POPULATION CHARACTERISTICS OF HUMPBACK WHALES IN GLACIER BAY AND ADJACENT WATERS: 2000

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ABSTRACT

We photographically identified 87 individual humpback whales (*Megaptera novaeangliae*), including 3 mother/calf pairs, in Glacier Bay and Icy Strait between June 1 and August 31, 2000. Although this count is lower than the record high count of 104 whales in 1999, it is substantially higher than any count made prior to 1997. Twenty-three whales were resident in Glacier Bay and 24 were resident in Icy Strait for more than 20 days. One yearling whale returned to the study area, bringing the 1974-2000 total number of returning offspring to 31. The crude birth rate of the population in 2000 was 3.4% (3 calves / 87 total whales), a figure which is lower than any crude birth rate observed in this population since 1985. Fluctuations in the crude birth rate since 1985 are not correlated with corresponding increases and decreases of the proportion of the population composed of mature females.

INTRODUCTION

This report summarizes the findings of the National Park Service's (NPS) annual humpback whale monitoring program during the summer of 2000, the sixteenth consecutive year of consistent data collection in Glacier Bay National Park and adjacent waters in 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 1981a). Humpback whales are federally listed as an endangered species, so the federal government is mandated to ensure that park management decisions do not have a negative impact.

The annual NPS humpback whale monitoring program began in 1985, to systematically characterize the humpback whale population in Glacier Bay and Icy Strait. The study area spans both Glacier Bay and Icy Strait because whales frequently move between these areas within and between years, effectively making them a single contiguous habitat. 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. Since 1993, biologists have recorded the water depth and temperature in areas used by humpback whales to characterize the abiotic features of their feeding habitat. In addition, we document opportunistic observations of human-whale

interactions including strandings, entanglements in fishing gear and disturbance by vessels and aircraft. Photographic identification data are shared with other researchers studying North Pacific humpback whales through a central data archive at the National Marine Mammal Laboratory in Seattle, Washington. 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 each summer in Glacier Bay.

The whales that frequent Glacier Bay and Icy Strait are part of the southeastern Alaska feeding herd, estimated at 404 whales (95% confidence limits 350 to 458) between 1979 and 1992 (Straley 1994). The number of whales documented in Glacier Bay and Icy Strait from 1985 to 1999 ranged from 41 to 104 (Gabriele, Doherty and Lewis 1999). In 1998, a statistically significant increasing trend in the whale counts in Glacier Bay was documented for the first time since the study began in 1985, although Icy Strait and the combined area had shown an increasing trend since 1996 (Gabriele et al. 1997). Throughout the study, site fidelity to the study area has been high, with the majority of whales (70%) identified in two or more years (Gabriele 1997). 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). Bubblenet, lunge and flick feeding generally occur infrequently compared with subsurface feeding (Jurasz and Jurasz 1979; Wing and Krieger 1983; Krieger and Wing 1984, 1986; Gabriele et al. 1997). This year's monitoring efforts add the sixteenth year of data to an increasingly valuable time series on humpback whale natural history and allow us to examine the trends for residence characteristics and behavior in the study area.

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 2000 are outlined below.

Vessel Surveys: We conducted surveys in Glacier Bay and Icy Strait from May 30 through October 18, 2000. We searched for, observed and photographed humpback whales from a 6-meter Boston Whaler powered with a 60 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.

We surveyed the main body of Glacier Bay (a rectangle defined by 4 corners: Bartlett Cove, Point Carolus, Geikie Inlet and Garforth Island) 3-4 days per week (Fig. 1). 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 (Fig. 1). Several Icy Strait surveys included 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 5 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 1981a; 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. 2). We photographed the ventral surface of the flukes of each whale with 1600 ASA black and white film. In previous

years we shot the film at 1600 ASA, but this year, starting on July 25, (roll # GB00-47) all film was 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.

