we recorded near humpback whales in 2014 were comparable to recent years, indicating no unusual warming at a local scale, however our instrument is only accurate to within 1.7°C (NPS unpublished data) so we are unable to discern small changes in temperature. Therefore, accurate trends in local sea surface temperatures are unknown at this time. Nevertheless, it is plausible that the anomalously warm waters in some parts of the North Pacific through which humpback whales migrate affected their abundance and distribution in GB-IS in 2014.

The second phenomenon that may have affected humpback whales in the study area in 2014 was a magnitude 6.1 earthquake that occurred on July 25 approximately 55 km west of the mouth of Glacier Bay (http://comcat.cr.usgs.gov/earthquakes/eventpage/usb000rx5i#summary, accessed 13 January 2015). The main shock was preceded by a magnitude 5.4 foreshock and followed in the next month by approximately 230 aftershocks in the same area (http://www.aeic.alaska.edu/quakes/palma_bay_20140725.html, accessed 13 January 2015). These seismic events triggered a large submarine landslide that severed a major fiber optic cable in Park waters in Cross Sound, approximately 35 km west of the mouth of Glacier Bay (Brooks 2014). For several weeks after July 25, we and other local mariners noticed a marked increase in turbidity in the surface waters of lower Glacier Bay and Icy Strait consistent with bottom sediments being suspended in the water column following a submarine landslide. Oceanographic data collected on August 4 in Icy Strait and lower Glacier Bay confirmed that turbidity was significantly higher than normal, especially near the ocean floor. By September 2, turbidity measurements had returned to within normal range (L. Sharman, pers. comm.). During the period of increased turbidity (which appeared to peak in late July and taper off by mid-August), we received anecdotal reports from private fishermen and the local charter fleet that it had become very difficult to catch fish in lower Glacier Bay and Icy Strait. The effects of these seismic events and the resultant increased local turbidity on forage fish (and, in turn, on their predators - including humpback whales) are unknown, but the timing of these events correlates well with the sharp drop in whale numbers that we documented beginning in late July (Fig. 4). Therefore, we speculate that increased turbidity caused by one or more seismically generated submarine landslides may have decreased humpback whale foraging success over a period of several weeks in lower Glacier Bay and Icy Strait. In response, humpback whales may have shifted their distribution to other areas, such as Frederick Sound, seeking better foraging conditions.

In summary, there is reason to believe that oceanographic conditions (mainly turbidity but also possibly water temperature) played a role in shifting whale distribution away from the GB-IS study area in 2014, and little reason to believe that survey effort levels were a factor.

Residency

In 2014, 84 of the 173 whales (49%) that we documented in the study area between June 1 and August 31, including five mother/calf pairs, remained 20 or more days, meeting our definition of ‘resident’. This is one of the lowest residency rates we have documented since the study began (1985-2013 mean = 0.63, SD =

0.08). The last time the residency rate was less than 50% was in 1995 (42%) (NPS unpublished data). Despite the relatively low residency rate in 2014, the Glacier Bay-Icy Strait region remains an important 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 frequently move between the two areas, demonstrating that the Glacier Bay-Icy Strait ecosystem is a single contiguous habitat (*e.g.*, Neilson *et al*. 2012).

Approximately one-third (34%) of the whales that we documented between June 1 and August 31, including four mother/calf pairs (plus another mother missing her calf that had been documented on May 30), were identified on just one day (21 in Glacier Bay and 37 in Icy Strait). While the proportion of whales sighted on one day between June 1 and August 31 varies widely each year (1985-2013 range = 17% - 44%), the proportion that we documented in 2014 (34%) was notably higher than in recent years (2009-2013 range = 19% - 24%). This suggests that in 2014, more whales passed briefly through the study area compared to recent years. These sightings occurred over a broad range of dates and locations, indicating that it was not a single pulse of transient whales arriving in the area. However, we did note a seasonal trend that mirrored the overall trend in whale numbers in 2014 (Fig. 4), with fewer whales identified on one day only as the summer progressed (June, n = 27; July, n = 23; August, n = 8).

Of the 58 whales that we documented on one day only between June 1 and August 31, we identified 14 of them again outside of the June 1 - August 31 monitoring period. The majority of these whales (n = 12) were observed in May (when overall whale numbers were high), one whale was observed in both May and September, and one whale was observed in October. We documented 17 additional whales on just one day outside of the June 1 - August 31 monitoring period. We observed the majority of these whales (n = 14) in May and only three in September.

