POPULATION CHARACTERISTICS OF HUMPBACK WHALES IN GLACIER BAY AND ADJACENT WATERS: 1993

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ABSTRACT

Fifty-four different humpback whales (*Megaptera novaeangliae*), including 3 calves (5.6%) were identified in Glacier Bay and Icy Strait between May 26 and September 14, 1993. Of these whales, 21 (39%) were seen solely in Glacier Bay, while 23 (43%) were seen only in Icy Strait. Ten whales (19%) were common to both areas. Seventeen (55%) of the Glacier Bay whales and 16 (48%) of Icy Strait whales were resident for more than 20 days. Peak whale use of Glacier Bay occurred in July and August, with the most activity concentrated in Whidbey Passage and the east side of Glacier Bay. Most Glacier Bay and Icy Strait whales practiced solitary, sub-surface feeding. The usual Icy Strait 'core group' was much less stable and persistent than it has been in previous years. Two whales first seen as calves (#1067 and #1049) were new returnees to the study area.

INTRODUCTION

This report summarizes humpback whale population monitoring in Glacier Bay and and Icy Strait during the late spring and summer of 1993. Humpback whale population monitoring, initiated in 1985 by the National Park Service (NPS), is intended to provide the NPS and the National Marine Fisheries Service (NMFS) with the necessary information to manage humpback whale populations in Glacier Bay and southeastern Alaska. Under this monitoring program, data have been collected in a systematic fashion with similar amounts of effort each year, to ensure comparability between years. These studies have revealed considerable variability in the number of whales using Glacier Bay (summarized in Gabriele 1992) and demonstrate a great deal of interchange between Glacier Bay and Icy Strait within and between years (Baker 1985, 1986, 1987; Perry et al. 1985; Baker and Straley 1988; Straley 1989, 1990; Gabriele 1991). Studies have also shown exchange between Glacier Bay/Icy Strait and other areas in southeastern Alaska, (Baker et al. 1986; Baker et al. 1990; Straley and Gabriele 1993 , suggesting that the number of whales in all of these areas is interdependent. The availability of whale prey in and around Glacier Bay is thought to be critical to an understanding of whale movement in southeastern Alaska. The systematic studies of individually-identified humpback whales in Glacier Bay constitute one of the longest and most complete time-series of data on a living baleen whale population (Jurasz and Palmer 1981; Perry et al. 1990).

Humpback whales migrate each year between summer coastal feeding grounds in high latitudes and winter breeding and calving grounds near islands or shallow banks in low-latitude waters (Baker et al. 1986). Known feeding areas in the eastern North Pacific occur along the rim of the Pacific basin from central California to the Aleutian Islands. Northern hemisphere humpbacks appear to form several geographically-isolated summer 'feeding herds' that congregate in low-latitude waters in winter (Baker et al. 1986; 1990a; 1990b; Katona and Beard 1990). Mark-recapture methods estimate that 547 humpback whales (95% confidence limits 504 to 590) visited southeastern Alaska between 1979 and 1986 (Baker et al. 1990a). The whales that use Glacier Bay and Icy Strait are considered to be part of the southeastern Alaska feeding herd.

Humpback whales have been known to inhabit Glacier Bay since at least the 1930's (Vequist and Baker 1987). The amount of vessel traffic in the bay has consistently increased throughout the twentieth century, undergoing a dramatic increase in the 1970's. Humpback whale studies began in Glacier Bay in the early 1970s, when Jurasz and his associates began identifying individual whales by their natural markings (Jurasz and Palmer 1981). In 1978, 17 of the 20 whales that Jurasz observed in Glacier Bay departed abruptly (Jurasz and Palmer 1981). Some investigators inferred that the whales had

because the level of vessel traffic had become intolerable, while others hypothesized that the whales' departure was best explained by a natural decline in the availability of their prey. Insufficient evidence with which to evaluate these hypotheses existed at that time. In 1979, the NPS requested consultation with the NMFS under section VII of the Endangered Species Act, to address these concerns.

The consultation with the NMFS resulted in a Biological Opinion 1979, which recommended that the NPS take the following actions: 1) regulate the number of vessel entries into Glacier Bay; 2) restrict vessels from approaching and pursuing whales in Glacier Bay; and 3) conduct studies in Glacier Bay and southeastern Alaska to characterize whale food and feeding behavior, the effects of vessels on whale behavior, and the underwater acoustic environment. The NPS took the recommended actions by enacting regulations to prohibit whale approach, regulate vessel numbers and operations in Glacier Bay (Federal Register 45 32228, May 15, 1980), and by initiating the recommended studies.

