POPULATION CHARACTERISTICS OF HUMPBACK WHALES IN GLACIER BAY AND ADJACENT WATERS: 2001

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ABSTRACT

We photographically identified 97 individual humpback whales (*Megaptera novaeangliae*), including 12 mother/calf pairs, in Glacier Bay and Icy Strait between June 1 and August 31, 2001. This represents the second highest number of whales ever identified in the study area since 1985. In contrast, in Glacier Bay, the whale counts were at their lowest levels in over five years. The frequency of whale sightings in western Icy Strait was high while the number of whale sightings in the Lower Bay was low. The standardized count of 57 whales and the total count of 82 whales in Icy Strait are the highest whale counts ever documented in Icy Strait. Twenty-six percent (n = 25) of the whales we identified were of known age. The number of calves we observed (n = 12) is almost double the average number of calves (6.2) since 1982. The sex of three of the mothers we identified (#1014, #1479 and #1273) was not known previously. We have documented whale #1014, the 1989 calf of #236, every year in the study area since 1991 without a calf, making her 12 years old at the age of her first known reproduction. We observed whale #587, identified with a calf in May and August, without her calf in September. We documented the evolution of an unusual deformity on whale #564's flank. We found whale #68, a pregnant female, dead near Point Gustavus in July from multiple fractures of the skull. The nature and severity of her injuries and the investigations into the circumstances surrounding her death indicate that this individual died from a collision with a large ship.

INTRODUCTION

This report summarizes the findings of the National Park Service's (NPS) annual humpback whale monitoring program during the summer of 2001, the seventeenth consecutive year of consistent data collection in Glacier Bay and Icy Strait. The initial impetus for this program stemmed from concern in the late 1970's that increased vessel traffic in Glacier Bay National Park (GBNP) 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 humpback whales because the species is endangered.

Each summer, GBNP biologists document the number of individual whales, as well as their residence times, spatial and temporal distribution, reproductive parameters and feeding behavior. These data are used to monitor long-term trends in the population's abundance, distribution and reproductive rates. Photographic identification data are shared with other researchers studying North Pacific humpback whales. In addition, Park biologists use whale distribution data locally to determine when and where NPS "whale waters" vessel course and speed restrictions should be implemented in Glacier Bay.

The number of whales documented in Glacier Bay and Icy Strait from 1985 to 2000 ranged from 41 to 104 (Gabriele and Hart 2000). Whale movement throughout southeastern Alaska 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 the study area 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 harengus pallasi*) (Wing and Krieger 1983; Krieger and Wing 1984, 1986). Notable exceptions are the large, stable "core group" that commonly feeds at Point Adolphus, and the much less consistent large pods at Bartlett Cove and Pleasant Island Reef (Baker 1985; Perry *et al.* 1985; Gabriele 1997).

METHODS

The methods used for population monitoring 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 2001 are outlined below.

Vessel Surveys: We conducted surveys in Glacier Bay and Icy Strait from May 18 through October 23, 2001. We searched for, observed and photographed humpback whales from a motorboat each day, using three different motorboats during the season: a 5.2-meter Boston Whaler powered with a 60 hp outboard engine, a 4.9-meter aluminum skiff powered with a 60 hp outboard engine and a 5.8-meter Safe Boat powered with a 115 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. However, if circumstances such as time, weather, or the presence of other vessels interfered with obtaining whale identification photographs, we occasionally returned to the same area on consecutive days. Glacier Bay is the main area of NPS management concern with regard to whales, but descriptions of the whales' use of Icy Strait are needed to put the Glacier Bay results in context, because whales frequently move between these areas.

We surveyed the main body of Glacier Bay (a rectangle defined by four corners: Bartlett Cove, Point Carolus, Geikie Inlet and Garforth Island) 3-4 days per week (Fig. 2). We surveyed the West Arm of Glacier Bay (as far north as Russell Island) every few weeks. We surveyed the East Arm of Glacier Bay infrequently (as far north as Adams Inlet). We conducted approximately one Icy Strait survey per week, with the greatest survey effort focused along the shoreline of Chichagof Island from Pinta Cove to Mud Bay. Several Icy Strait surveys included Idaho Inlet, Dundas Bay, Lemesurier Island and Pleasant Island.

After we found whales, we recorded the latitude and longitude coordinates of their initial location, determined with a Garmin III Plus (using NAD27-Alaska datum) Global Positioning System (GPS). We defined a pod of whales as one or more whales within five body lengths of each other, surfacing and diving in unison. We used datasheets to record all information pertaining to the pod, including the 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, temperature and any prey patches observed on the echo-sounder, as well as details pertaining to feeding behavior.

Individual Identification: Each whale's flukes have a distinct, stable black and white pigment pattern that allows individual identification (Jurasz and Palmer 1981; Katona *et al.* 1979). We took whale fluke photographs with a Nikon N90S camera equipped with a motor drive, databack and 300 mm lens (Fig. 1). We photographed the ventral surface of the flukes of each whale with 1600 ASA black and white film shot at 800 ASA to accentuate the markings on flukes. Photographs of the dorsal fin shape and scarification are also used for individual identification. Panda Photographic Lab in Seattle, Washington processed and printed the film. We analyzed the contact sheets and field notes to determine the date and location where each whale was photographed.

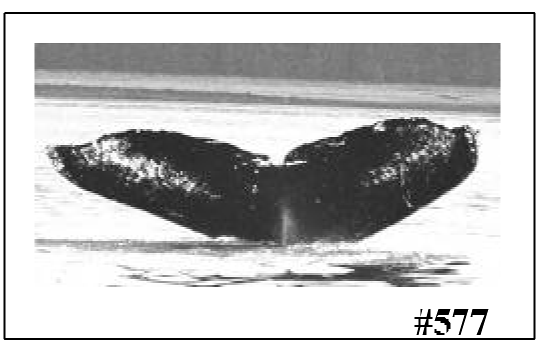

Figure 1. Sample whale fluke identification photograph.

We compared fluke photographs to previous NPS photographs and to other available fluke catalogs (Cartwright unpubl. data; Darling 1991; Jurasz and Palmer 1981; Perry *et al.* 1985; National Marine Mammal Laboratory unpubl. data; Perry *et al.* 1988; Sharpe unpubl. data; Straley and Gabriele 1997; Uchida and Higashi 1995; von Ziegesar 1992) to determine the identity and past sighting history of each whale. We referred to many whales by an identification number issued by the Kewalo Basin Marine Mammal Laboratory (KBMML) catalog of North Pacific humpback whales (Perry *et al.* 1988). Identification numbers lower than #950 coincide with those in the KBMML catalog; those higher than #950 are unique to the combined catalogs of Glacier Bay National Park and University of Alaska Southeast researcher Jan Straley (Straley and Gabriele 1997). We also referred to those whales first photo-identified by Jurasz and Palmer (1981) by their nicknames (Appendix 1).

We assigned temporary identification codes to whales that had not been previously identified in Glacier Bay and Icy Strait, denoting the film roll and frame number of the identification photograph, for example GB01-7(2). We replaced temporary "filmcodes" with permanent identification numbers if we identified the whale on more than one day, or if it had been identified elsewhere or in previous years. We assigned calves an identification number if we obtained adequate photographs of the flukes, but only if the calf was sighted on more than one day. We are able to identify an increasing number of whales by their dorsal fin alone, enabling us to augment the sighting histories of individuals whose dorsal fins we recognize from other observations accompanied by a fluke photograph. After we completed the photographic analysis, we added each whale's identity and the sighting data from the field notes to a Microsoft Access database containing Glacier Bay and Icy Strait whale sighting histories from 1977 to 2001. Finally, we printed and catalogued the best 2001 photograph of each individual.