Reproduction and Juvenile Survival

We identified 14 mother/calf pairs in 2014 (Table 3) with a crude birth rate (8.1%) slightly lower than the historic average (9.4%) but within the documented range of values since 1985 for this highly variable parameter (3.3% - 18.5%) (Table 4).

Whales #1846, #1848 and #2170 were documented with their first known calves. Whale #1846 was already known to be a female based on genetic analysis, but the sex of the other two whales was previously unknown.

We identified one mother/calf pair exclusively in Glacier Bay, eight pairs exclusively in Icy Strait and five pairs in both Glacier Bay and Icy Strait. As previously noted, four of the mother/calf pairs (#250 + calf on June 16; #1090 + calf on June 27; #1846 + calf on July 23; #2170 + calf on July 24) were identified on just one day.

For the first time in recent years, we did not identify any new known age whales in the study area in 2014 (*i.e.*, whales that had not been documented in SEAK since they were calves). It was surprising that none of the calves we documented in 2013 (n = 10) returned as yearlings, after we documented five yearlings in 2013 and 1-2 yearlings for several years prior (Neilson *et al.* 2014; NPS unpublished data).

The value of the longevity of this study is highlighted by the fact that 35% (n = 60) of the non-calf whales that we identified in 2014 (n = 173) 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.

Table 3. Mother-calf pairs documented in 2014.

Mother ID#	Mother's age (years)	No. of previous calves documented	Calf skin collected?	Calf ID#	Documented in
250	unk	4	No	250_calf_2014	IS
573	unk	10	No	2594	IS
1088	20	1	No	2590	GB & IS
1090	25	2	Yes	1090_calf_2014	IS
1246	unk	2	No	2591	GB & IS
1295	22	2	No	2592	IS
1298	**22**	**4**	No	**1298_calf_2014**	**GB & IS**
1304	**22**	**2**	No	**2593**	**GB & IS**
1428	17	3	No	1428_calf_2014	GB & IS
1832	**unk**	**1**	No	**1832_calf_2014***	**IS**
1846	10	0	No	1846_calf_2014	IS
1848	**unk**	**0**	No	**1848_calf_2014**	**GB**
1896	**unk**	**1**	**Yes**	**1896_calf_2014**	**GB & IS**
2170	unk	0	No	2170_calf_2014	IS

GB = Glacier Bay; IS = Icy Strait.
* Indicates mother/calf pair documented only outside of the June 1 – August 31 study period.
Bold type indicates calves that were missing in late season 2014 (see Table 5).

Table 4. Reproduction and known age whales in Glacier Bay and Icy Strait, 1982-2014.

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	16.3	2	49
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	7.7	8	52
1992	12	10	83	18.5	8	65
1993	3	3	100	6.0	12	50
1994	9	5	56	15.0	11	60
1995	3	2	67	5.3	9	57
1996	6	3	50	7.8	19	77
1997	9	7	78	11.0	17	82
1998	8	7	88	8.7	19	92
1999	9	5	56	8.7	25	104
2000	3	2	67	3.3	23	90
2001	12	9	75	12.1	27	99
2002	11	6	55	12.9	25	85
2003	7	5	71	6.0	27	116
2004	16	12	75	11.5	37	139
2005	10	5	50	6.8	38	146
2006	13	8	62	8.7	41	149
2007	17	12	71	10.6	43	161
2008	15	12	80	9.4	52	160
2009	12	10	83	6.7	56	180
2010	21	15	71	10.9	55	193
2011	11	8	73	5.0	65	220
2012	16	14	88	7.7	60	209
2013	10	9	90	4.2	77	239
2014	14	6	43	8.1	60	173
1985-2013 average:	**9.3**	**6.8**	**72.3**	**9.4**	**26.9**	**107.6**

Number of calves photo ID'd is the number of calves with fluke photos (vs. dorsal fin only photos). Crude Birth Rate (CBR) is a percentage computed by # calves / total whale count. CBRs for 1982 & 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.

Missing calves

Between early August and late October, five of the 14 mothers that we had documented earlier in the season appeared to be missing their calves (Table 5). The number of calves that appeared to be missing in 2014 was unprecedented. Furthermore, after August 7 we had no sightings of the other nine mothers to confirm the presence or absence of their calves. The complete lack of calf sightings from early August through the fall was highly unusual compared to previous years and made it difficult to verify whether the calf absences were temporary or permanent.