The acoustic and behavioral studies demonstrated the influence of vessel presence on underwater noise and the movement and respiration of whales (Baker et al. 1982; Baker et al. 1983; Baker and Herman 1989; Malme, Miles and McElroy 1982; Miles and Malme 1983). The whale-prey studies demonstrated seasonal and annual variation in whale prey type and abundance in Glacier Bay and other parts of southeastern Alaska (Wing and Krieger 1983; Krieger and Wing 1984; Krieger and Wing 1986). In summary, the studies corroborated some aspects of each hypothesis for the whales' 1978 departure, and neither hypothesis was rejected. Integrating historical whale counts and the early results of the scientific studies, a second Biological Opinion was issued by the NMFS in 1983 (Federal Register 49 15482, April 18, 1984). The 83 Biological Opinion reccomends that the NPS continue to monitor whale numbers in Glacier Bay from June 1 to August 31 each year, and recommends a rationale for regulating vessel numbers in the bay. Vessel regulations were enacted in the summer of 1985 (CFR 36 13.65), and are subject to annual review and modification at the discretion of the Park Superintendent.

The NPS will soon release a Vessel Management Plan which could substantially change the number of vessels that enter Glacier Bay each summer. NPS initiated consultation with the NMFS in August 1992; NMFS issued a third Biological Opinion in February 1993. In the 1993 Biological Opinion, NMFS found that the NPS's proposed vessel traffic increase in Glacier Bay was not likely to jeopardize the continued existence of the North Pacific humpback whale population. The NMFS also recommended that the NPS implement a humpback whale feeding ecology research program to correlate whale movement within southeastern Alaska with temporal and spatial distribution of whale prey, and studies of the relationship between whale distribution, behavior and vessel presence. It also recommended that the NPS continue monitoring whale presence and individuals' length of stay in Park waters.

METHODS

Vessel Surveys:

The 1993 humpback whale monitoring program concentrated in Glacier Bay and Icy Strait from late May to late August. Humpback whales were observed and photographed from a 17' Boston Whaler powered with a 60 hp outboard engine. The main body of Glacier Bay (a rectangle defined by four corners: Bartlett Cove, Point Carrolus, Geikie Inlet and

North Island was usually surveyed three days per week. Surveys of the upper bay were conducted approximately bi-weekly or when whale sightings were reported by tour vessels. Upper bay surveys extended as far north as Russell Island in the West Arm and Goose Cove in the East Arm. Icy Strait surveys were performed approximately once per week, with the greatest survey effort along the shoreline of Chichagof Island, from Mud Bay to Burger Point. Surveys of the north and west shorelines of Pleasant Island were intermittently conducted as time and weather permitted. Icy Strait surveys also resulted in a survey of the mouth of Glacier Bay, because that area is crossed in transit from Bartlett Cove to Icy Strait.

Surveys were not conducted in the same area on consecutive days to minimize the potential impact that monitoring efforts might have on the whales. On occasions when circumstances such as time, weather, or the presence of other vessels prevented whale identification photographs from being taken, consecutive surveys of the same area were made. Positions of nearly all whales were determined using a Magellan NAV1000 Global Positioning System (GPS). Table 1 shows the number of surveys per month in Glacier Bay and Icy Strait in from 1985-1993. Table 2 shows 1985-1993 hours of search and observation time.

Individual identification:

Whale fluke photographs were taken with a Nikon 8008 camera equipped with a motordrive, databack, and 300 mm lens. High speed (400 ASA pushed to 1600) black and white film was used to obtain clear photographs of the ventral fluke surface of each whale. Each whale fluke has a distinct black and white pigment pattern that allows individual identification (Jurasz and Palmer 1981; Katona et al. 1979). Photographs of the dorsal fin supplemented the identification of individuals. The film was processed and printed by Panda Lab in Seattle, Washington. Contact sheets were used for preliminary data analysis. The season's best photograph of each individual was printed and catalogued. A copy of each print was submitted to the North Pacific humpback whale photographic archive at the National Marine Mammal Laboratory (Mizroch, Beard and Lynde 1990). Sighting data including whale identity, pod size, and location are added to a Foxpro database recently developed by NPS staff.

Photographs of individuals were compared to previous Glacier Bay photographs and to available catalogs (Jurasz and Palmer 1981; Perry et al. 1985; Perry et al. 1988; von Zeigesar 1992) to determine the identity and past sighting history of each whale. Many whales are referred to by an identification number issued by the Kewalo Basin Marine Mammal Laboratory (KBMML) catalog of North Pacific humpback whales (Perry et al. 1988). Whales first photoidentified by Jurasz and Palmer (1981) are also listed by their nicknames. Identification numbers smaller than ID# 950 coincide with those in the KBMML catalog, but those ID#s greater than 950 are unique to the Glacier Bay catalog. Whales that were previously unidentified in Glacier Bay and Icy Strait were assigned a temporary identification code, for example GB 93-01, indicating the year and location of the sighting. Temporary codes were replaced with permanent identification numbers if the whale was seen more than once in a season, or if it had been identified elsewhere or in previous years.