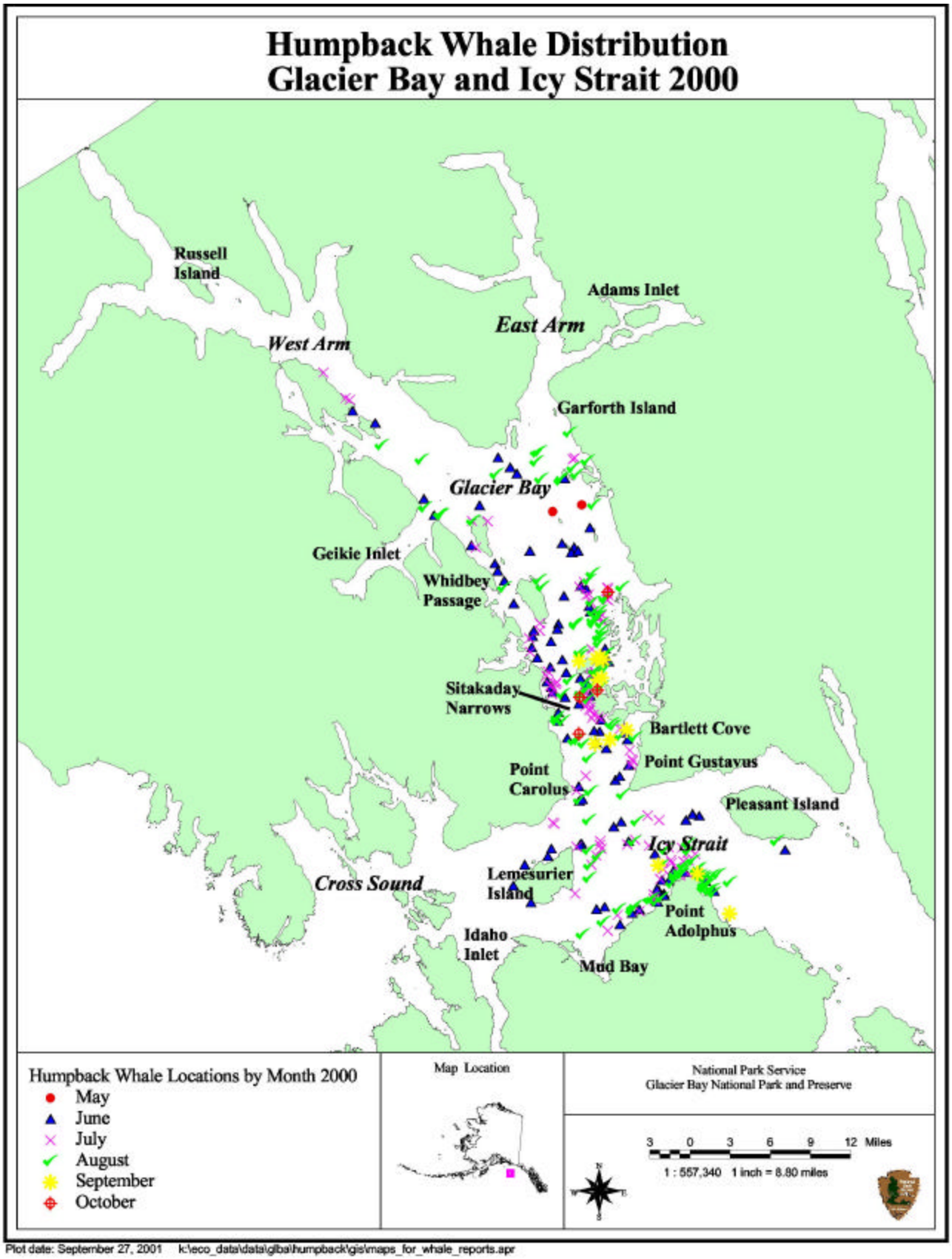

Figure 1. Study area in Glacier Bay and Icy Strait, showing humpback whale distribution in 2000.

We compared fluke photographs to previous NPS photographs and to other available fluke catalogs (Cartwright unpubl. data; Darling 1991; Jurasz and Palmer 1981a; 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 (1981a) by their nicknames (Appendix 1).

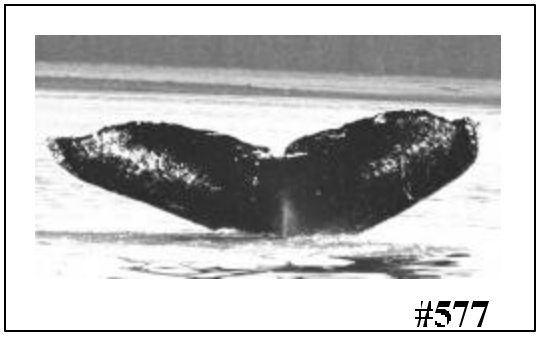

Figure 2. Sample whale fluke identification photograph

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 GB00-9(20). 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 2000. Finally, we printed and catalogued the best 2000 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 1

June to 31 August and for a 'standardized period' (after Perry et al. 1985) from 9 July to 16 August. 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).

Habitat Characteristics: At the start of each pod observation we measured sea surface temperature and water depth with a Raytheon V850 dual-frequency color video echo sounder. We rounded depth measurements to the nearest meter. We described the depth, density and morphology of prey patches appearing on the echo-sounder screen in the presence of whales. We used a standardized chart-speed setting (speed = 9) on the echo sounder to ensure that images observed on different sampling occasions would be comparable. We used standardized gain settings (gain = 75%) for the 50 kHz and 200 kHz transducers on the echo sounder. We recorded the water depth at the top and bottom of prey patches to the nearest meter. We qualitatively described prey patches using the following five categories: '*scattered*'- appeared like falling snow; a '*layer*'- a horizontal linear aggregation; a '*patch*' - a non-discrete, shapeless aggregation; a '*ball*' - a discrete, curvilinear form; and a '*mass*' - completely filled the echo-sounder screen, such that we could not determine the shape of the aggregation. 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 with a dip net.

RESULTS

Vessel Surveys: In Glacier Bay, the total number of survey days (n = 65) and hours (n = 321) during the 1 June – 31 August study period was slightly higher than in 1999, and higher than the 1985-2000 average of 43 survey days and 248 hours (Table 1, 2). In Icy Strait, the total amount of effort was 19 survey days and 84 hours during the June-August study period, somewhat higher than recent years (Table 2). Effort in May was quite low, with only one Glacier Bay survey, but in September we were able to survey both Glacier Bay and Icy Strait at least once. However, data collected outside the main June through August monitoring season are provided for descriptive purposes only and are not included in the analyses in this report.

Table 1. Humpback whale survey days per month in Glacier Bay and Icy Strait, 1985-1999.

	GLACIER BAY						ICY STRAIT					
Year:	**May**	**June**	**July**	**Aug**	**Sept**	***TOTAL June-Aug***	**May**	**June**	**July**	**Aug**	**Sept**	***TOTAL June-Aug***
1985	0	10	11	10	0	*31*	0	7	4	3	1	*14*
1986	0	13	17	6	0	*36*	0	5	3	6	2	*14*
1987	3	12	12	5	1	*29*	2	5	7	7	2	*19*
1988	0	11	12	12	7	*35*	0	5	7	5	3	*17*
1989	3	17	14	16	1	*47*	1	6	6	7	4	*19*
1990	6	16	18	14	0	*48*	4	5	6	8	0	*19*
1991	7	14	17	13	6	*44*	3	7	6	4	3	*17*
1992	3	19	17	12	7	*48*	2	4	5	4	1	*13*
1993	2	10	13	7	1	*30*	1	3	3	5	1	*11*
1994	1	9	10	13	1	*32*	0	5	4	8	1	*17*
1995	3	10	11	10	2	*31*	2	4	4	7	2	*15*
1996	4	11	17	16	3	*44*	2	5	10	3	1	*18*
1997	5	17	21	19	9	*57*	2	4	7	6	4	*17*
1998	10	20	23	12	5	*55*	4	3	6	4	2	*13*
1999	4	16	18	18	5	*52*	1	4	6	3	1	*13*
2000	1	21	21	23	5	*65*	0	8	5	6	1	*19*

Note: This table shows the number of survey days for May through September although our annual whale counts encompass June through August only.