Table 5. Summary of missing calves in 2014.

Calf ID#	Mother ID #	Mother-calf sighting dates	Lone mother sighting dates	Notes from sightings of lone mothers	Confidence that calf was missing
2593	1304	5/9, 5/12, 5/30, 7/7, 7/25, 7/28	8/11, 8/20, 8/21, 8/27, 9/8	Observed mother for 60 min in good visibility on 8/11 with no sign of calf. Also alone during four subsequent encounters.	very high
1848_calf_2014	1848	7/21, 8/7	10/24	Observed mother for 72 min in good visibility with no sign of calf	high
1896_calf_2014	1896	5/5, 5/6, 5/9, 5/12, 6/25, 6/30, 7/10, 7/25, 7/31	8/18	Observed mother for 60 min in good visibility with no sign of calf	high
1832_calf_2014	1832	5/30	8/20	Observed mother for 35 min, including a 13 min dive, in good visibility with no sign of calf	medium
1298_calf_2014	1298	5/28, 7/1, 7/16	10/14	Observed three surfacings by mother over 26 min in rough seas but good visibility (back-lit blows) with no sign of calf. Dives were 11 min and no other whales were seen in the area.	low

Although we occasionally observe mothers separate from their calves for periods up to one hour, in most cases we eventually document both the mother and the calf on the same day. Our confidence in whether the five missing calves in 2014 were truly absent (versus temporarily separated from their mothers) ranges from low to very high depending on the amount of time that we were able to spend observing the mother alone and the conditions under which she was observed (Table 5), therefore it is possible that we have overestimated the number of missing calves. However, even if that were the case, it is unusual for so many mothers to be temporarily separated from their calf to the degree that we surmise that the calf is missing.

For comparison, using similar criteria from 1985-2013, eight calves were either confirmed to be or believed to be missing, with no more than one case per year (Baker 1986; Baker and Straley 1988; Doherty and Gabriele 2001, 2002, 2004; Neilson and Gabriele 2007, 2010; Neilson et al. 2013). One of these eight missing calves (#2033, born in 2007) is known to have survived based on sightings in subsequent years (NPS unpublished data), one calf is known to have died (Doherty and Gabriele 2004) and two calves are presumed to have died based on repeated sightings of their lone mothers early in the summer (Baker 1986; Baker and Straley 1988). The fate of the other four missing calves, whose absences were detected over a range of dates between August 4 and September 19 (Doherty and Gabriele 2001, 2002; Neilson and Gabriele 2010; Neilson et al. 2013) is unknown. To the best of our knowledge, none of these individuals has been re-sighted (NPS unpublished data; University of Alaska Southeast unpublished data).

Late season calf absences are very ambiguous given observations of temporary mother/calf separation as well as weaning on the feeding grounds (Baraff and Weinrich 1993; Straley 1994; Steiger and Calambokidis 2000). In the case of #2033 in 2007, this calf's mother (#1593) was observed alone twice on August 31 and September 15, however our observations were not long enough to conclude definitively that the calf was missing (Neilson and Gabriele 2007). Given #2033's documented survival in subsequent years, it is apparent that during our observations of #1593 without her calf, the calf was either temporarily separated from its mother or fully weaned and independent.

Humpback whale calves are born over several months in the winter and typically remain with their mothers for at least 10.5 months of lactation (Chittleborough 1958). The three most likely explanations for why a calf would be missing during our observations are: 1) the calf died, 2) the calf was temporarily separated from its mother or 3) the calf was fully weaned and completely separated from its mother. We considered each of these explanations for why the five calves appeared to be missing in 2014.

Calf mortalities?

It is possible that five out of 14 (0.357) calves died in 2014, however the estimated calf mortality rate for North Pacific humpback whales in their first year of life is low (0.182), with an even lower mortality rate (1 of 29 cases) after calves arrive on the feeding grounds (Gabriele *et al.* 2001). No dead humpback calves were observed or reported in GB-IS or any of the surrounding waters in 2014. If a calf had died, the carcass would likely sink, but given the water depths in the study area (0 - 500 m), we would expect the carcass to eventually rise to the surface as decomposition gases inflated the abdomen (Allison *et al.* 1991; NOAA Alaska Region unpublished data). No whale-vessel collisions were reported in the area, although we recognize that collisions may go unreported or undetected. Killer whales (*Orcinus orca*) are common in GB-IS, yet there are no known cases of successful predation on humpback whales in the area (NPS unpublished data).