Whale Counts:

After all photographs were analyzed, the number of distinct individual whales in the sample was counted. Separate counts were made of Glacier Bay and Icy Strait, for the total monitoring period and for a 'standardized period' (after Perry

1985, from 9 July to 16 August. The standardized period was chosen by Perry and co-workers (1985), to coincide with the study dates in 1982-1984, so that valid comparisons of counts between years could be made. Although the standardized period is substantially shorter than the current NPS monitoring season, and the beginning and ending dates have no particular biological significance, the standardized counts tend to reflect trends in total counts relatively well (see Figure 1). Continued use of the 'standardized period' is currently the only way of comparing whale counts over the entire systematic data collection period of 1982-1992.

Prey Assessment: While tracking whales for photographic identification, the depth and density of potential whale prey was determined using a Raytheon V850 dual-frequency color video echo-sounder. Distinguishing between fish and planktonic targets was possible because 200 kHz echoes were better at reflecting fish, while the 50 kHz echoes allowed resolution of plankton. Gain and chart-speed settings were standardized (gain for 50 kHZ and 200kHz transducers were set at 75%, chart speed was set at 9) to ensure that different sampling occasions would be comparable. The screen was qualitatively described in the field notes. Photographs of the echo-sounder screen were taken using 200 ASA color slide film (shutter speed 1/30) to store particularly interesting images. On some occasions, the type of prey was determined when visible near the water's surface. Sample fish were sometimes caught with a dipnet in the vicinity of feeding whales. Surface temperature and water depth were recorded for each whale observed.

Table 1. Number of humpback whale survey days per month in Glacier Bay and Icy Strait, 1985-1993.

	Glacier Bay					Icy Strait				
	May	June	July	Aug	Sept	May	June	July	Aug	Sept
1993	2	10	13	7	1	1	3	3	5	1
1992	3	19	17	12	7	2	4	5	4	1
1991	7	14	17	13	6	3	7	6	4	3
1990	6	16	18	14	0	4	5	6	8	0
1989	3	17	14	16	1	1	6	6	7	4
1988	0	11	12	12	7	0	5	7	5	3
1987	3	12	12	5	1	2	5	7	7	2
1986	0	13	17	6	0	0	5	3	6	2
1985	0	10	11	10	0	0	7	4	3	1

Table 2. Total search and encounter time in Glacier Bay (GB) and Icy Strait (IS); 1985 and 1988-93.

Year	GB (hrs)	IS (hrs)	Total (hrs)	Total Whale Count (GB and IS)
1993	192	62	254	51
1992	248	71	319	68
1991	256	100	356	52
1990	215	115	330	50
1989	231	123	354	42
1988	199	108	307	55
1987	-	-	-	59
1986	-	-	-	51
1985	234	92	326	41

RESULTS

Counts:

A total of 54 individual humpback whales were photographically identified in Glacier Bay and Icy Strait between 26 May and 14 September 1993 (Table 3; Appendix A). Of this total count, 10 (19%) whales were common to both areas. A number of whales (25, including 1 cow/calf pair) were sighted exclusively in Icy Strait and 21 (including 2 cow/calf pairs) were observed exclusively in Glacier Bay (Table 3). Limiting the count to only those whales seen during the standardized period (Perry et al. 1985), yielded a standardized count of 23 (including 1 cow/calf pair) whales in Glacier Bay and 25 (including 1 cow/calf pair) in Icy Strait (Table 3). For Icy Strait and Glacier Bay combined, there were 42 whales observed during the standardized period. Standardized and full-season counts are variable (Figure 1).

Many whales identified this summer are individuals that return annually to the Glacier Bay/Icy Strait region. At least 14 of the whales that were sighted in 1993 were first documented in this area in the mid-1970's (Jurasz and Palmer 1981) and have been identified in the area in many subsequent years (Perry et al. 1985; Baker 1986, 1987; Baker and Straley 1988; Straley 1989, 1990; Gabriele 1991; Gabriele 1992).

ble 3. Standardized and total counts of humpback whales in Glacier Bay and Icy Strait: 1982-1993.

	Glacier Bay		Icy Strait		Glacier Bay & Icy Strait	
	Standardized Count	Total Count	Standardized Count	Total Count	Standardized Count	Total Count
1982	22	22	5	15	33	33
1983	10	10	9	9	17	17
1984	24	25	21	22	39	39
1985	10	15	19	30	27	41
1986	26	32	27	35	42	51
1987	28	33	34	48	49	59
1988	17	39	29	36	41	55
1989	20	24	19	30	33	42
1990	16	26	24	34	36	50
1991	16	19	34	40	45	52
1992	27	35	38	51	51	68
1993	23	31	25	33	42	54

Note: Total counts refer to the number of whales (adults and calves) identified during the entire monitoring season. 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 slightly smaller than the sum of Glacier Bay and Icy Strait counts, because some whales are identified in both areas.