Whale Counts: Eighty-seven individual humpback whales were photographically identified in Glacier Bay and Icy Strait between June 1 and August 31 (Table 3). We identified 57 whales in Icy Strait between June 1 and August 31 and 57 in Glacier Bay during the same time period. These counts are among the highest ever documented in either area. The number of whales documented in Glacier Bay during the standardized period, July 9 to August 16, (n = 43) is slightly lower than in 1997 or 1998 but is greater than the 1985-1999 average of 24 whales. The number of whales documented in Icy Strait during the standardized period (n = 26) is noticeably lower than the 1985-1999 average of 29 whales. The 1999 standardized count for the combined Glacier Bay/Icy Strait area was relatively high (n = 61) compared with the 1985-1999 average of 46 whales.

Table 2. Survey hours in Glacier Bay and Icy Strait, June - August 1985-1999

	GLACIER BAY		ICY STRAIT		
Year	**survey hours**	**survey days**	**survey hours**	**survey days**	***TOTAL hours***
1985	234	31	92	14	326
1986	-	-	-	-	-
1987	-	-	-	-	-
1988	199	35	108	17	307
1989	231	47	123	19	354
1990	215	48	115	19	330
1991	256	44	100	17	356
1992	248	48	71	13	319
1993	192	30	62	11	254
1994	169	32	92	17	261
1995	167	31	90	15	258
1996	259	44	116	18	374
1997	327	57	90	17	417
1998	344	55	64	13	397
1999	318	52	64	13	382
2000	321	65	84	19	405

Note: Hours of effort for 1986 and 1987 are not available.

Seasonal Distribution: We observed whales throughout Glacier Bay and Icy Strait, with the highest numbers concentrating around Beardslee Entrance in Glacier Bay and Point Adolphus in Icy Strait (Fig. 1). From early to mid-June, the highest density of whales in Glacier Bay was near the Marble islands, where up to 10 whales were sighted on one day. These whales ranged widely over the area from Tlingit Point to Flapjack Island. The majority of pods documented in this area consisted of lone whales, but pods of 2-4 whales were sighted regularly. A high number of whales sighted in Whidbey Passage led to the implementation of whale waters vessel restrictions in this area from June 23-30. In this period, we sighted 9-19 whales within the defined boundaries of Whidbey Passage, including a large shoal of 12 whales at the south end of Willoughby Island on June 15.

Table 3. Counts of humpback whales in Glacier Bay and Icy Strait, 1982-2000.

Year	Glacier Bay		Icy Strait		Glacier Bay & Icy Strait	
	Standardized Count	Total Count	Standardized Count	Total Count	Standardized Count	Total 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

Note: Total counts refer to the number of whales (adults and calves) identified during the entire monitoring season (1 June – 31 August). Standardized counts refer to the number of whales sighted between 9 July and 16 August each year. The combined count for Glacier Bay and Icy Strait is typically smaller than the sum of Glacier Bay and Icy Strait counts because some whales are identified in both areas.

Throughout the month of June, between 5 and 13 whales were dispersed widely throughout the lower bay in small pods of 1-2 whales. Judging from the large groups of whales sighted just outside Glacier Bay in June, and the ebb and flow of up to 17 whales in and out of the Lower Bay and Whidbey Passage, many individuals were moving regularly between Glacier Bay and Icy Strait. In June there were at least 10 whales in the Lower Bay at any given time, while Whidbey Passage was heavily but sporadically used. The lower bay whale waters speed restriction was implemented on June 23 and removed on September 20, 2000. In August and September, we identified very high numbers of whales in the lower bay, including 18 whales on August 8, and 16 whales on September 13. Whales were noticeably absent from Bartlett Cove in 2000 with only 8 sightings occurring there in 2000, in sharp contrast with much higher numbers in some previous years (Fig. 3). Underwater acoustic monitoring with an anchored hydrophone in outer Bartlett Cove documented vocalizing whales in the lower bay until November 16.

Whales maintained a presence in the Gustavus Flats area of Icy Strait beginning in mid-May. By mid-June, some whales returned to their habitual feeding areas near Point Adolphus, but many others remained quite widely dispersed from the mouth of Idaho Inlet to the eastern end of Pleasant Island. Similarly, in July and August, many whales used the Point Adolphus area, but others, including groups of 3-4 whales, remained offshore in the middle of Icy Strait, east of Lemesurier Island. Icy Strait whales remained quite widely dispersed throughout the summer, although they sporadically congregated at Point Adolphus.

Local Movement and Residency: Twenty-nine of 87 total whales, including one mother/calf pair, were sighted in both Glacier Bay and Icy Strait between June 1 and August 31. Eighteen whales were sighted exclusively in Glacier Bay and 22, including 2 mother/calf pairs, were sighted exclusively in Icy Strait. Twenty-one individuals (24%) made one or more round trips between Glacier Bay and Icy Strait (Appendix 1). Twenty-three (40 %) of the 57 whales that entered Glacier Bay between June 1 and August 31 remained 20 or more days, long enough to be considered resident (after Baker et al. 1983). Twenty-four (42 %) of the 57 whales in Icy Strait were considered resident in that area during the study. An additional 10 (12%), including one mother/calf pair, of the 87 whales sighted in Glacier Bay/Icy Strait were resident in the combined Glacier Bay/Icy Strait area but not in either specific sub-region. One whale, #118, was resident in both Glacier Bay and Icy Strait, apparently staying more than 20 consecutive days within each area, concentrating in Glacier Bay in late June through late July, and Icy Strait from late July through the end of August (Appendix 1).

Twenty-three (26%) of the whales that entered the study area between June 1 and August 31 were identified on just one day: 10 in Glacier Bay and 13 in Icy Strait. These individuals were sighted throughout Glacier Bay and Icy Strait, in areas that are historically part of our regular survey areas. Sixteen of the sightings of whales that were seen on just one day occurred in June, although their temporal distribution suggests that they do not represent a pulse of whales arriving together in the study area (Appendix 1).