Whale Counts: After we analyzed all of the photographs, we counted the number of distinct individual whales in the sample. We made separate counts of Glacier Bay and Icy Strait for the total monitoring period from June 1 to August 31 and for a 'standardized period' (after Perry *et al.* 1985) from July 9 to August 16. Although the standardized period is substantially shorter than the current NPS June through August monitoring season, 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 subsequent years (Gabriele *et al.* 1995). We also determined the number of whales that were 'resident' in Glacier Bay, Icy Strait and the combined area. We defined a whale as resident if it was photographically identified in the study area over a span of 20 or more days (after Baker 1986).

Prey Identification: We used field guides (Hart 1988; Pearse *et al.* 1987; Smith and Johnson 1977) to taxonomically identify sample prey items that we opportunistically collected at the surface.

RESULTS

Vessel Surveys & Whale Counts

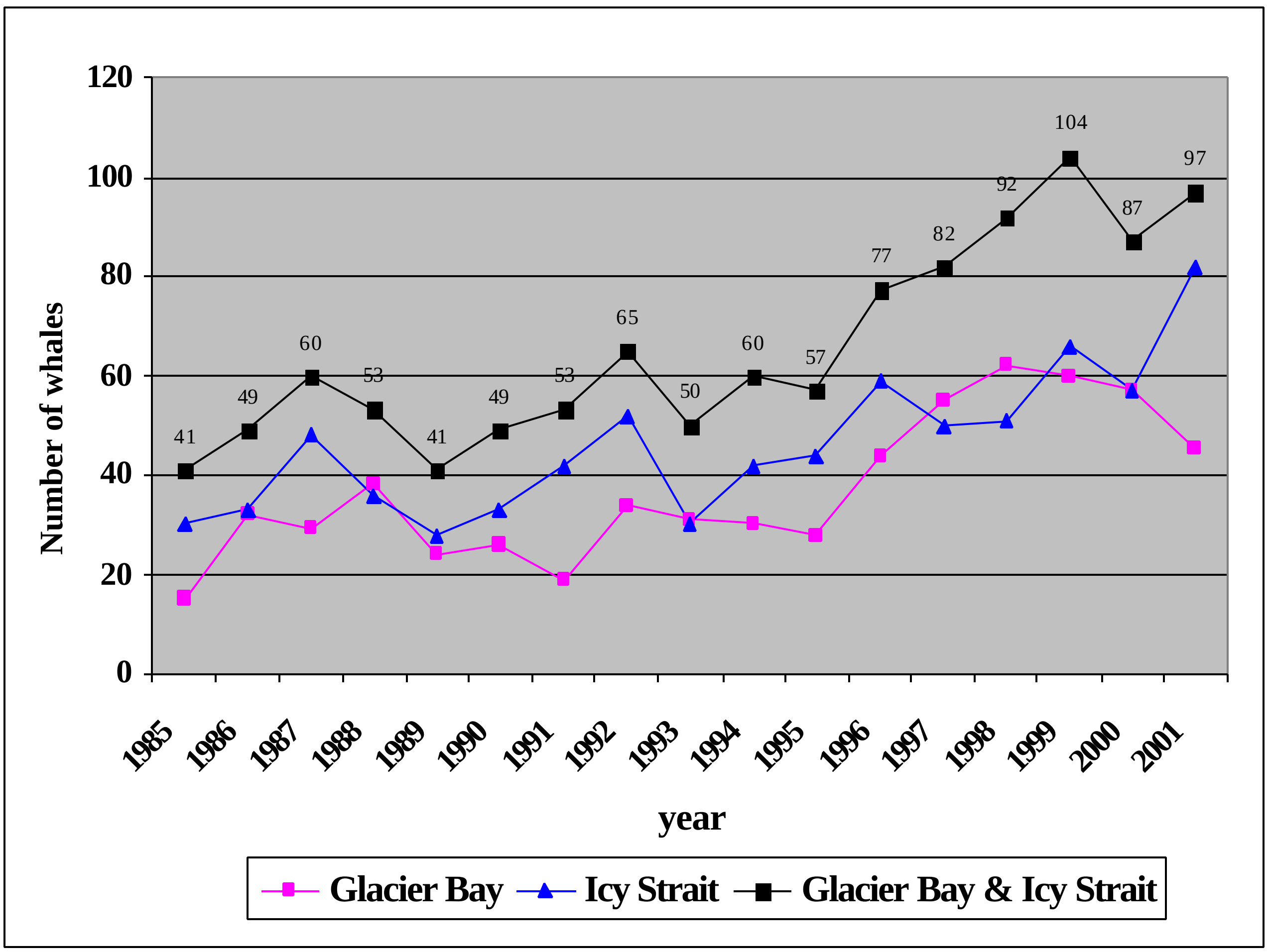

Figure 2. Number of individual whales documented in Glacier Bay and Icy Strait, 1985-2001. See Appendix 2 for a detailed annual summary of the standardized and total whale counts in Glacier Bay and Icy Strait.