One of the calves in question (#2593) was observed on July 28 with a seemingly minor entanglement with salmon trolling gear on the calf's left fluke tip (Fig. 6). On August 11, and subsequent encounters with this calf's mother (#1304), she was alone (Table 5). The entanglement involved a "hoochie" lure and fishing line snagged on the tip of the calf's left fluke blade. Although the calf's behavior precluded a thorough assessment of its tailstock and other body parts, the entanglement seemed to be highly localized and appeared to be not life threatening. However, the entanglement may have involved other body parts that we were unable to assess, in which case it may have been more serious, which could have led to the calf's death. No other humpback whale calves were reported entangled anywhere in southeastern Alaska in 2014.

Temporary mother-calf separation?

We believe that temporary mother-calf separation may explain at least two of the missing calves (1832_calf_2014 and 1298_calf_2014), given that both mothers were seen alone only once, the encounters were relatively brief (26 - 35 min) and the encounters occurred late enough in the season (August 20 and October 14) that the calves would have been old enough to be temporarily separated from their mothers. Gabriele *et al.* (2001) found a 1.4% probability (10 of 687 cases) that a humpback whale calf in Alaska would be missed during an encounter in which it was temporarily separated from its mother.

Figure 6. Calf #2593 with a "hoochie" fishing lure and line entangled on the tip of its left fluke blade.

Complete weaning and mother-calf separation?

Complete weaning and mother-calf separation would explain our observations, though none of the calves appeared to be unusually large (which might indicate an earlier birthdate) or precocious (*i.e.*, seen straying from their mothers more than is typical), although we do not systematically note these types of observations. Three of the five missing calves were detected between August 11 and August 20, which would be extremely early for complete weaning based on historic observations of mother/calf pairs in the study area and elsewhere in southeastern Alaska (NPS unpublished data; University of Alaska Southeast unpublished data). In the Gulf of Maine, a humpback whale calf was weaned early and became independent of its mother sometime between October 10 and 13, however this was considered atypically early (Baraff and Weinrich 1993). We are unaware of any documented instances of complete weaning and calf independence prior to mid-October for humpback whales in the northern hemisphere. Therefore, only the two missing calves detected in mid-October (1848_calf_2014 and 1298_calf_2014) seem like potential candidates for complete weaning and calf independence under normal conditions.

In North Atlantic right whales (*Eubalaena glacialis*), less experienced cows, independent of their age, were more likely to extend the length of time they associated with their calves, but none of the more experienced cows was documented weaning their offspring anomalously early (Hamilton and Cooper 2010). In our study, four of the five mothers were experienced cows (Table 3). Therefore, if early weaning is the reason for the missing calves that we documented, we doubt that the experience level of these five mothers was a factor.

Instead, we speculate that one or more factors, such as unusual environmental conditions and/or maternal body condition, may have caused some of this year's mothers to wean their calves unusually early (*i.e.*, beginning in August). The effects of environmental conditions and maternal body condition on the duration of lactation in baleen whales are unknown (*e.g.*, Hamilton and Cooper 2010). In other mammals, the relationship between maternal food quality, lactation, and age at weaning is complex. Trends conflict among different species, with stressful environmental conditions and/or nutritional limitations causing an early age at weaning in some species, but extended lactation in others. In some species early weaning has been associated with food abundance (Lee *et al.* 1991).

In western gray whales (*Eschrichtius robustus*), Bradford *et al.* (2012) visually assessed the body condition of mother-calf pairs, found that lactating females were often in poor body condition, their calves were consistently in good condition, and suggested that mothers may provide an energetic buffer to their offspring at the expense of their own body condition. We do not systematically assess the body condition of whales in the study area, however we opportunistically note when a whale appears to be thin (as evidenced by their scapulae appearing to protrude), and mothers are often noted as appearing thin. However, based on our opportunistic visual observations in 2014, none of the mothers (or calves) appeared to be unusually emaciated or nutritionally compromised compared to past years.