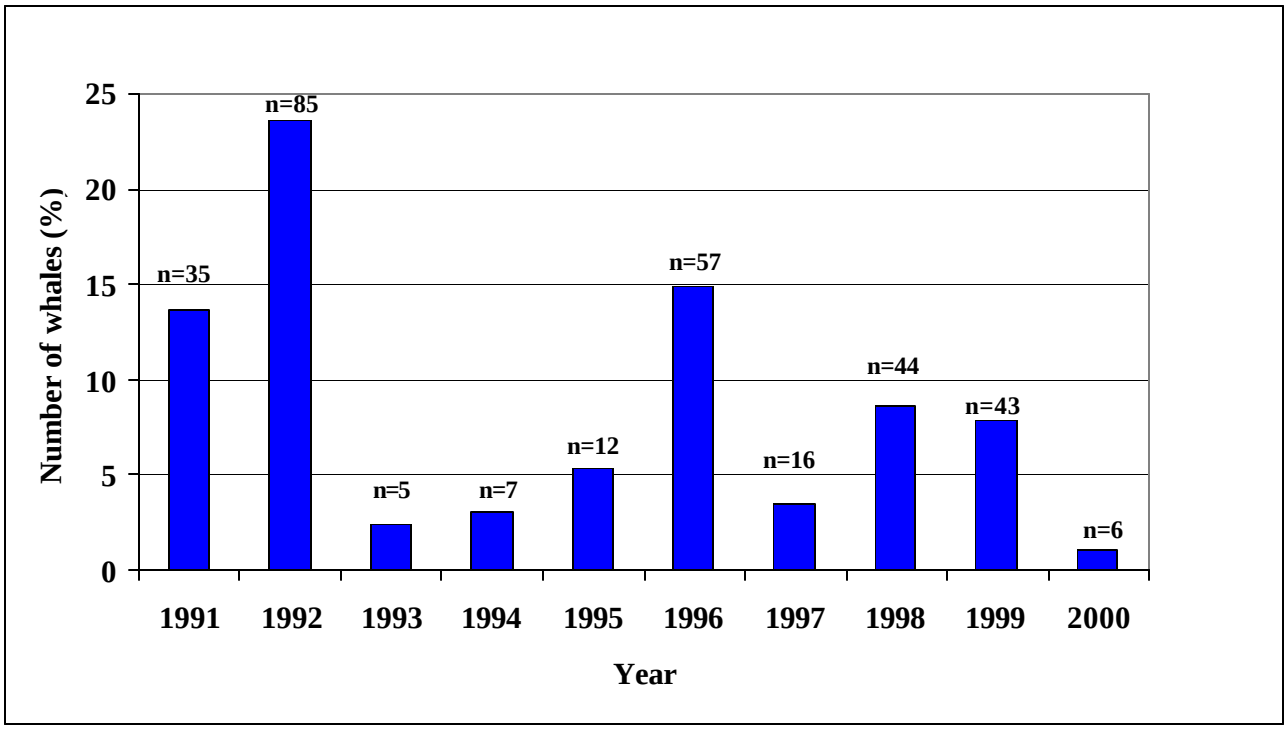

Figure 3. Proportion of Glacier Bay Whale Sightings Occurring in Bartlett Cove 1991-2000. The number of Bartlett Cove sightings is found above each bar in the graph.

Reproduction and Juvenile Survival: We documented 3 mother/calf pairs in the study area in 2000. All of the mother/calf pairs were sighted in either Glacier Bay or Icy Strait; none of the pairs was sighted in both areas (Table 5). The sex of whale #1042 was not previously known before these sightings of her this year with a calf in Mud Bay. This mother/calf pair was sighted a total of 4 times in June between Point Adolphus and Mud Bay and was not sighted at all in July or August. On June 12, #1042 and her calf were sighted just offshore of #1042's mother (#581) with her own new calf at Point Adolphus. Mother #581 and her calf were not sighted at any other time during the season. The third mother/calf pair was sighted 4 times in Glacier Bay at Drake Island, Strawberry Island and Point Carolus, spanning a period between June 30 and July 27, 2000. All of our sightings of this mother (#250) and calf occurred within Glacier Bay, although the sighting of them near Point Carolus suggests that this pair may have traveled into Icy Strait for a short period. On July 27, the calf of #250 was sighted feeding without its mother at Strawberry Island, rejoining its mother 70 minutes after the calf was first encountered.

We obtained fluke identification photographs of all 3 of the mothers but only 2 of the calves. We obtained a poor quality fluke photograph and a high quality dorsal fin photographs of the remaining calf. We identified one whale that had not been sighted in the study area since it was a calf: yearling whale #1485, offspring of female #219. The crude birth rate of the study population for 2000 was 3.4 %, the lowest that we have observed in this study (Table 6). The number of mature females in the population is the most obvious factor that might account for fluctuations in the crude birth rate. The number of females older than 5 years of age ranged from 15 - 35 females (Table 6) who comprised 28.3 – 41.5 % of the annual population count. Fluctuations in the crude birth rate do not show any correlation with percentage of the population composed of mature females (Fig. 4).

Table 5. Females Identified with a Calf in Glacier Bay and Icy Strait 2000.

Mother ID#	**Calf ID#**	**# of days sighted in Glacier Bay**	**# of days sighted in Icy Strait**
1. 1042	1480	0	4
2. 581	-	0	1
3. 250	1490	4	0

Note: Only calves sighted on more than one day, and whose flukes were photographed adequately for re-identification, received an identification number.

Habitat Characteristics: We measured sea surface temperature during 346 whale observation sessions in June, July and August 2000. The average sea surface temperature was 8.8 ^{o}C (s.d. = 1.2, range = 7-12.5, Fig. 2). Note that these data are suitable for examining sea temperatures near whales, but may not reflect year to year differences in the study area's sea surface temperatures because our observations are cofounded by the geography of whale distribution. For example, if whales aggregated further up bay (where sea surface temperatures would be expected to be lower due to their proximity to tidewater glaciers) in a particular our average sea surface temperature would be correspondingly lower. Our observations would reflect a lower sea surface temperature overall, regardless of whether Glacier Bay's average sea temperatures in the area where the whales aggregated was comparatively low or high for that year. We measured water depth during 346 whale observations in June, July and August 2000. The majority of whales (56 %) were in water 65 m or less in depth. However, whales were found in a wide range of water depths ranging from 5 to 245 m.