Seasonal Distribution:

Few whales were present in Glacier Bay until mid-June, when numbers increased relatively rapidly. The highest numbers of whales were present in Glacier Bay from late June to mid-July, when approximately 15 whales were present. Whale presence in the bay declined in early August, leaving approximately 5 whales in the bay. The largest number of whales identified in a single Glacier Bay survey was 7, on 16 June and 7 July. Icy Strait whale numbers were moderate by early June, declined slightly just after a peak in July and declined relatively rapidly in late August. The highest number of whales identified in a single Icy Strait survey was 17, on 15 July.

Glacier Bay whale sightings occurred throughout the bay, but concentrated in the east side of the bay (Leland Island, Sandy Cove, Sturgess Island) in June and July, and Whidbey Passage in July and August (Figure 2). Icy Strait whale activity concentrated at Point Adolphus throughout the summer, with few sightings along the coastline between Pinta Cove and Burger Point. In July and August, a small group of whales was sighted regularly at the daymarker between Mud Bay and Point Adolphus.

Local Movement and Residency:

Whale movement between Glacier Bay and Icy Strait was uncommon. Ten whales (19% of all identified whales) were sighted in both Icy Strait and Glacier Bay, with 3 individuals (#236, #352, #221) making one or more roundtrips between areas (Appendix 1). Seventeen (55%) of the 31 whales that entered Glacier Bay remained 20 or more days, long enough to be considered residents (after Baker et al. 1983). Using the same residency criterion, 16 (48%) of the 33 Icy Strait whales were considered resident in that area during the study.

Feeding Behavior:

Humpback whale feeding behavior in Glacier Bay and Icy Strait is typically characterized by solitary, sub-surface browsing. In 1993, as in previous years, many whales foraged alone, with frequent sightings of pairs but few larger groups. Early in the season, lateral and vertical lunge feeding were observed relatively frequently in Glacier Bay, a few times in the mouth of Bartlett Cove, South Sandy Cove, Geikie Inlet, and east of Johnson Cove. On many of these occasions, the whales released a cloud of bubbles or a bubblenet prior to surfacing. It was not possible to determine the prey type during these episodes. Coordinated feeding by larger groups of whales at Point Adolphus was less prevalent in 1993 than it has been in previous years. On many survey days, the whales were dispersed over a large area approximately 1-2 mile northwest of Point Adolphus. Many of the typical members of the large 'core group' (Perry et al. 1985) were not sighted in the study area for a large part of the season.

Potential humpback whale prey were shown on the echo-sounder at various depths and in various densities in the study area, and in most cases appeared to be composed of both fish and plankton. Based on information from previous studies, the primary prey item available to Icy Strait whales is thought to be herring (*Clupea harengus*) (Wing and Kreiger 1983; Kreiger and Wing 1984, 1986). Similarly, the primary whale prey items in Glacier Bay are believed to be schooling fish such as capelin (*Mallotus villosus*) and sand lance (*Ammodytes hexapterus*) (Kreiger and Wing 1984, 1986). A single juvenile pollock (*Theragra chalcogramma*) was captured with a dipnet west of Leland Island, where a whale was feeding. Sand lance were visually identified nearshore in the vicinity of a feeding whale approximately 1 mile west of Point Adolphus.

Reproduction and Juvenile Survival:

Three cow/calf pairs were identified in the study area in 1993. Two cow/calf pairs were sighted exclusively in Glacier Bay (#235 with calf #1079 and #535 with calf #1080), and 1 was sighted exclusively in Icy Strait (#581 with calf #1081). Fluke identification photographs were taken of all 3 calves. The crude birth rate (CBR), computed by dividing the number of calves by the total number of whales, provides a measure of the reproductive rate for the local population. Table 5 shows the crude birth rate for the years 1982-1993. Figure 3 illustrates the cyclic nature of this parameter.

Whale #1067, first identified in 1992 as the calf of #530 (Gabriele 1992), was observed in Glacier Bay in July. Whale #1049 is another juvenile sighted this year in Glacier Bay. Whale #1049 was first observed as a the calf of #801 in 1990, both of these whales were resident in Glacier Bay this summer. Adult #349, first sighted as the calf of #535 in 1984, was re-sighted in 1993 for the second year since its birth year (Straley 1989). Juvenile male #1014 was sighted in Glacier

for the third consecutive year since it separated from its mother (#236). Whale #236 was also in Glacier Bay for a large part of the summer. A total of 13 animals that were first identified as calves have been re-sighted in the study area since 1974.

Whale/Vessel Interactions:

No whale entanglements in fishing gear were reported or observed in Glacier Bay or Icy Strait. However, male #166 was observed on 27 August in Icy Strait with a round red wound on his tail stock, resembling a rope-entanglement wound, and possibly indicating that he had been entangled prior to the observation. In subsequent observations in September, the wound had scarred over and turned white.