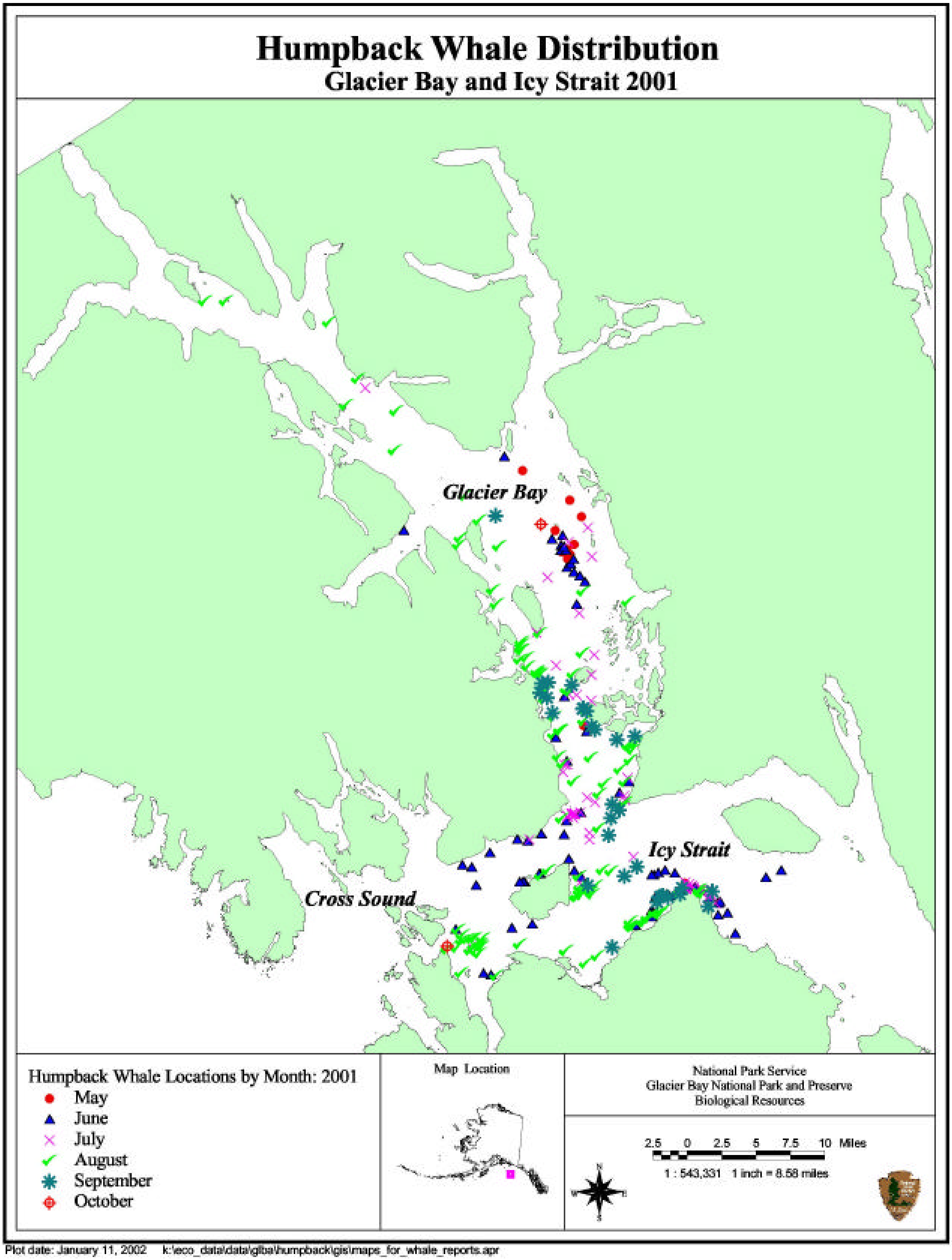

Figure 3. Study area in Glacier Bay and Icy Strait, showing humpback whale distribution in 2001. See Appendix 3 for a detailed summary of survey effort in the study area.

Seasonal Distribution: We observed whales throughout the study area, with the highest numbers concentrating around the Marble Islands, Point Carolus, Point Adolphus and western Icy Strait (Fig. 3). With only two notable exceptions, the number of whales in Glacier Bay was relatively low and the whales were very spread out until mid-August, especially in the Lower Bay. From late May until the end of June, we observed large numbers of whales consistently near the Marble Islands, particularly around South Marble Island, where as many as 12 whales were documented on one day. While the average pod size in 2001 in Glacier Bay was 1.56 whales, pods around the Marble Islands averaged 2.8 whales, with pods of three or more whales sighted regularly. These pods were often comprised of the same individuals who apparently stayed in the immediate area, as they were not documented elsewhere in the study area in June. By the end of June, whales were no longer concentrating around the Marble Islands and were again scattered widely in Glacier Bay. Whale use of the eastern side of the mid-bay remained low for the remainder of the summer. In mid-July, very high numbers of whales concentrated around Point Carolus with 18 individual whales identified there on July 16. By early August, the whales at Point Carolus had dispersed and we estimated that fewer than 15 whales were present throughout all of Glacier Bay.

In mid-August, whale numbers in lower Glacier Bay finally increased to levels typical of previous years. A concentration of whales between Rush Point and lower Whidbey Passage necessitated a 10-knot speed limit in this area from August 25 to September 14. By late August, whale densities throughout the Lower Bay increased with up to 11 whales observed on one day in this area. The Lower Bay whale waters 10-knot speed limit was implemented on August 31 and removed on September 28, 2001.

Despite this late summer surge in whales numbers in the Lower Bay, whales were noticeably absent from Bartlett Cove all summer (Fig. 4). We documented the first whale sighting in Bartlett Cove on August 15. Subsequently, we documented only five different whales in Bartlett Cove during the 2001 monitoring period, over a total of nine sightings. Despite this lack of sightings, underwater acoustic monitoring with an anchored hydrophone in outer Bartlett Cove documented singing whales in the Lower Bay until November 14, 2001 (Gabriele *et al.* 2001a).

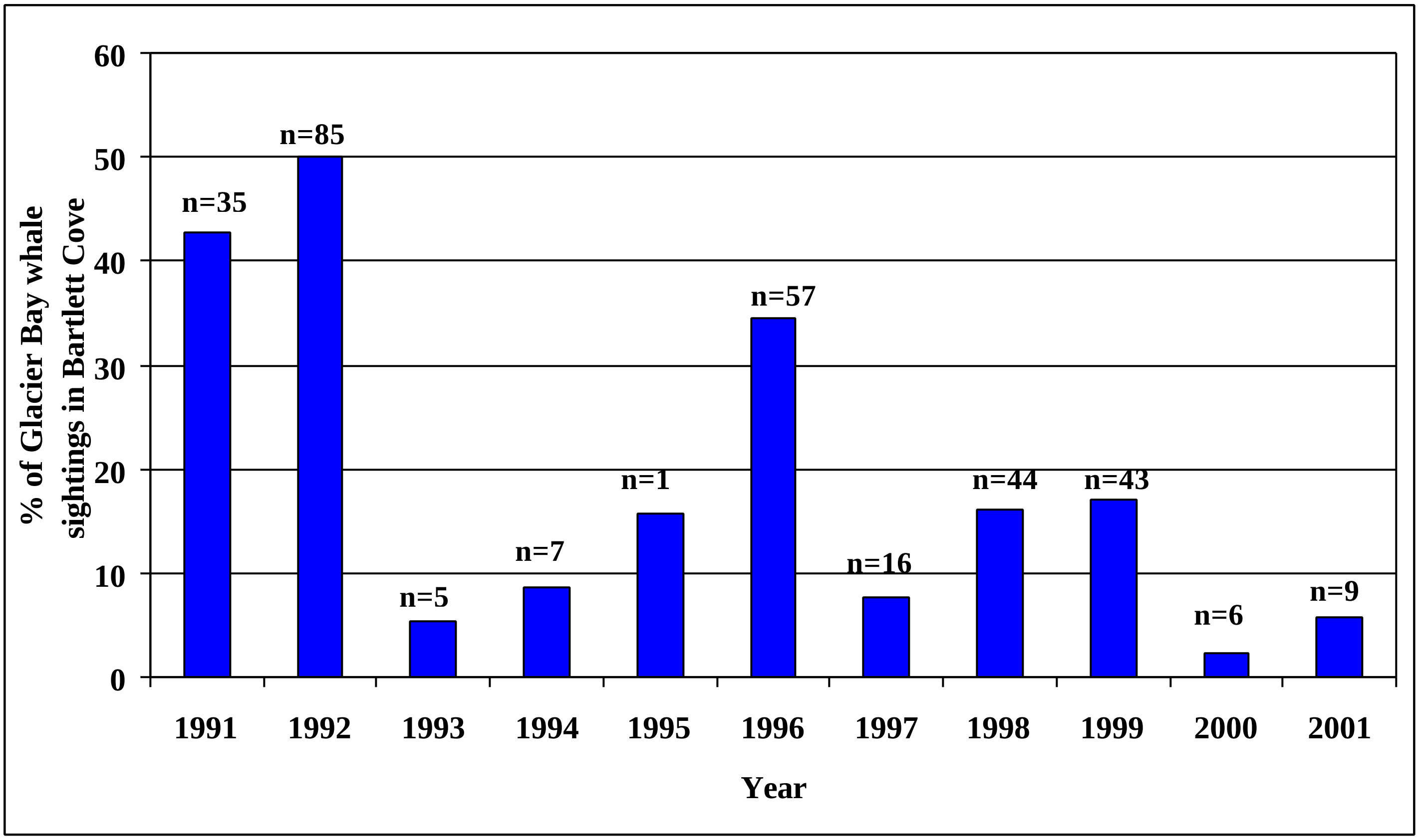

Figure 4. Proportion of Glacier Bay annual whale sightings occurring in Bartlett Cove 1991-2001. The number of Bartlett Cove whale sightings is found above each bar in the graph.