Table 6. Crude birth rate of humpback whales in Glacier Bay and Icy Strait, June – August 1985-2000.

Year	#Whales	#Calves	Crude Birth Rate (%)	#Females Older Than 5 Years	#Calves Photographically Identified
1985	41	2	4.9	17	1
1986	49	8	16.3	18	5
1987	60	4	6.7	21	3
1988	53	8	15.1	15	5
1989	41	5	12.2	16	3
1990	49	6	12.2	19	6
1991	53	4	7.5	16	4
1992	65	12	18.5	27	11
1993	50	3	6.0	17	3
1994	60	9	15.0	21	5
1995	57	3	5.3	21	3
1996	77	7	9.1	27	2
1997	82	9	11.0	30	7
1998	92	8	8.7	30	7
1999	104	9	8.7	35	4
2000	87	3	3.4	28	2

Note: #Whales = total number of Glacier Bay and Icy Strait whales (including adults and calves), #Calves = number of calves, CBR % = crude birth rate, a percentage computed by #Calves / #Whales.

Feeding Behavior: We documented the feeding behavior of 284 different groups of whales. We categorized most of the feeding behavior we observed as subsurface feeding (n = 204), although in 46 of these cases, the whale(s) employed other methods as well. We observed vertical or lateral lunge-feeding on 41 occasions, usually in combination with subsurface feeding. We observed 3 instances of single whales bubblenet feeding: once each at Geikie Rocks, Gilbert Peninsula and Flapjack Island. In addition to the 217 encounters in which we thought the whales were feeding, there were 67 other cases in which we suspected that the whale was travelling or resting and not feeding, and 11 observations we could not determine whether or not the whale was feeding. Except when whales were feeding at the surface, it was impossible to verify our assumptions of whether or not the whales were feeding.

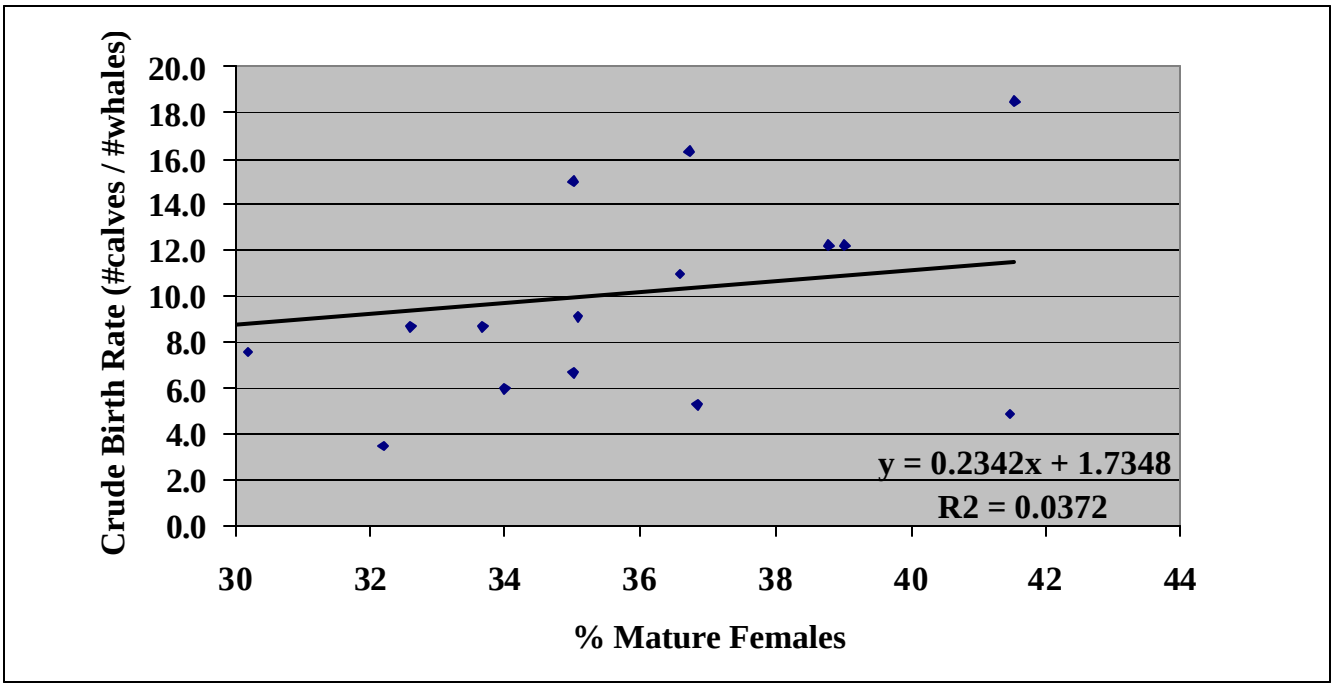

Figure 4. Crude Birth Rate versus Proportion of Mature Females Occurring in Glacier Bay and Icy Strait 1985-2000. Crude birth rate is a percentage computed by #calves / #whales. Mature females were defined as those older than 5 years of age. Proportion of females was computed by dividing the number of females by the total whale count for each year.

On 3 occasions near Point Adolphus, we saw dozens of small schools (1-3 ft diameter) of forage fish intermittently boiling at the surface. Several individual whales swam rapidly between schools and occasionally lunged through a school. We could see that each school was composed of 2 species of smaller fish near the surface, with the much larger Pacific herring visible below. We captured a few of the smaller fish, which were later identified as juvenile pollock and juvenile pink salmon (*Oncorhynchus gorbuscha*) (M. Robards and C. Soiseth, pers. comm.).