Various types of vessels were observed within 1/4 mile of whales in Glacier Bay on numerous occasions. NPS staff aboard cruise ships and tour boats reported 6 instances when a whale surfaced near their vessel in Sitakaday Narrows or South Marble Island. In Icy Strait, the number of whale watching vessels appeared to be comparable to that of recent years. Whales tended to be more dispersed than usual in 1993, so the whale watching was not as focused on the 'core group' as it had been in 1991 and 1992.

Table 4. Crude birth rates for humpback whales in Glacier Bay and Icy Strait, 1982-1993

	#Whales	#Calves	CBR %
'82	33	6	18.2
83	17	0	0
1984	39	7	17.9
1985	41	2	4.5
1986	51	8	15.7
1987	59	4	6.8
1988	55	8	14.5
1989	42	5	11.9
1990	50	6	12.0
1991	52	4	7.7
1992	68	12	17.6
1993	54	3	5.9

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.

DISCUSSION

The 1993 whale monitoring season was characterized by a moderate number of whales dispersed throughout the study area and comparatively little movement between Icy Strait and Glacier Bay. Concentrations of whales occurred in Whidbey Passage and near Point Adolphus but were relatively short-lived. The timing of whale presence in Glacier Bay was consistent with previous years. The mid-summer decline in the number of whales in Icy Strait, however, contrasts with

vious observations. The decline in the number of hours of effort in Icy Strait was primarily due to the fact that longer surveys were not necessary when whales were not abundant. No quantitative analysis of prey abundance is possible using the present methods, so it is not possible to assess whether the prey density or abundance in Icy Strait was reduced in 1993. The observed Icy Strait whale distribution might also have taken place if prey abundance in the area were comparable to other years, while an increased prey abundance occurred elsewhere in southeastern Alaska.

There was a marked decrease in the stability and persistence of the 'core group' (Perry et al. 1985) at Point Adolphus, compared to recent years. Previously, the core group has been less cohesive in years when group members have calves (Perry et al. 1985) but none of the females in the group were observed with a calf in 1993. One typical group member (male #577) was sighted in early June and mid-August but was apparently not in the study area for most of the summer, while others appeared to depart the area in mid-July and not return (e.g., females #155, #573, #587 and #353). Female #236 fed in lower and mid-Glacier Bay for most of July, then returned to Point Adolphus in mid-August to feed with other typical core-group members, (males #186 and #166) who had remained in the area all summer. The change in group stability suggests a change in the abundance or behavior of their prey, presumed to be Pacific herring (Wing and Kreiger 1983; Kreiger and Wing 1984, 1986). One might surmise that group feeding is advantageous to group members only under certain circumstances, and when these conditions are not met, group feeding declines. The Point Adolphus 'core group' is also subject to frequent and prolonged whale watching activity and spends a large proportion of its day being approached and followed by 1 to 4 whale-watching boats, including cruise ships and tour boats entering or departing Glacier Bay. e potential exists that the added stress of this attention is an additional factor that decreases whales' incentive to feed in groups.

Yearling #1067 is only the second whale in this study that has been re-sighted as a 1 year old, (Gabriele 1992), although the return of yearlings is typical in a comparable study in Massachusetts Bay (Clapham and Mayo 1987). The return of juvenile #1049 to a part of Glacier Bay that its mother frequents provides further documentation of maternally-directed fidelity to feeding areas. Calf return and recruitment are expected to be one of the best determinants of future whale abundance in the study area. Relatively few calves were seen this year, with a consequent drop in the crude birth rate. As first noted by Baker (1986), years of low crude birth rate tend to occur in years with low whale numbers in Glacier Bay. The driving forces behind the apparent oscillation in reproductive rate (Table 4) are unknown, but a similar phenomenon has been observed in North Atlantic fin whales (Lockyer 1986). To resolve this compelling question, further studies of individual variability in calving intervals and female reproductive synchrony are necessary.