The unusually low whale counts that we documented in 2014, especially as the season progressed, indicate that conditions were less than optimal for humpback whales in GB-IS. We suggest that although we noted no outward indications of poor maternal body condition, some mothers may have been nutritionally stressed by August and weaned their calves earlier than normal. Alternatively, something about conditions this season may have made calves more prone to be temporarily separated from their mothers.

Determining the fate of the missing calves will rely on identifying them in subsequent years based on their flukes and/or dorsal fins or genotype. We obtained a fluke photograph of one of them (#2593) and a tissue sample from another (1896_calf_2014), but the others were identified solely based on their dorsal fins, making recognizing these whales in future years more challenging. It will also be interesting to see if any of the other calves not seen since August 7 (n = 9) return in future years.

Tissue Samples

In 2014 we collected 15 sloughed skin samples, including samples from two calves. Since 1996, we have collected 297 sloughed skin samples in the study area. Genetic analysis of these samples allows sex determination, definition of mitochondrial DNA haplotype and nuclear DNA genotyping.

Feeding Behavior and Prey Identification

The median water depth in which we found whales in 2014 (46 m) was significantly more shallow than the median water depth in which we found whales in recent years (2009-2013) (64 m) ($p < 0.0001$). Anecdotally, the number of whales found feeding in water too shallow for the research vessel to approach also seemed higher than usual, although these types of encounters were still rare. Because feeding is the most common behavior we observe in GB-IS (NPS unpublished data), we surmise that the prey available to whales in 2014 was found in shallower waters compared to recent years. This interpretation is supported by the fact that the proportion of whales we identified based solely on dorsal fin photographs (43.5%), which usually indicates a whale is not diving deep, was much higher than the proportion in recent years (2009-2013 range: 20.1%-26.8%).

From mid-June through July 25, whale activity in Bartlett Cove was very high. Numbers peaked in mid-July, with at least 12 whales documented in Bartlett Cove on several days. On June 22, private fishermen reported catching halibut in Bartlett Cove that were "full of fresh herring" (J. Johnson and S. Neilson, pers. comm.). In mid-July, a local charter vessel captain reported seeing capelin at the head of Bartlett Cove but said that his herring jigs were coming up empty (J. Kearns, pers. comm.).

In July, whales were frequently observed surface lunge feeding in very close proximity to the Bartlett Cove docks. On July 14, several park visitors reported that a whale struck the public dock from below, shaking the dock. One boy stated that he saw the whale swim under the dock ramp. No injured whales were observed or reported following this incident, and the dock did not appear to be damaged. Several forage fish species were observed around the public use dock the same day, including fish schooling around the dock pilings that were identified as Gadidae spp. (*e.g.*, juvenile walleye pollock or juvenile Pacific cod (*Gadus microcephalus*)), mixed with sand lance and likely capelin (M. Arimitsu and J. Rodstrom, pers. comm.). Two days later, a park employee reported seeing a humpback whale feeding between the east side of the dock float and the beach. The whale swam twice under the dock ramp during high tide (C. Cook, pers. comm.). This is the first year that humpback whales have been reported feeding in these nearshore waters so close to the dock.

Similar to past years, in 2014 we primarily detected capelin and sand lance near feeding whales (Table 6). Most of our observations of whale prey occurred in June and July. In late July, capelin and sand lance appeared to be especially abundant in portions of lower Glacier Bay and lower Whidbey Passage, where we dipnetted seven samples near feeding whales between July 25-29 (capelin, n = 3; sand lance, n = 3; mixed school of capelin and sand lance, n =1).

Table 6. Humpback whale prey type determinations.

Method	**Prey species (# of cases)**					
	capelin	***capelin?***	***sand lance***	***mixed capelin + sand lance***	***Gadidae spp.***	***unknown forage fish spp.***
Collected specimen with dip net	3		3	1		
'Cucumber' smell in air		5				
Fish observed near surface		2			1	2
Seabirds observed eating fish		1				6

By August, we had only two observations of prey in the vicinity of whales, which is consistent with the drop in whale numbers that we documented around this time. In addition, on August 11 we observed large numbers of gulls and murrelets feeding off the east side of Lemesurier Island. Though we did not observe any whales nearby, we collected a single myctophid (most likely the northern lampfish (*Stenobrachius leucopsarus*) that we found swimming slowly, apparently stunned, at the water's surface. Previous studies in Icy Strait have found myctophids to be relatively rare compared to more typical humpback whale prey species such as capelin and walleye pollock (Abookire *et al*. 2002). We have documented myctophids several times in past years, often in association with feeding humpback whales (*e.g.*, Doherty and Gabriele 2002; Neilson and Gabriele 2006, 2008).