Although we documented few whales in the West Arm, NPS rangers reported occasional sightings of single whales there throughout the summer. Whale use of the West Arm appeared to be spread out and comparable to past years. In late May there were two sightings of humpback whales in Tarr Inlet. One of the whales was sighted approximately one mile south of Margerie Glacier (K. Jones, M. Ausema, pers. comm.). Another notable West Arm whale sighting occurred on July 4 when a small humpback whale was reported at Jaw Point (D. Johnson, pers. comm.). From late July until mid-August there were repeated sightings of a lone whale inside Reid Inlet (D. Johnson, L. Boesser-Koschmann, J. Luthy, pers. comm.). Reports of whales in the East Arm were infrequent except during the first week in July when at least one whale was sighted repeatedly in Adams Inlet (P. Vanselow, pers. comm.).

We sighted whales regularly in Icy Strait, with especially high numbers of sightings in western Icy Strait. In early June, as many as 15 whales concentrated between Dundas Bay, Lemesurier Island and Idaho Inlet. From mid-June until early August, whales congregated in high numbers around Point Adolphus, although we rarely saw the ‘core group’ (after Perry et al. 1985; Gabriele 1997). We documented only two sightings of the core group (on July 25 and

August 6) with a maximum group size of nine whales. Starting in mid-August, whale activity appeared to shift westward away from Point Adolphus with at least seven whales identified near Mud Bay on August 10, at least nine whales identified off the east side of Lemesurier Island on August 15 and at least 16 whales identified at the mouth of Idaho Inlet on August 17. The whales identified in western Icy Strait in June (n = 21) were not the same as the whales identified there in August (n = 23), with the exception of two individuals that were documented in both June and August. By early September, whale numbers in western Icy Strait declined as whale numbers near Point Adolphus increased.

Local Movement and Residency: Thirteen (29%) of the 45 whales that entered Glacier Bay between June 1 and August 31 remained 20 or more days, long enough to be considered resident. Twenty-nine (35%) of the 82 whales in Icy Strait were considered resident in that area during the study. Interestingly, a few of the Icy Strait residents, such as #159 and #1244, are historically residents of Glacier Bay. An additional 15 (15%) of the 97 whales sighted in Glacier Bay/Icy Strait, including one mother/calf pair, were resident in the combined Glacier Bay/Icy Strait area but not in either specific sub-region. We identified 28 of the whales (29%) that entered the study area between June 1 and August 31, including five mother/calf pairs, on just one day: six in Glacier Bay and 22 in Icy Strait. We sighted 14 of these whales, including four mother/calf pairs, in western Icy Strait only (in Idaho Inlet, Gull Cove and North Pass), although their temporal distribution suggests that they do not represent a pulse of whales arriving together in this area (Appendix 1).

Reproduction, Sex Ratios and Juvenile Survival: We documented 12 mother/calf pairs in the study area in 2001 (Table 1). The sex of three of the mothers (#1014, #1479 and #1273) was not previously known. We have documented whale #1014, the 1989 calf of #236, every year in the study area since 1991 without a calf, making her 12 years old at the age of her first known reproduction in 2001. Whale #236, the mother of #1014, is the third documented grandmother in the study population, although we have not documented her in the study area since 1999. Whale #1273 was first sighted in Sitka Sound in 1993 as an adult (J. Straley, pers. comm.), so her age is unknown. The same is true for whale #1479, who was first sighted in Frederick Sound in 1994 as an adult (J. Straley, pers. comm.).

Table 1. Reproduction, sex ratios and known age whales in Glacier Bay and Icy Strait, 1982-2001.

Year:	# Calves	# Calves Photo ID'd	% Calves Photo ID'd	Crude Birth Rate (%)	# Females	# Males	# Unk. Sex	# Known Age Whales	Total # Whales
1982	6	3	50	-	-	-	-	-	-
1983	0	0	0	-	-	-	-	-	-
1984	7	5	71.4	17.9	-	-	-	-	39
1985	2	1	50	4.9	17	16	8	3	41
1986	8	5	62.5	16.3	17	16	16	2	49
1987	4	3	75	6.7	24	20	16	5	60
1988	8	5	62.5	15.1	18	18	17	4	53
1989	5	3	60	12.2	17	14	10	5	41
1990	6	6	100	12.2	20	15	14	7	49
1991	4	4	100	7.5	20	18	15	8	53
1992	12	11	91.7	18.5	31	17	17	7	65
1993	3	3	100	6.0	21	16	13	12	50
1994	9	5	55.6	15.0	23	21	16	10	60
1995	3	3	100	5.3	25	18	14	9	57
1996	7	2	28.6	9.1	30	19	28	17	77
1997	9	8	88.9	11.0	33	23	26	15	82
1998	8	7	87.5	8.7	35	24	33	17	92
1999	9	5	55.6	8.7	38	25	41	22	104
2000	3	2	66.7	3.4	31	25	31	20	87
2001	12	9	75	12.4	35	23	39	25	97

Notes:

- Crude Birth Rate (CBR) = a percentage computed by # calves / total whale count.
- CBR's for 1982 & 1983 could not be calculated because total whale counts for these years are not available.
- Sex ratios are not available for 1982-1984.
- Number of known age whales does not include calves of the year. These data are not available for 1982-1984.

On May 24, we documented whale #587 with her calf (#1535) near South Sandy Cove. On August 6, we resighted the calf alone at Point Adolphus and noted that the calf was relatively "big". Soon after this encounter began, #587 rejoined her calf. On September 10 we documented #587 at Point Adolphus without her calf. We observed #587 from 13:01 to 13:24 and again from 14:40 until approximately 15:11. During the last encounter, #587 traveled rapidly toward the Porpoise Islands with no sign of her calf nearby. We subsequently documented neither #587 nor her calf in the study area.

We identified two whales that had not been sighted in the study area since they were calves: #1088 (age 7) and #1470 (age 3), bringing the 1974-2001 total number of returning offspring to 35. Of these 35 known age whales, we documented 25 in the study area in 2001 (Table 1).

Prey Identification: We observed schools of Pacific herring intermittently boiling at the water's surface near feeding whales at Pt. Adolphus and Pinta Cove on June 5 and June 21. On July 8, NPS naturalist Sean Nielson photographed whale #118 feeding on small schooling fish in Adams Inlet. From his photographs we identified the prey species as sand lance (M. Litzow, pers. comm.). On August 21 we opportunistically collected a 15 cm juvenile walleye pollock at the entrance to Berg Bay that was dropped by gulls that were feeding over whale #1293.

Whale/Human Interactions: There were no whales entangled in fishing gear or disturbed by aircraft reported in the Glacier Bay/Icy Strait area in 2001. However, on July 16 we discovered the bloated body of a dead adult female humpback whale floating approximately one mile west of Point Gustavus. After towing the whale's carcass to the beach at Point Gustavus (Fig. 5), we performed an initial necropsy on July 18 which

Figure 5. Dead humpback whale #68 lying ventral side up at Point Gustavus, July 2001.

revealed extensive hemorrhaging near the whale's left eye. On July 22, veterinarian Dr. Frances Gulland from the Marine Mammal Center in Sausalito, CA worked with NPS staff and local volunteers to conduct a detailed necropsy in order to determine the cause of death. The necropsy revealed "multiple compound fractures of the skull…consistent with a traumatic injury resulting from a severe blunt blow to the right side of the head. The extent of skull damage would have been immediately fatal" (Gulland 2001). In addition, we discovered that the whale was pregnant after we found bones (ribs, mandible and skull) from a fetal whale loose within her peritoneal cavity.