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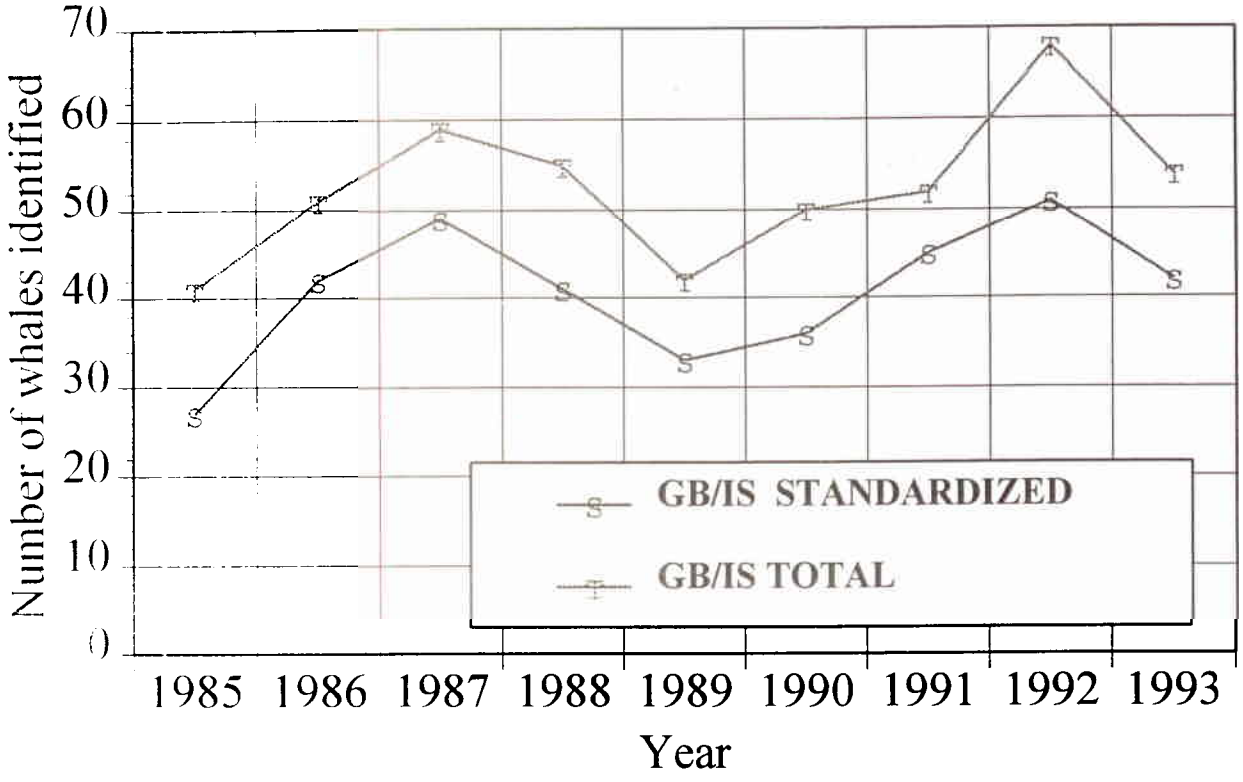

Figure 1: Total count refers to the number of whales identified between June 1 and August 31. Standardized count refers to the number of whales identified in the 'standardized period' July 9 to August 16 (after Perry et al. 1985).