Unlike 2013 when the Point Adolphus "core group" was never observed (Neilson *et al.* 2014), on several occasions between late June and late July 2014 we documented the core group at Point Adolphus, but the group was relatively small, containing only 5-8 individuals. For the second year in a row, whale activity around Point Adolphus was comparatively low for most of the summer. Unlike some past years, we did not observe any herring around Point Adolphus (or anywhere else in the study area) in 2014. On July 18, we observed a small school of fish (~2 cm in length) at the water's surface near Point Adolphus. No humpback whales were in the immediate area, however we collected a sample of the fish, which were later tentatively identified as either juvenile walleye pollock or juvenile Pacific cod (J. Rodstrom and K. Rayfield, pers. comm.).

Elsewhere in Icy Strait, on June 27 we documented high numbers of whales (n = 14) off the "Gustavus Flats" (east of Point Gustavus) and on July 7 we documented many whales (n = 26) spread out and feeding in Mud Bay, including several typical core group members and three mother-calf pairs.

Whale/Human Interactions

Having whales so accessible near the Bartlett Cove dock created an unprecedented opportunity for shore-based whale watching in Bartlett Cove. It also created incidents in which some people unwisely (and sometimes unlawfully) approached whales. In July, a person sea kayaking in Bartlett Cove was cited for approaching one or more humpback whales in violation of the park's humpback whale approach regulations, however this matter has not been adjudicated (Title 36 CFR Subpart N, 13.1170) (Incident Management Analysis and Reporting System file #NP14081325).

Whale waters

Similar to 2013, whale activity in lower Glacier Bay fluctuated greatly within the season and whale waters were implemented intermittently as a reflection of these trends. Beginning May 7, a 13-knot vessel speed limit was implemented in a specially designated area within the lower bay centered on the mouth of Glacier Bay. This is the earliest onset date for temporary whale waters anywhere in park waters and is indicative of the high numbers of whales in this area very early in the season. By May 14, whale numbers had increased throughout lower Glacier Bay, and a 13-knot vessel speed limit and mid-channel course restriction were implemented. However, similar to last year, in early June whale use of the lower bay decreased to the point that the vessel speed limit was temporarily raised from 13 knots to 20 knots for five days. By June 10, whale numbers in the lower bay increased and the speed limit was lowered again to 13 knots. However, by early August, whale numbers in the lower bay dropped significantly and the whale waters speed limit was raised to 20 knots, where it remained until its annual expiration on September 30. This was the earliest date that the reduced speed limit (*e.g.*, 13 knots, or 10 knots prior to 2003) has been lifted in lower Glacier Bay since 1988 and is a reflection of the unusually low number of whales that we observed in this area beginning in August.

In total, the 13-knot vessel speed limit was in place in lower Glacier Bay (or parts thereof) for 82 days. The duration of these speed restrictions has varied greatly from year to year depending on whale use in the lower bay, however, this was the shortest cumulative duration for the 13 knot speed limit in recent years (2007-2013 range = 92 - 143 days). Notably, this was also the first year since 1996 that no temporary whale waters were designated anywhere in Glacier Bay outside of the lower bay. In addition, this was the first year since 2004 that whale numbers in park waters around Point Carolus in Icy Strait were not high enough to warrant designating temporary whale waters in this area.

Vessel collisions

In late June, the operator of a 12-meter charter vessel reported accidentally bumping a humpback whale while whale-watching in Icy Strait. The vessel's engines were in forward idle when a whale came up closer than the operator expected. When the whale arched its back to dive, the boat lightly struck the whale's tail. The strike was not hard enough to damage or jar the vessel or injure anyone onboard.

On July 5, the operator of an 8-meter private vessel reported hitting an unknown object underwater near South Marble Island in Glacier Bay that tore off the vessel's out-drive. Most likely, the vessel struck a rock. However, this was never confirmed, and it is possible that the vessel struck a whale.