Based on a post-mortem fluke identification photograph, we identified the dead whale as whale #68. This individual was first sighted by Charles Jurasz in 1975 in Berg and Fingers Bays (C. Jurasz, unpubl data). Between 1975 and 2001, she was sighted repeatedly in southeastern Alaska, as well as in Hawaii. Her last documented sighting alive was on June 26, 2001 when we photographed her off the north side of Lemesurier Island with female #941.

Coincidentally, on July 2, 2001 the National Marine Fisheries Service (NMFS) implemented a new regulation prohibiting vessels from approaching within 100 yards of humpback whales in Alaska (National Oceanic and Atmospheric Administration / NMFS 2001). Previously, NMFS had published guidelines recommending that vessel operators not approach within 100 yards of humpback whales, but no law prohibited approach within a particular distance. Under the new NMFS Alaska regulations, vessel operators are also prohibited from positioning their vessel in the path of an oncoming humpback whale so that the whale surfaces within 100 yards of their vessel. Finally, vessel operators are required to maintain a "slow, safe speed" when maneuvering near humpback whales in Alaska.

In 2001, the NPS sponsored the second year of a study of whale-vessel interactions in Icy Strait to inform its whale and vessel management policies (Gabriele *et al.* in prep.).

We documented the evolution of an unusual deformity on whale #564's flank over the course of five weeks. Beginning on July 13, we photographed whale #564 with a large, broad swelling anterior to his dorsal fin. When we resighted him on August 2 the swelling had grown into a pronounced soccer ball-sized lump (Fig. 6). However, when we photographed #564 next on August 17 the lump was gone. We observed some loose skin where the lump had been located and it appeared that the lump may have burst. During these three observations of whale #564, his behavior did not appear to be affected by the presence of the lump.

Figure 6. Whale #564 with pronounced lump anterior to dorsal fin on August 2, 2001.

Interestingly, in September we received a report of a humpback whale near Juneau with a “soccer-ball sized lump” on its left flank (G. van Vliet, pers. comm.). We do not know the identity of this whale, but we assume that it was a different individual because whale #564 was sighted in Glacier Bay on September 11 with no visible lump on his flank.

DISCUSSION

Vessel Surveys: While the number of days we spent surveying in Glacier Bay and Icy Strait was above average for all years since the study began in 1985, the number of hours we spent surveying in each area was below average for all years since 1985. In Glacier Bay, the numbers of hours and days we spent surveying in 2001 were at their lowest levels since 1995 and 1996, respectively. In Icy Strait, the numbers of hours and days we spent surveying in 2001 were lower than in 2000, but comparable to levels since 1996. Three possible reasons why overall survey effort was relatively low in 2001, especially in Glacier Bay, are: 1) it was an unusually windy summer in Glacier Bay with strong northerly winds which frequently created unworkable sea conditions and caused us to abort surveys early, 2) the lack of whales in Glacier Bay meant that the time needed for each survey was shorter and 3) obligations related to the whale mortality incident in July 2001 reduced our survey effort in both Glacier Bay and Icy Strait in July (Appendix 3). In order to maintain comparable levels of survey effort in each area for all years of the study, we will increase the length of surveys in Glacier Bay and Icy Strait in future years.

Whale Counts: Despite the fewer number of hours we spent surveying in 2001, the total count of 97 whales represents the second highest number of whales ever identified in the study area in a single season since 1985 (Appendix 2). Overall, the 2001 data add to the continued increasing trend documented in recent years in Glacier Bay, Icy Strait and the combined Glacier Bay/Icy Strait area. However, unlike in recent years with high annual whale counts, Glacier Bay and Icy Strait did not contribute equally to the high whale count in 2001. In Icy Strait, the standardized count of 57 whales and the total count of 82 whales are by far the highest ever recorded since the study began in 1985. Prior to 2001, the highest standardized count ever documented in Icy Strait was 43 whales and the highest total count ever documented in Icy Strait was 66 whales. In contrast, in Glacier Bay, the standardized count of 26 whales and the total count of 45 whales are the lowest they have been since 1995 and 1996, respectively, but still above average for all years. If the relatively low number of whales we documented in Glacier Bay was an artifact of the below average number of hours we spent surveying in Glacier Bay, then one would also expect us to have documented relatively low numbers of whales in Icy Strait, where the number of hours we spent surveying was also below average. However, this was not the case. Despite below average survey effort in Icy Strait, the number of whales that we documented in this area was at a record high. Therefore, it appears that the observed increase in whale numbers in Icy Strait was not a result of disproportionate survey effort, but rather a result of a real increase in whale numbers in this area.

Seasonal Distribution: As expected, the high number of whales in Icy Strait and the relative lack of whales in Glacier Bay are reflected in the seasonal distribution of whales in 2001. Overall, whale distribution in Glacier Bay in 2001 was unusual in that whale activity did not concentrate in the Lower Bay until late August and it was generally clumped in the northwestern part of the Lower Bay. In past years, it has been common for the Lower Bay to be widely used by large numbers of whales starting in early July. As we documented in 2000, Bartlett Cove was not as heavily used in 2001 as it has been in most of the past several years.

The June 2001 sightings of up to 12 whales near the Marble Islands were consistent with observations of high numbers of whales in this area in June and July 1999 and June 2000 (Gabriele *et al.* 1999; Gabriele and Hart 2000).

Given the concurrent frequent vessel traffic in this area, it may be advisable to consider implementing special vessel operating restrictions such as a 10-knot speed limit around the Marble Islands if whales continue to congregate there in future years.

Unfortunately, our ability to conduct West Arm surveys in 2001 was hampered by frequent northerly winds that created unworkable sea conditions. Given the historical rarity of whale sightings in close proximity to the glaciers, and despite the low number of surveys that we conduct in the upper West Arm annually, it is interesting that whales have been sighted repeatedly in Reid Inlet in 1998, 1999 and 2001 (Gabriele and Doherty 1998; Gabriele *et al.* 1999). Robards *et al.* (1999) reported large numbers of adult Pacific snake pricklebacks (*Lumpenus sagitta*), a forage fish species tolerant of glacial silt dominated systems, and euphausiids near Reid Glacier in June 1999. It would be interesting to determine if the whales frequenting Reid Inlet are feeding, and if so, to identify the species upon which they are feeding.

In Icy Strait, whales were distributed comparably to past summers with the majority of whales concentrated around Point Adolphus. In contrast to previous years, however, was the prolonged use of western Icy Strait by whales, as illustrated by the high number of sightings between Dundas Bay, Lemesurier Island and Idaho Inlet early in the season and in Idaho Inlet in August. Although in July 1999 large numbers of whales shifted from Point Adolphus to the mouth of Idaho Inlet (Gabriele *et al.* 1999), the overall use of western Icy Strait in 2001 far exceeded that documented in recent years.

We presume that the low whale numbers in Glacier Bay were correlated with a relatively low abundance of whale prey there compared with other areas. In previous years, capelin have been identified as one of the primary fish species preyed on by whales in Glacier Bay (Wing and Krieger 1983; Krieger and Wing 1984, 1986). Preliminary data from a survey of forage fish in Glacier Bay in summer 2001 indicate that capelin were surprisingly absent from the bay in July (J. Piatt *et al.*, unpubl data), perhaps accounting for the lack of whales we observed in Glacier Bay. In turn, the disproportionate number of whales in Icy Strait in 2001 may have been due to a relatively high abundance of forage fish in this area. Unfortunately, data on the abundance and distribution of forage fish in Glacier Bay and Icy Strait are not collected annually. A beach seine study in June 1999 provided a one-time assessment of the distribution and abundance of small schooling fish in the nearshore areas of Glacier Bay (Robards *et al.* 1999). Standardized, annual assessments of forage fish temporal and spatial patterns throughout the study area are needed in order to understand how these patterns affect whale distribution and abundance, especially in the context of the Park's vessel management policies pertaining to whale waters.