We observed the 'core group' (after Perry et al. 1985; Gabriele 1997) in the vicinity of Point Adolphus on 6 occasions between July 7 and August 23. The size of the core group ranged from 5- 8 whales, with 13 different individuals participating in total. Male #577 was in the group on 3 occasions. Males #186 and #166 who typically frequent the group, participated on only one occasion, although each was sighted in the study area numerous times in

2000. Female #236, another typical core group member, was absent from the group for the fourth consecutive year, although she was not identified in the study area at all in 2000. The predominance of in-air vocalizations, first noticed in 1999, continued in 2000. During all of our observations, one or more whales frequently produced a "trumpet blow" several times during the surfacing(s) of the group. Shore-based observers conducting a whale-vessel interaction study at Point Adolphus also noted that whales in the group vocalized almost continuously (J. Womble, pers. comm.).

Whale/Human Interactions: In June-August 2000, the NPS sponsored a shore-based whale/vessel interaction study at Point Adolphus, conducted by University of Alaska Fairbanks graduate student Jamie Womble and coordinated by the local non-profit group Southeast Alaska Wilderness Exploration, Analysis and Discovery (SEAWEAD). The preliminary results of the study have been reported (Womble and Kelly 2001), and the study will be continued in 2001. The National Marine Fisheries Service (NMFS) is in the process of implementing regulations specifying a 100-yard minimum approach distance to humpback whales in Alaska waters. There were no recorded whale/vessel collisions in the study area to the best of our knowledge.

We documented that male #441 had a large swelling or lump on his left flank that had not been noted in past years. Whale #1304 was noted to have a large, watermelon-sized swelling on her peduncle about 1 ft anterior to the base of her flukes. We can not ascertain the cause of either of these injuries, and are not certain whether they indicate entanglement in fishing gear or vessel collision or other causes. There were no whale strandings, entanglements in fishing gear, or disturbances by aircraft reported in the Glacier Bay/Icy Strait area.

However, Park whale biologist C. Gabriele assisted with a humpback whale disentanglement in Taiya Inlet, near Skagway in December 2000 (Gabriele and Straley 2000). The whale was badly entangled in shrimp pot long line gear such that it was anchored at the site. Rescue efforts resulted in removal of all of the line except a short piece of line with a red buoy attached at the right pectoral fin. The whale was sighted a few days later by a charter vessel captain near Barlow Cove, at the southern end of Lynn Canal, approximately 76 miles from the disentanglement site.

DISCUSSION

Whale Counts: The 2000 total count of 87 whales is among the 3 highest counts of identified whales in the study area since the start of the study in 1985 (Table 3). Notably, all 3 of the highest Glacier Bay and total counts occurred since 1998. Glacier Bay and Icy Strait appeared to contribute equally to the high whale count, with 30 whales sighted only in Glacier Bay, 30 whales sighted only in Icy Strait and 27 whales sighted in both areas. Overall, the 2000 data add to continued increasing trend in Glacier Bay, Icy Strait and in the combined Glacier Bay/Icy Strait area.

Female #236, a whale that is typically sighted repeatedly in the study area, was conspicuously absent in 2000. Prior to 2000, female #236 had been sighted annually in the study area since 1983. In recent years she has been a consistent inhabitant of the lower bay, and has a history of participation with the Point Adolphus core group. Four of her 6 known-aged offspring were in the study area this year, demonstrating her prolific contributions to the local whale population. Female #236's absence from Glacier Bay is notable, but it does not necessarily indicate mortality, since individual whales are known to range throughout southeastern Alaska. Moreover, some whales that habitually used the Glacier Bay area in the late 1970's and early 1980's have returned to the area after absences of several years. For example, whale #232 was sighted here in 2000 after an 11 year absence. This whale was first identified here in 1975 and used the area consistently until 1988. Several factors could also cause us to miss identifying an individual in the study area, including changes in home range use or a decrease in the duration of their stay. For example, male #237, who has been sighted in the study area annually since 1982, with the exception of 1986, was sighted just once in Glacier Bay in early June (Appendix 1) and in 1999, he was sighted only twice. We surmise that his use of the area has changed, thus we are at higher risk of not photographing him in the short periods he now uses the study area. Sightings of individuals in places outside the study area help us distinguish mortality from changes in habitat use, highlighting the value of regional collaborations (e.g. Straley and Gabriele 1997).

Seasonal Distribution: Overall, whale distribution in Glacier Bay was similar to previous summers in that whale activity concentrated in the lower bay after mid-June. However, Bartlett Cove and Sitakaday Narrows were not as heavily used in 2000 as they have been in most of the past several years. In 2000, a lower percentage of whale sightings were made in Bartlett Cove (1.1%) than any previous year in the study (Fig. 3). The number of whales using Bartlett Cove each year is quite variable, probably relating to the relative abundance of whale prey there compared

with other areas. The June sightings of up to 10 whales near the Marble islands were consistent with observations in 1999, which documented an unusually high number of whales frequenting the Marble islands between late June and early July. These whales appeared to spread out over a large area, similar to 1998 when we observed a high concentration of whales in late May and early June 1998 between Adams Inlet and Sandy Cove (Gabriele and Doherty 1998). Whale numbers in Whidbey Passage were higher than 1998 and 1999 but quite sporadic. Continued monitoring and analysis of whale distribution will allow us to distinguish short-term changes from long-term trends, especially as they relate to the Park's vessel management policies pertaining to whale waters.

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 occurrence of a prolonged early- season concentration of whales in the Gustavus Flats area, and the fact that whales remained widely dispersed in Icy Strait throughout the summer. Although we saw one large group West of Lemesurier Island in mid-June, we did not see a shift of large numbers of whales from Point Adolphus to the mouth of Idaho Inlet comparable to what we observed in 1999 (Gabriele *et al*. 1999).