On July 9, we documented deep propeller scars on an adult whale (nicknamed "No Fluke Charlie" years ago by whale-watch operators near Juneau) that were not there in photos taken during our previous encounter with this whale on July 18, 2013 (Fig. 7). The wounds appeared to have healed in most areas, although a small amount of pink tissue was still visible. This whale's distinct dorsal fin has allowed us to individually identify it since 1999 but we have never obtained a fluke photograph so it has no identification number and it is therefore not included in our whale counts. "No Fluke Charlie" has also been documented over many summers near Juneau and may have been struck by a 10-meter tourboat going approximately 25 knots in 2008, however there were no visible injuries after this collision (NOAA unpublished data; J. Moran pers. comm.).

Figure 7. Adult whale "No Fluke Charlie" on July 9, 2014 with new propeller scars. The photo on the right is of the left side of the whale's caudal peduncle.

On July 17 we documented an injury on whale #2541's right side (Fig. 8) that was not there when we last photographed this part of the animal's body in 2013. This whale's age and sex are unknown but #2541 was noted as being a "small" whale in 2013 and all sightings (n = 5) of this individual have occurred in western Icy Strait. The origin of the injury could not be determined based on the photograph that we obtained, but we suspect that it may have been from a vessel collision.

Elsewhere in Alaska in 2014, four humpback whale-vessel collisions were reported (two in southeastern Alaska and one near Whittier; NOAA Alaska Region unpublished data). In addition, two humpback whales died in collisions (see Dead whales).

Figure 8. Whale #2541 on July 17, 2014 showing injury on right side.

Dead whales

No dead humpback whales were found in the study area in 2014. However on July 1, the carcass of adult female #539 [nicknamed "Max" by Jurasz and Palmer (1981)] was found floating in upper Chatham Strait. This whale was first identified in SEAK in 1975 by Charles Jurasz (S. Mizroch, pers. comm., National Marine Mammal Laboratory, FlukeFinder database) and frequented Glacier Bay and Icy Strait but had not been documented in the study area since August 2012 (NPS unpublished data). The carcass was towed to shore and a necropsy revealed that #539 was in good body condition but had massive trauma to her head characterized by a fractured left mandible and dislocated right mandible. The cause of death was determined to be ship strike, although no collisions were reported in this area (NOAA Alaska Region unpublished data).

On July 26, the carcass of a juvenile (10 m) female humpback whale was found pinned to the bulbous bow of the Alaska state ferry *Kennicott* near Kodiak. A necropsy found that the whale had a fractured skull, and the cause of death was confirmed as ship strike (as opposed to the ship picking up an already dead whale on its bulbous bow) (NOAA Alaska Region unpublished data). It is unknown when or where the strike might have occurred. This was the second bow-caught whale carcass in Alaska in 2014. In the other case, the carcass of a fin whale (*Balaenoptera physalus*) was discovered draped over the bulbous bow of a 264-meter freighter on July 13 as it transited approximately 700 km west of Dutch Harbor in the Bering Sea. The ship slowed down and maneuvered astern, displacing the carcass from the bow. Due to the remote location of this carcass, no necropsy or further observations occurred (NOAA Alaska Region unpublished data).

On April 27, a highly decomposed whale carcass was found on the outer coast of GLBA south of Lituya Bay (L. Sharman, pers. comm.). On August 26, two highly decomposed whale carcasses approximately 3 km apart were reported by kayakers on the western side of Chichagof Island (N. Borson and Z. Brown pers. comm.). No samples were collected from these carcasses, and it was not possible to determine the species based on photos.

On November 13, a pilot spotted a dead humpback whale on a remote beach approximately 180 km southeast of Cordova. Based on the relative size of gulls shown sitting on the carcass in an aerial photo, the whale appeared to be a calf or a juvenile. Due to the remote location of this carcass, no necropsy or further observations occurred (NOAA Alaska Region unpublished data).

Entangled whales

On February 19, 2014 an adult humpback whale off the coast of Maui was disentangled from shrimp pot gear that had originated in Chatham Strait (NOAA unpublished data), over 4400 km away.

Besides calf #2593 (Fig. 6), there were no entangled whales reported in the study area in 2014. Elsewhere in SEAK, ten humpback whales were reported entangled. Some of these reports may have been re-sights of the same individuals, but at least seven appeared to be unique cases. One of the whales freed itself after being entangled in a charter vessel’s anchor line; the fate of the other animals is unknown. Elsewhere in Alaska, three more humpback whales and one unidentified large whale were reported entangled (NOAA Alaska Region unpublished data).

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