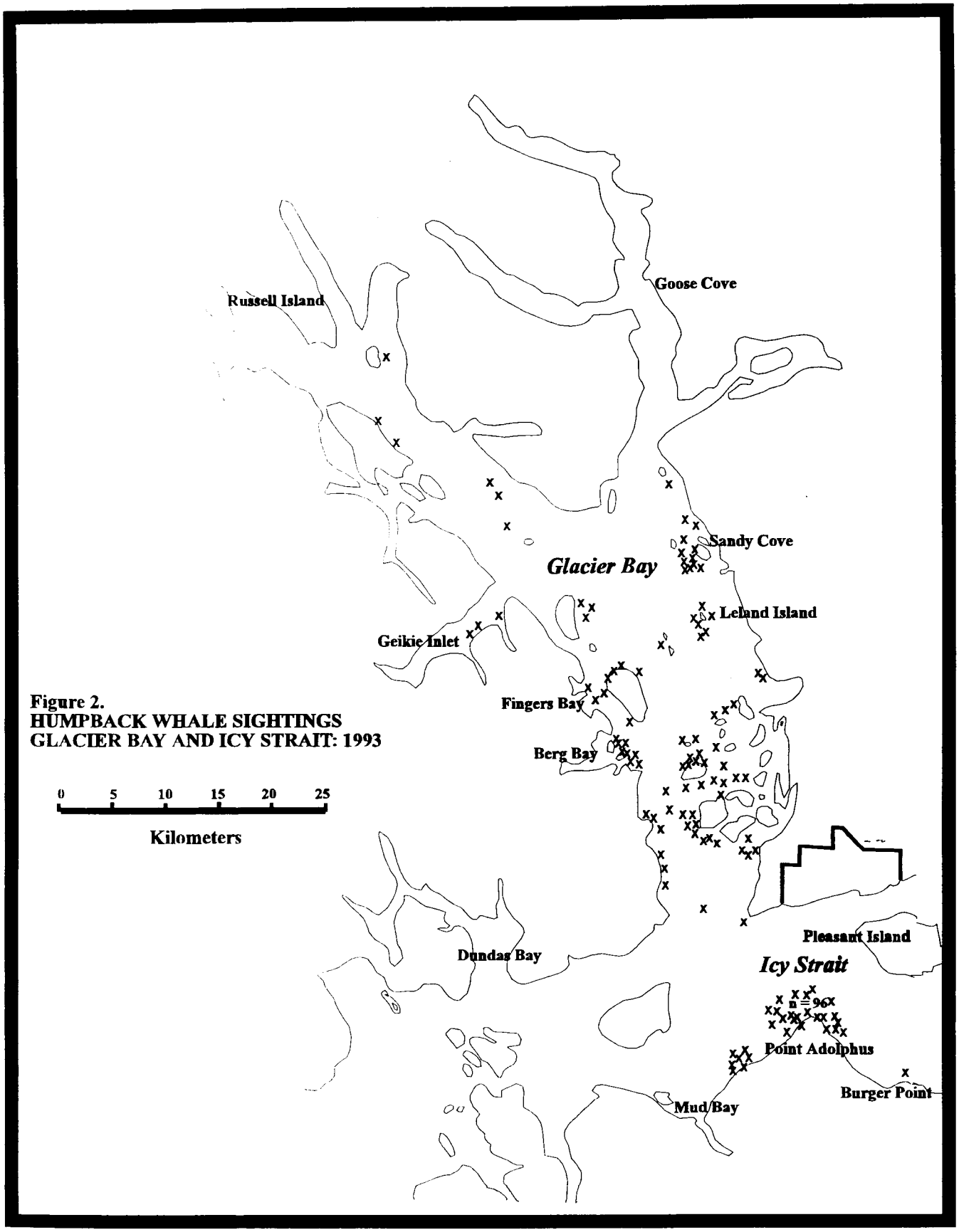

Figure 2.
HUMPBACK WHALE SIGHTINGS
GLACIER BAY AND ICY STRAIT: 1993

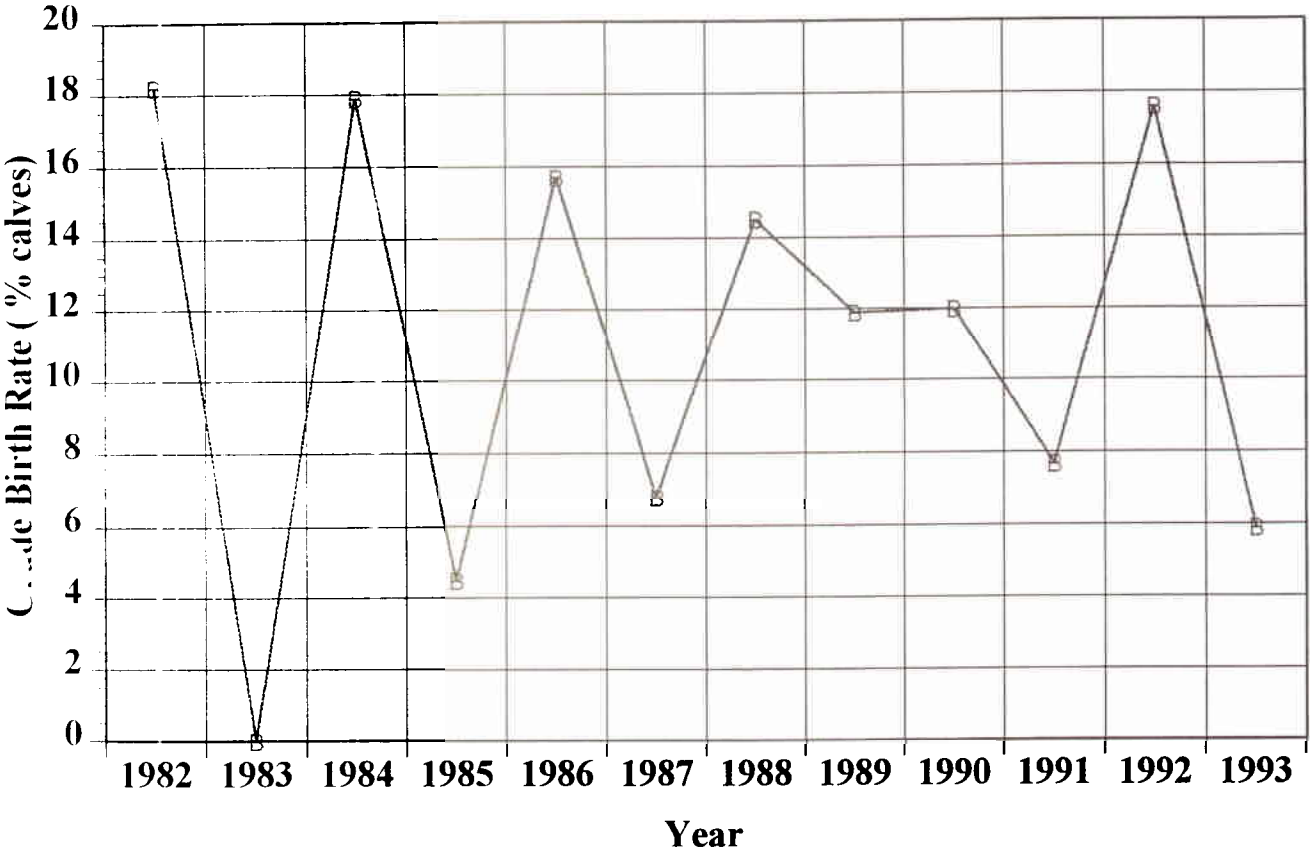

Figure 3. Crude birth rate equals the number of calves sighted / number of whales sighted in a given year. Sample sizes for each year are given in Table 4.