Local Movement and Residency: Glacier Bay proper 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. Overall patterns of whale movement and occupation in 2000 were similar to previous years. However, the percentage of whales documented making round trips between Glacier Bay and Icy Strait was (24%), considerably higher than the typical (10-14%) documented between 1994 and 1999. Similarly, a number of whales (11%) that met the residency criteria of remaining 20 or more days (after Baker et al. 1983) were resident in the combined Glacier Bay/Icy Strait area but not in either specific sub-region. Both of these factors suggest that whales made frequent trips in and out of Glacier Bay. The proportion of whales sighted on just one day during the study period in 2000 (26%) was similar to the proportion in 1998 and 1999 (23-24%), but low compared with the proportions documented between 1994 and 1997 (30-43%).

Reproduction and Juvenile Survival: The comparatively low number of calves observed in 2000 was reflected in the lowest crude birth rate (3.4%) observed in this study since it began in 1985. The average crude birth rate of the study population was 10.5 % (s.d. = 4.3 %) between 1985 and 1999. The crude birth rate does not appear to be

related to the number of mature females or the proportion of the population composed of mature females (Table 6, Fig 4). The factors which influence the rates and timing of conceptions are unknown, as are the sources of calf mortality which could contribute to annual variability in the crude birth rate.

The discovery that #1042 is a female contributes much to our 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 13. Although we have sighted this whale almost every year since she was born in 1987, she was not sighted in 1993 and 1995 (at age 6 and 8, respectively). Given her sighting history, we surmise that #1042 has probably given birth in previous years. However, the early indications are that females are older than age 5-7 when they are first sighted with calves in Glacier Bay and Icy Strait. We plan to collaborate with other researchers in the North Pacific to investigate the average age at first female reproduction.

Feeding Behavior: The widespread and repeated occurrences of small multi-species schools of fish 'boiling' at the water's surface we saw in summer 2000 were noteworthy. We believe that the 'boiling' behavior indicated a predator (juvenile pink salmon) and prey (juvenile walleye pollock) interaction, because we observed the larger fish (both herring and juvenile pink salmon) eating the smaller ones. It appeared that the whales were exploiting all 3 species' predatory interactions by swiftly moving between schools and gulping up the whole mixture. Although we have occasionally seen 'boiling' schools of herring or capelin (presumably feeding on zooplankton), we had not previously observed whales preying upon them. Herring and juvenile walleye pollock have previously been documented as humpback whale prey in the study area. Juvenile pink salmon have been previously identified as humpback whale prey in other areas of the North Pacific (Tomilin 1957) but this is the first record in the study area.

The predominance of subsurface feeding behavior in 2000 was typical of previous years. The 41 documented occurrences of lunge feeding appeared comparable to previous years (Gabriele et al. 1999, Gabriele and Doherty 1998). The 3 occurrences of bubblenet feeding also seems typical of observations in recent years.
The behavior and composition of the core group resumed its previous dynamics after the remarkably large group observed in 1999. The predominance of airborne vocalizations, however, continued in 2000, for unknown reasons. The similarity of what we termed "trumpet blows" observed near Point Adolphus to the "shrill whistles (similar to those

of a locomotive engine), which could be distinctly heard over a distance of one kilometer" made by a harpooned female humpback observed by Tomilin (1957, p. 280) indicate that stress can be associated with such vocalizations. It will be interesting to see if airborne vocalization becomes a long-term trend, and to determine which individuals produce the noise.

Whale/Human Interactions: The peduncle deformation we observed on whale #441 this year and the five peduncle deformations noted last year (Gabriele et al. 1999) suggest that although we rarely observe entanglements or whale-vessel collisions, the whales in the study population encounter these risks either in our area or elsewhere. A systematic study of entanglement scars and other injuries, similar to the work done by Mattila and Robbins (1998) would greatly advance our knowledge of entanglement and provide an essential basis of comparison to other areas.

Data from the 2000 (Womble and Kelly 2001) and 2001 Point Adolphus study, as well as a pilot study of whale and vessel distribution conducted by SEAWEAD in 1999 (Koehler 2001) represent the first systematic attempts to document the increasing vessel traffic in the area. Prior to those efforts, descriptions of increasing vessel traffic at Point Adolphus have relied upon anecdotal observations made during the NPS whale monitoring program. For example, on the morning of July 19, 2000, we observed some of the highest vessel traffic observed in the area since 1991 (C. Gabriele, pers. observation), when 7 whale watching boats and 6 kayaks that had been launched off a local charter boat surrounded the 5 whales in the "core group". As we noted in last year's report (Gabriele et al. 1999), we had not previously observed a vessel dropping off kayakers near a pod of whales. Data on recreational use will help to quantify the increasing use of the area and determine its effect on the whales who depend on the Point Adolphus area.

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Appendix 1. Sighting Histories of Individually Identified Whales - 2000