Local Movement and Residency: The slightly lower proportion of whales that were considered resident in Glacier Bay (29%, as compared to 31-64% in 1992 and 2000) likely relates to the overall lack of whales documented in Glacier Bay. For example, typical Glacier Bay resident whales #159 and #1244 appear to have frequented Icy Strait more than Glacier Bay in 2001. Whether or not this is a temporary shift in habitat use by these historic Glacier Bay residents is unknown. The proportion of whales that were considered resident in Icy Strait (35%) was typical for the period between 1992 and 2000 (24-55%).

The proportion of whales sighted on just one day during the study period in 2001 (29%) was comparable to the proportion between 1994 and 2000 (23-43%). Most of the 28 whales sighted on just one day were sighted in Icy Strait (n = 22) while the remaining six whales were sighted in Glacier Bay, similar to other patterns documented in 2001. It is noteworthy that 14 of the whales, including four mother/calf pairs, that were sighted on only one day were sighted in western Icy Strait. If we had not surveyed in western Icy Strait on these days, we would have missed identifying a sizeable proportion (14%) of the 2001 population.

Reproduction, Sex Ratios and Juvenile Survival: The number of calves observed in 2001 (n = 12) ties with 1992 for the highest number of calves observed in the study area over the past 20 years and is almost double the average number of calves (6.2) for all years. The high number of calves in 2001 resulted in a high crude birth rate (12.4%), although not as high as in 1992 when the crude birth rate reached a record level of 18.5%.

The discovery that #1014 is a female contributes to our developing understanding of the demographics of the study population. Based on available information from the North Atlantic humpback whale population, where female humpbacks have their first calf at an average age of 5-7 years (Clapham 1992), it would be unusual for a female humpback to have her first calf at the age of 12. However, whale #1014's reproductive history, added to the reproductive history of several other well-known females in the study population, lends weight to our hypothesis that females are older than age 5-7 when they are first sighted with calves in Glacier Bay and Icy Strait (Gabriele and Hart 2000). We plan to collaborate with other researchers to investigate the average age at first reproduction for female humpback whales in the North Pacific. The value of long-term studies is highlighted by the fact that 26% (n = 25) of the whales that we identified in 2001 are of known age. We expect this proportion to increase annually as we continue to accumulate long-term sighting histories of the humpback whales in the study area.

Although we occasionally observe calves separate from their mothers for periods up to one hour (NPS, unpubl. data), in most cases we eventually document both the mother and the calf on the same day. The absence of calf #1535 during approximately 54 minutes of observations of its mother, #587, on September 10 without any subsequent sightings of the calf on that day is cause for some concern. Only two documented cases of calf mortality have been recorded in the study area (Baker 1986, Baker and Straley 1988). However, even if #1535 is not resighted, we cannot presume that it died, because 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). Given that #1535 was noted as being a "big" calf during previous observations, it seems plausible it was weaned and independent of #587 by September 10. We will not know the fate of this calf unless we resight it in subsequent years using the fluke and dorsal fin photographs that we took during the July sightings.

Another ambiguous calf absence occurred in 1999, when #1246 had a calf that was sighted twice in July but was absent during a 24- minute encounter with #1246 in August under poor observation conditions (Gabriele *et al.* 1999). The fate of #1246's 1999 calf remains unknown because fluke identification photos were not obtained. The issue of mother/calf separation in late summer and fall was identified by Gabriele *et al.* (2001b) as the major challenge in determining the calf mortality rate.

Prey Identification: Our observations of herring boiling at the surface near Point Adolphus and Pinta Cove in June are not unusual, although we do not observe this phenomenon every summer. Pacific herring are known to be one of the primary fish species preyed on by whales in the study area, particularly in Icy Strait (Wing and Krieger 1983; Krieger and Wing 1984, 1986). This is the first time that we have identified whale prey (sand lance) from a photograph of a whale feeding in the study area, and certainly the first time that a kittiwake has inadvertently contributed a juvenile walleye pollock to our collection of whale prey specimens. Both sand lance and juvenile walleye pollock have been previously documented as humpback whale prey in the study area. It is interesting that no capelin were collected from Glacier Bay in 2001, which has been the most common species identified in previous years (Gabriele *et al.* 1997; Gabriele and Doherty 1998; Gabriele *et al.* 1999).

Whale/Human Interactions: This is the first time that a dead humpback whale has been found in the study area since the study began in 1985. The loss of even one individual from this endangered humpback whale population, particularly a reproductively active female such as whale #68, is extremely unfortunate. We were fortunate to have the expertise of Dr. Frances Gulland during the necropsy which allowed us to determine that whale #68 died from multiple skull fractures. The nature and severity of whale #68's injuries and the investigations into the circumstances surrounding her death indicate that this individual died from a collision with a large ship. In their comprehensive review of collisions between ships and whales, Laist *et al.* (2001) state, "Given the force needed to break large whale bones, it was considered unlikely that fractured jaws, skulls, or vertebrae were caused by anything other than ship collisions." In addition, they found that most lethal or severe injuries are caused by ships 80 meters or longer and that most of these injuries involve ships traveling 14 knots or faster (Laist *et al.* 2001). Reports of collisions between large ships and whales in southeastern Alaska are rare. The only incident of which we are aware occurred in 1999 when the cruise ship *Westerdam* struck and apparently killed a humpback whale in Stephens Passage, approximately 100 km south of Juneau (Fry 1999). The body of that whale was not examined because as the *Westerdam* slowed down, the whale slipped off the bulbous part of the bow and sank.

Habituation to vessel presence and increasing populations of whales and vessels are two main factors contributing to the high risk of vessel/whale collisions in southeastern Alaska. Documenting the incidence of such collisions is important, and would be made far easier by implementing mandatory reporting of whale vessel collisions in U.S. waters (Marine Mammal Commission 2001). The new whale approach regulations implemented in July 2001 by the NMFS are an important step in safeguarding humpback whales in Alaska from collisions and behavioral disturbance, but they lack an enforceable speed limit that could decrease the fatality rate. Additional data are needed on the reasons why whales fail to avoid ships that they should have been able to detect acoustically. Investigation of the "bow null effect" (Terhune and Verboom 1999) for the types of ships that coexist with whales in southeastern Alaska could direct management actions that would decrease the risk of whale/vessel collisions.

We cannot determine the origin of the pronounced lump on #564's flank, nor whether it resulted from an interaction with humans. We plan to circulate photographs of the abnormality to veterinarians and other experts to determine whether it was symptomatic of injury or disease.

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LITERATURE CITED

Baker, C.S. (1985). The population structure and social organization of humpback whales (*Megaptera novaeangliae)* in the central and eastern North Pacific. Ph.D. dissertation, University of Hawaii, 306 pp.

Baker, C.S. (1986). Population characteristics of humpback whales in Glacier Bay and adjacent waters: Summer 1986. Report to the National Park Service, Gustavus, AK, 30 pp.

Baker, C. S. and J. Straley (1988). Population characteristics of humpback whales in Glacier Bay and adjacent waters: summer 1988, U.S. National Park Service, Glacier Bay National Park and Preserve.

Baker, C.S., J.M. Straley and A. Perry (1990). Population Characteristics of Humpback Whales in Southeastern Alaska: Summer and Late-Season 1986. Final Report to the Marine Mammal Commission, PB90-252487, 23 pp.

Baraff, L. and M.T. Weinrich (1993). Separation of humpback whale mothers and calves on a feeding ground in early autumn. *Marine Mammal Science* 9(4):431-434.