APPENDIX 1. HUMPBACK WHALE SIGHTING HISTORIES 1993

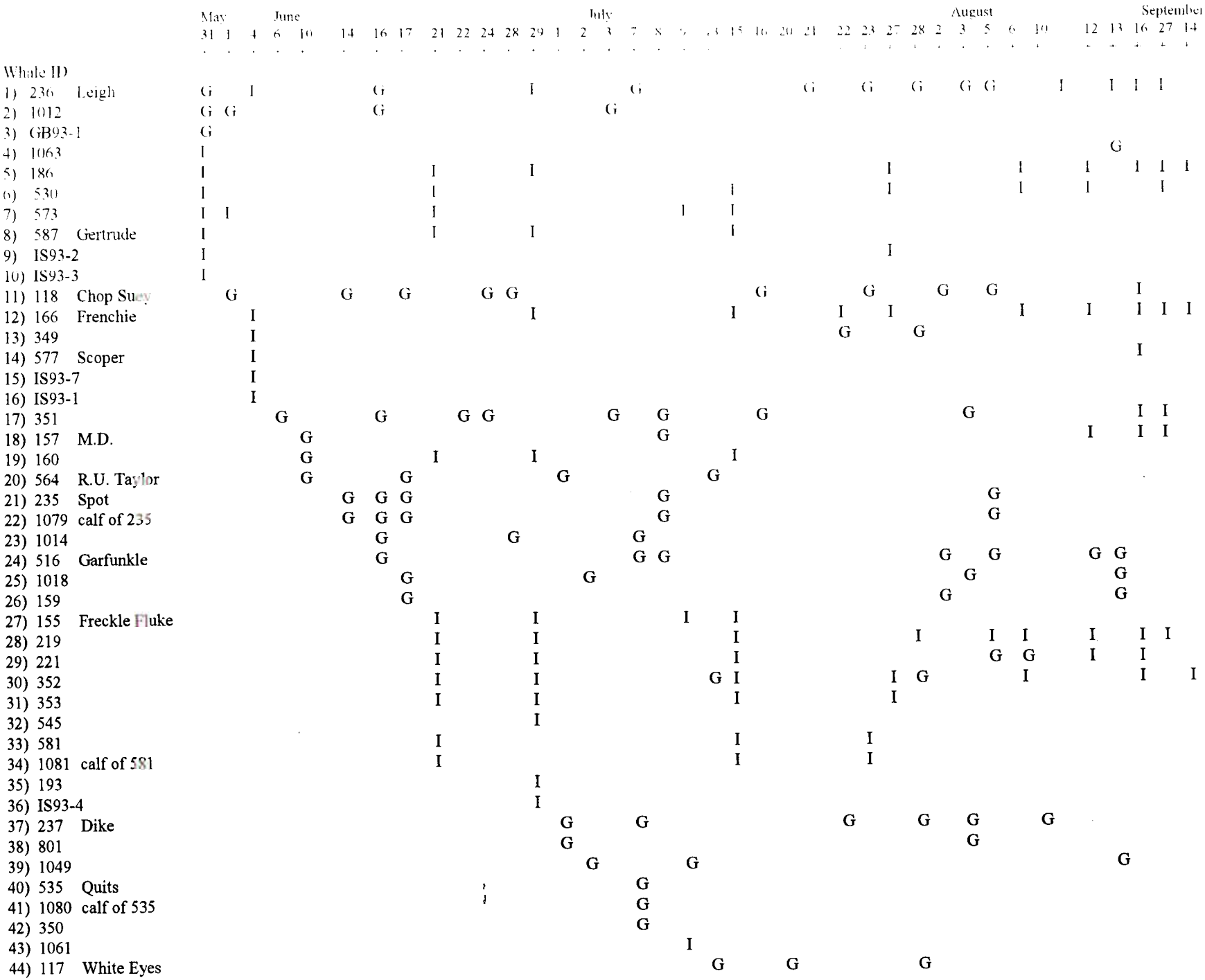

table continuesA""FNDIX 1. continued **HUMPBACK WHALE SIGHTING HISTORIES 1993**

	May		June											July															August						September			
	31	1	4	6	10	14	16	17	21	22	24	28	29	1	2	3	7	8	9	13	15	16	20	21	22	23	27	28	2	3	5	6	10	12	13	16	27	14
	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
45) 161 B.W.M.																				G			G															
46) 875																					I											I		I				
47) IS93-5																					i																	
48) 1075																					I				G													
49) 1083																				I													I	I				
50) 1067																						G																
51) 1082																						G			G	G			G						G			
52) GB93-6																								G														
53) IS93-9																																			I			
54) 1031																																						