#	Whale ID	Nickname	5/30/2000	6/1/2000	6/5/2000	6/6/2000	6/7/2000	6/8/2000	6/9/2000	6/12/2000	6/13/2000	6/14/2000	6/15/2000	6/17/2000	6/20/2000	6/22/2000	6/23/2000	6/24/2000	6/26/2000	6/27/2000	6/29/2000	6/30/2000	7/3/2000	7/5/2000	7/6/2000	7/7/2000	7/10/2000	7/11/2000	7/12/2000	7/13/2000	7/14/2000	7/17/2000	7/18/2000	7/19/2000
1	1014		G			I				G	G			G	G		I			I													G	G	
2	937		G			I		G		I			G				I																G	G	
3	564	Roundup Taylor	G						G		G		G	G	G												G					G		
4	1485	calf of 219	G																															
5	159			G				G	G			G	G		G								G				G							
6	1244			G							G			G											I						G			
7	535	Quits		G									G				I			G													G	
8	GB00-3(2)			G																														
9	GB00-3(7)			G																														
10	1079			G																													G	
11	117	White Eyes			G			G					G											G			G							
12	351				G			G	G		G		G			G											G	G						
13	196				G								G																					
14	237	Dike			G																													
15	577	Scoper				I				I							I		I												I			
16	161	BWM				I				I							I		I												I			
17	1019					I	I										I																	
18	1461						I			G				G	G																			
19	587	Gertrude					I			I							I		I							I					I			I
20	186						I			I															I	I								I
21	1480	calf of 1042					I			I							I		I															
22	1042						I			I							I		I															
23	166	Frenchie					I				G			G									G								I			
24	539	Max					I				G			G																				
25	1031						I															I									I			
26	1431						I																											
27	157	M.D.					I																		I						I			I
28	1593						I																											
29	352						I																		I	I					I			I
30	221							G							G					G											I			
31	1302								G				G											G				G				G		
32	1065								G						G																			
33	225	Vagn							G																									
34	465								G																									
35	1295									G					G		I					I											G	G
36	353									I								I								I					I			I
37	1306									I								I							I	I								
38	1474									I																								
39	581									I																								
40	none	581_calf_2000								I																								
41	1304											G								I														
42	1233											G																						
43	1292											G																						
44	235	Spot										G	G				I			G													G	
45	933												G				I	I																
46	1012														G					G													G	
47	397																I		I												I			I
48	1298																I		I			I												
49	118	Chop Suey															I			G											G	G		G
50	616																I					I									I			
51	219																I									I					I			
52	584																I																	
53	541																I																	
54	516	Garfunkle															I											G						I
55	441																	G	I															
56	1313																	G		G														
57	1299																	G															G	
58	1473																	G																
59	155	Freckle Fluke																I							I	I					I			I
60	513																	I																
61	572																	I																
62	875																		I						I						I		G	
63	817																		I															
64	1345																		I															
65	187																		I															
66	1235																			G														
67	1082																				G								G	G				
68	350	Lace																			G													
69	1490	calf of 250																				I					G			G				
70	250																					I					G			G				
71	1046																					I												
72	1049																						G			I								
73	283																								I									
74	1061																									I								
75	1083																											G						
76	1479																											G						
77	1018																													G				
78	573																														I			I
79	1472																																	I
80	387																																	
81	1246																																	
82	1063																																	

#	Whale ID	7/21/2000	7/25/2000	7/26/2000	7/27/2000	7/31/2000	8/1/2000	8/2/2000	8/3/2000	8/7/2000	8/8/2000	8/9/2000	8/10/2000	8/11/2000	8/14/2000	8/15/2000	8/16/2000	8/17/2000	8/18/2000	8/21/2000	8/23/2000	8/24/2000	8/25/2000	8/28/2000	8/29/2000	8/30/2000	9/5/2000	9/13/2000	9/19/2000	9/26/2000	10/3/2000	10/18/2000	10/25/2000
1	1014			G		G		G		G										G								G					
2	937	G		G		G				G					G					G													
3	564	G		G		G		G		G										G				G									
4	1485											G										G											
5	159							G		G				G		G	G																
6	1244		G	G				I																					I				G
7	535	G				G		G		G					G				G	G													
8	GB00-3(2)																																
9	GB00-3(7)																																
10	1079				G					G	G											G									G		
11	117							G		G														G				G	I				
12	351															G							G	G									
13	196																																
14	237																																
15	577								I				I						G		I				I								
16	161					G			I																								
17	1019																				I												
18	1461					G				G										G													
19	587							G	I				I						G		I				I				I				
20	186												I					I			I												
21	1480																																
22	1042																																
23	166															G					I				I								
24	539								I				I																				
25	1031		I										I																				
26	1431																				I												
27	157												I					I			I				I			G					
28	1593																																
29	352								I											G	I												
30	221	G		G									I																				
31	1302						G			G						G												G					
32	1065									G					G			I	G	G								G					
33	225																																
34	465																																
35	1295			G														I			I												
36	353												I								I				I								
37	1306																																
38	1474																																
39	581																																
40	none																																
41	1304								I									I		G													
42	1233															G			G								G						
43	1292																																
44	235	G								G					G				G	G													
45	933																																
46	1012				G																							G		G			
47	397												I												I								
48	1298							G		G					G			I	G	G													
49	118												I					I			I				I								
50	616												I																				
51	219												I					I			I				I								
52	584		I															I															
53	541																																
54	516																	I			I				I			G					
55	441					G												I															
56	1313				G					G									G							G		G					G
57	1299				G																	G											
58	1473						G																										
59	155												I					I			I				I								
60	513																																
61	572																																
62	875								I																								
63	817																																
64	1345																																
65	187																																
66	1235																																
67	1082	G																															
68	350	G		G						G																							
69	1490				G																												
70	250				G																												
71	1046						G																										
72	1049											G																					
73	283												I																				
74	1061																																
75	1083	G		G												G				G		G						G					
76	1479																																
77	1018																																
78	573								I				I					I			I				I								
79	1472								I				I						G														
80	387		I						I																								
81	1246		I																														
82	1063							G								G			G			G	G	G									

Appendix 1. Sighting Histories of Individually Identified Whales - 2000

	Whale ID	Nickname	5/30/2000	6/1/2000	6/5/2000	6/6/2000	6/7/2000	6/8/2000	6/9/2000	6/12/2000	6/13/2000	6/14/2000	6/15/2000	6/17/2000	6/20/2000	6/22/2000	6/23/2000	6/24/2000	6/26/2000	6/27/2000	6/29/2000	6/30/2000	7/3/2000	7/5/2000	7/6/2000	7/7/2000	7/10/2000	7/11/2000	7/12/2000	7/13/2000	7/14/2000	7/17/2000	7/18/2000	7/19/2000	7/21/2000	7/25/2000	7/26/2000	7/27/2000	7/31/2000	8/1/2000	8/2/2000	8/3/2000	8/7/2000	8/8/2000	8/9/2000	8/10/2000	8/11/2000	8/14/2000	8/15/2000	8/16/2000	8/17/2000	8/18/2000	8/21/2000	8/23/2000	8/24/2000	8/25/2000	8/28/2000	8/29/2000	8/30/2000	9/5/2000	9/13/2000	9/19/2000	9/26/2000	10/3/2000	10/18/2000	10/25/2000
83	232																																							G				G						G							G						
84	1293																																								G					G																	G		
85	1432																																								G																							G		
86	1273																																																G	G																					
87	GB00-78(10)																																																																					
88	1531																																																																										