Clapham, P.J. (1992). Age at attainment of sexual maturity of humpback whales, *Megaptera novaeangliae*. *Canadian Journal of Zoology* 70:1470-1472.

Darling, J.D. (1991). Humpback Whales in Japanese Waters (Ogasawara and Okinawa) Fluke Identification Catalogue 1987-1990. World Wide Fund for Nature Japan, Minato-ku, Tokyo, Japan, 56 pp.

Fry, E. (1999). Westerdam hits, kills humpback. Juneau Empire, July 27, 1999. Juneau, AK.

Gabriele, C.M. (1997). Comparison of Humpback Whale Group Dynamics Between Hawaii and Alaska. In: Report of the Workshop to Assess Research and Other Needs and Opportunities Related to Humpback Whale Management in the Hawaiian Islands, compiled by P.M. Payne, B. Phillips, E. Nitta. U.S. Department of Commerce, NOAA Tech Memo. NMFS-OPR-11, pp. 31-37.

Gabriele, C.M. and J.L. Doherty (1998). Population characteristics of humpback whales in Glacier Bay and adjacent waters: 1998. Report to the National Park Service, Glacier Bay National Park and Preserve, Gustavus, AK, 33 pp.

Gabriele, C.M., J.L. Doherty and A.G. Andrews (1997). Population characteristics of humpback whales in Glacier Bay and adjacent waters: 1997. Report to the National Park Service, Glacier Bay National Park and Preserve, Gustavus, AK, 31 pp.

Gabriele, C.M., Doherty, J.L. and T.M. Lewis (1999). Population characteristics of humpback whales in Glacier Bay and adjacent waters: 1999. Glacier Bay National Park and Preserve. Gustavus, Alaska 99826, 35 pp.

Gabriele, C. M., A. S. Frankel and T. M. Lewis (2001a). Frequent humpback whale songs recorded in Glacier Bay, Alaska in Fall 2000 and 2001. Poster presentation at the 15th Biennial Conference of the Society for Marine Mammalogy. Vancouver, British Columbia. November 2001.

Gabriele, C. M., J. M. Straley, S. A. Mizroch, C. S. Baker, A. S. Craig, L. H. Herman, D. Glockner-Ferrari, M. J. Ferrari, S. Cerchio, O. von Ziegesar, J. Darling, D. McSweeney, T. J. Quinn II and J. K. Jacobsen (2001b). Estimating the mortality rate of humpback whale calves in the central North Pacific Ocean. *Canadian Journal of Zoology* 79: 589-600.

Gabriele, C.M. and T.E. Hart (2000). Population characteristics of humpback whales in Glacier Bay and adjacent waters: 2000. Glacier Bay National Park and Preserve. Gustavus, Alaska 99826, 25 pp.

Gabriele, C.M., J.M. Straley and C. S. Baker (1995). The Variability of Humpback Whale Counts in Glacier Bay and Icy Strait. Proceedings of the Third Glacier Bay Science Symposium, 1993, edited by D.R. Engstrom, pp. 239-245.

Gulland, F. (2001). Humpback whale necropsy report, July 22 2001. Unpublished report. 1 p.

Hart, J.L. (1988). Pacific Fishes of Canada. Fisheries Research Board of Canada., Ottawa, Canada K1A 0S9.

Jurasz, C.M. and V.P. Palmer (1981). Censusing and establishing age composition of humpback whales (*Megaptera novaeangliae*), employing photodocumentation in Glacier Bay National Monument, Alaska. Report to the National Park Service, Anchorage, AK, 42 pp.

Katona, S.K., B. Baxter, O. Brazier, S. Kraus, J. Perkins and H. Whitehead (1979). Identification of Humpback whales by Fluke Photographs. In: Behavior of Marine Animals, vol. 3: Cetaceans. Edited by H.E. Winn and B.L. Olla, Plenum Press, pp. 33-44.

Krieger, K.J. (1990) Relationship between prey abundance and usage of Glacier Bay by humpback whales. In: Milner AM, Wood Jr. JD, editors; Sept 19-22, 1988; Glacier Bay National Park and Preserve, AK. U.S. National Park Service, pp. 90-95.

Krieger, K. and B.L. Wing (1984). Humpback whale prey studies in southeastern Alaska, Summer 1983. Northwest and Alaska Fisheries Center, Auke Bay Laboratory, Auke Bay, AK, 42 pp.

Krieger, K. and B.L. Wing (1986). Hydroacoustic monitoring of prey to determine humpback whale movements. NOAA Technical Memorandum NMFS F/NWC-98, 62 pp.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, and M. Podesta (2001). Collisions between ships and whales. *Marine Mammal Science* 17(1):35-75.

Marine Mammal Commission (2001). Humpback whales in Alaska (*Megaptera novaeangliae*). Draft annual report. 11 pp.

National Oceanic and Atmospheric Administration / National Marine Fisheries Service (2001). Regulations governing the approach to humpback whales in Alaska (50 CFR Part 224). Federal Register 66(105): 29502-29509.

Pearse, V., J. Pearse, M. Buchsbaum, and R. Buchsbaum (1987). Living invertebrates. Boston, Mass., Blackwell Scientific Publications.

Perry, A., C.S. Baker, and L.M. Herman (1985). The natural history of humpback whales (*Megaptera novaeangliae*) in Glacier Bay. Final Report to the National Park Service, Alaska Regional Office, Anchorage, AK, 41 pp.

Perry, A., J.R. Mobley, Jr., C.S. Baker and L.M. Herman (1988). Humpback whales of the central and eastern North Pacific. University of Hawaii Sea Grant Miscellaneous Report UNIHI-SEAGRANT-MR-88-02, 236 pp.

Robards, M., J. Piatt and G. Drew (1999). Distribution and abundance of small schooling fish in nearshore areas of Glacier Bay, Alaska during June, 1999. Preliminary summary to the USGS Biological Resources Division, Alaska Biological Science Center, Anchorage, AK, 22 pp.

Smith, D. L. and K. B. Johnson (1977). A guide to marine coastal plankton and marine invertebrate larvae. Kendall/Hunt, Dubuque, Iowa. 221 pp.

Straley, J.M. (1994). Seasonal Characteristics of Humpback Whales (*Megaptera novaeangliae*) in southeastern Alaska. Masters Thesis, University of Alaska, Fairbanks. 121 pp.

Straley, J.M. and C.M. Gabriele (1995). Seasonal Characteristics of Humpback Whales in Southeastern Alaska. Proceedings of the Third Glacier Bay Science Symposium, 1993, ed. D.R. Engstrom, pp. 229-238.

Straley, J.M. and C.M. Gabriele (1997). Humpback Whales of Southeastern Alaska. Humpback whale fluke identification catalog, National Park Service, P.O. Box 140, Gustavus, Alaska, 106 pp.

Terhune, J. M. and W. C. Verboom (1999). Right whales and ship noise. *Marine Mammal Science* 15: 256-258.

Uchida, S. and N. Higashi (1995). Fluke Identification Catalogue of Humpback Whales in Japanese Waters off Okinawa 1991-1995. Okinawa Expo Aquarium, Motobu-Cho, Okinawa, Japan 905-03, 18 pp.

von Ziegesar, O. (1992). A catalogue of Prince William Sound humpback whales identified by fluke photographs between the years 1977 and 1991, North Gulf Oceanic Society, P.O. Box 15244, Homer, Alaska 99603, 29 pp.

Wing, B.L. and K. Krieger (1983). Humpback whale prey studies in southeastern Alaska, summer 1982. Report to the Northwest and Alaska Fisheries Center Auke Bay Laboratory, National Marine Fisheries Service, NOAA, P.O. Box 155, Auke Bay, Alaska, 99821, 60 pp.

Appendix 1. Sighting Histories of Individually Identified Whales - 2001

	Whale ID	Nickname	5/18/01	5/21/01	5/24/01	6/4/01	6/5/01	6/6/01	6/7/01	6/11/01	6/13/01	6/15/01	6/18/01	6/19/01	6/20/01	6/21/01	6/22/01	6/25/01	6/26/01	6/28/01	6/29/01	7/2/01	7/3/01	7/5/01
1	235	Spot	GB		GB				IS															
2	235 calf 2001		GB		GB																			
3	937		GB					GB																
4	1052		GB																					
5	1299		GB															GB						
6	1431		GB		GB											IS			IS					
7	186			IS			IS		IS						GB									
8	1046				GB				IS								GB							
9	564	Roundup Taylor			GB			GB		GB				GB										
10	1534				GB																			
11	587	Gertrude			GB																			
12	1535	calf of 587			GB																			
13	1536					GB																		
14	1083						IS									IS					IS		GB	
15	118	Chop Suey					IS						GB								IS			
16	455						IS														IS			
17	1538	calf of 455					IS														IS			
18	219						IS									IS					IS			
19	1537	calf of 219					IS									IS					IS			
20	584						IS		IS															
21	166	Frenchie					IS														IS			
22	1014							GB		GB				GB			GB							
23	1539	calf of 1014						GB		GB				GB			GB							
24	159							GB		GB				GB			GB							
25	1019								IS															
26	1298								IS															
27	1304								IS												IS			
28	352								IS							IS					IS			
29	573								IS							IS								
30	1540	calf of 573							IS							IS								
31	577	Scoper							IS															
32	1531								IS															
33	161	B.W.M.							IS															
34	539	Max							IS															
35	GB01-7(2)								IS															
36	1012									GB				GB								GB	GB	
37	1063									GB				GB			GB							
38	1065									GB				GB			GB			GB		GB		
39	1079									GB							GB					GB		
40	1313									GB														
41	283									GB														
42	351									GB							GB			GB			GB	
43	1082										GB											GB		
44	196										GB													
45	1244											IS												
46	1293											IS					GB		IS				GB	
47	1489													GB										
48	1057															IS								
49	1297															IS								
50	157	M.D.														IS					IS			

	Whale ID	Nickname	7/9/01	7/11/01	7/12/01	7/13/01	7/16/01	7/20/01	7/25/01	7/26/01	7/27/01	7/31/01	8/1/01	8/2/01	8/3/01	8/6/01	8/8/01	8/10/01	8/13/01	8/14/01	8/15/01
1	235	Spot																			
2	235 calf 2001																				
3	937					GB															
4	1052																				
5	1299																				
6	1431															IS					
7	186															IS					
8	1046																				
9	564	Roundup Taylor				GB								IS							
10	1534																				
11	587	Gertrude														IS					
12	1535	calf of 587														IS					
13	1536																				
14	1083																	IS			
15	118	Chop Suey				GB						IS									IS
16	455																				
17	1538	calf of 455																			
18	219								IS			IS				IS					
19	1537	calf of 219							IS			IS				IS					
20	584													IS							IS
21	166	Frenchie							IS							IS					
22	1014						IS														
23	1539	calf of 1014					IS														
24	159						IS														
25	1019													IS							
26	1298																				
27	1304		IS				IS									IS					IS
28	352				GB							IS									
29	573								IS							IS					
30	1540	calf of 573							IS							IS					
31	577	Scoper																			
32	1531						IS														
33	161	B.W.M.																			
34	539	Max																			
35	GB01-7(2)																				
36	1012							GB							GB						GB
37	1063																				
38	1065		IS																		
39	1079						IS														
40	1313					GB	IS							IS							
41	283						IS														
42	351		IS			GB	IS					IS									
43	1082			GB																	
44	196																	IS			
45	1244															IS					
46	1293		IS			GB	IS														
47	1489		IS			GB								IS							
48	1057																				
49	1297																				
50	157	M.D.																IS			

	Whale ID	Nickname	5/18/01	5/21/01	5/24/01	6/4/01	6/5/01	6/6/01	6/7/01	6/11/01	6/13/01	6/15/01	6/18/01	6/19/01	6/20/01	6/21/01	6/22/01	6/25/01	6/26/01	6/28/01	6/29/01	7/2/01	7/3/01	7/5/01	7/9/01	7/11/01	7/12/01	7/13/01	7/16/01	7/20/01	7/25/01	7/26/01	7/27/01	7/31/01	8/1/01	8/2/01	8/3/01	8/6/01	8/8/01	8/10/01	8/13/01	8/14/01	8/15/01
51	353															IS															IS												
52	1650	calf of 353														IS															IS												
53	581															IS															IS			IS				IS					
54	875															IS														GB													
55	1042															IS					IS										IS			IS				IS		IS			
56	1479																GB																										GB
57	1479 calf 2001																GB																										GB
58	801																GB							GB													GB				GB	GB	
59	1049																		IS		IS								IS														
60	117	White Eyes																	IS																GB								IS
61	1246																		IS																					IS			IS
62	68	Snow																	IS																								
63	387																		IS																								
64	941																		IS																								
65	1292																				IS																						
66	1306																				IS										IS												
67	193																				IS													IS									
68	516	Garfunkle																			IS																	IS					IS
69	441	Festus																					GB																	IS			
70	221																						GB					GB															
71	1302																								IS			GB	IS		IS	GB							GB				IS
72	1432																												IS														
73	1485																												IS														
74	1532																												IS								GB						
75	155	Freckle Fluke																													IS							IS					
76	397																														IS							IS					
77	1233																																GB										IS
78	535	Quits																																	GB								
79	GB01-35(7)	calf of 535																																	GB								
80	1031																																			IS							IS
81	1273																																			IS							
82	1273 calf 2001																																			IS							
83	1472																																			IS				IS			
84	616	Lesser																																		IS							
85	350	Lace																																			GB						
86	1061																																					IS					
87	933																																					IS		IS			
88	1533																																						GB			GB	
89	1018																																								GB		
90	1473																																								GB		
91	250																																										IS
92	GB01-45(5)																																										IS
93	1470																																										
94	1474																																										
95	451																																										
96	GB01-48(2)	calf of 451																																									
97	944																																										
98	GB01-47(20)	calf of 944																																									
99	1011	Wide White Eyes																																									
100	1088																																										

Appendix 2.

Standardized and Total Whale Counts, 1985-2001

	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	24	33	39	49
1987	18	29	33	48	40	60
1988	17	38	29	36	40	53
1989	20	24	20	28	32	41
1990	16	26	24	33	32	49
1991	17	19	33	42	44	53
1992	27	34	38	52	48	65
1993	24	31	24	30	40	50
1994	17	30	29	42	44	60
1995	18	28	26	44	37	57
1996	37	44	43	59	65	77
1997	41	55	33	50	66	82
1998	45	62	28	51	69	92
1999	36	60	40	66	69	104
2000	43	57	26	57	61	87
2001	26	45	57	82	71	97

Appendix 3.

Monthly & Annual Survey Effort, 1985-2001

YEAR	MAY # survey days		JUNE # survey days		JULY # survey days		AUGUST # survey days		SEPTEMBER # survey days		TOTAL # SURVEY DAYS (June 1 - August 31)		TOTAL # SURVEY HOURS (June 1 - August 31)		
	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	257
1996	4	2	11	5	17	10	16	3	3	1	44	18	259	116	375
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