

**Preliminary Assessment of Harbor Seal Haulout Behavior and
Sources of Disturbance at the
Spider Island Reefs in Glacier Bay National Park**

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FINAL REPORT

1997

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INTRODUCTION

Haulout patterns of harbor seals (*Phoca vitulina richardsi*) during the August molt (shedding) at a major terrestrial haulout in Glacier Bay National Park were markedly different in 1997 compared to previous years. This extreme change in haulout use, coupled with other observations made in 1996 and apparent increases in human activities near the haulouts, suggests that human disturbance may have altered harbor seal behavior in 1997. Between 1992 and 1996, three reefs west of Spider Island in the Beardslee Islands in Glacier Bay National Park were occupied by an average of 1,000 (n = 16; SD = 362) harbor seals during standardized aerial surveys conducted close to low tide in mid-August (Mathews 1995). This area is routinely used by more than half of the harbor seals found at terrestrial haulouts in Glacier Bay during both pupping (May-June) and molting (August) periods (Mathews 1992, Mathews 1997), and harbor seals have used these reefs for at least 15 years (Calambokidis et al. 1987, Lentfer and Maier 1989). During five of six surveys in August, 1997 I observed no seals at these reefs, and only about 100 seals were counted on the final day of the survey. Harbor seals traditionally exhibit strong year-to-year site fidelity for specific haulouts within a season (Pitcher and McAllister 1981; Brown and Mate 1983; Jeffries 1986; Thompson 1989).

Peak visitation in Glacier Bay occurs primarily from June through August, exactly the months of sensitive phases in reproduction and molting for harbor seals. Harbor seals at haulouts are easily flushed into the water (disturbed) by humans. In order to reduce disturbance to seals and nesting shorebirds, the National Park Service (NPS) prohibits foot traffic and camping on Spider Island from May 31 to August 31. In addition, all vessels are supposed to remain at least $\frac{1}{4}$ nm (0.46 km) from the Spider Island reefs. Compliance with NPS wildlife regulations is incomplete and the effectiveness of NPS wildlife regulations is not known.

This report summarizes preliminary observations made in 1996 and 1997 on haulout use near Spider Island during the annual molt in August. I also identify potential sources of disturbance of harbor seals at haulouts near Spider Island and suggest methods for further clarification of the sources of disturbance. If boaters are frequently flushing seals from haulouts, disturbance could be reduced through several mechanisms, including improved education of visitors, increased enforcement of existing regulations, and, if necessary, re-evaluation of existing regulations.

BACKGROUND

National Parks are charged with “[conserving] the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations” (NPS Organic Act, 1916, *summarized in*: NPS, VMP 1995). Glacier Bay was designated as a National Park in 1980, as a provision of the Alaska National Interest Lands Conservation Act (ANILCA). This Act states that Glacier Bay has been set aside to “maintain sound populations of, and habitat for, wildlife species of inestimable value to the citizens,” and to “preserve wilderness resources and related recreational opportunities” (ANILCA, 1980). As more and more people seek opportunities for viewing wildlife (Duffus and Deardon 1990) and for exploring wilderness areas, the Park’s dual mandates to preserve natural resources while providing for recreational opportunities are increasingly difficult to balance.

Worldwide, there is a general trend of growth in non-consumptive wildlife tourism (Duffus and Deardon 1990). In Glacier Bay in 1996, the number of entry permits for cruise ships in was increased by 30%, although a daily cap of 2 vessels per day was maintained), and seasonal quotas for charter and private boats were increased by 8% (Fed. Reg. 61(105): 27008). In addition, backcountry use, including Wilderness waters, by visitors in non-motorized vessels in Glacier Bay increased by about 50% between 1991 and 1996 (Hennessy et al. 1996).

In 1996, the Beardslee Islands (designated as Wilderness Waters since 1980) were closed to motorized craft, including floatplanes and boats, with the exception of commercial fishing vessels (NPS, Vessel Management Plan, 1995). The reduction in motorized vessel traffic in the Beardslee Islands increases the area’s value as wilderness, and it is possible that this will result in higher levels of non-motorized traffic. Increased use of the Beardslee Island Wilderness area by visitors in non-motorized craft, predominately kayaks, is likely to result in increased disturbances of harbor seals, unless an aggressive preventive program is initiated. Contrary to intuition, kayakers tend to startle harbor seals from greater distances (mean = 169 m) than motorized pleasure (mean distance = 130m) or tour (mean distance = 134m) vessels. That is, at the same distance, more seals are typically flushed by kayakers than by power boats (Calambokidis et al. 1985).

Because the sandy reefs near Spider Island are the most important terrestrial haulouts used harbor seals in Glacier Bay during sensitive phases of their life history, we initiated a pilot study to develop methods for monitoring harbor seal haulout patterns and interactions with boaters. Our intent was to determine if there was any evidence of repeated human disturbance of seals at haulouts, and if so to: 1) begin characterizing the nature and degree of the disturbances, and 2) determine if further study or information was needed to reduce disturbance at haulouts.

The potential consequences of repeated disruption of resting seals at major haulouts are summarized below.

- 1) Disturbance that causes groups of seals to stampede into the water may result in permanent separation of females and their dependent pups; pups separated prematurely from their mothers will starve and die if not reunited, or be easy targets for predators.
- 2) Repeated disturbance of females with dependent offspring can result in short-term separations and reduce opportunities for resting and nursing; this may result in reduced likelihood of survival of weaned pups.
- 3) Chronic disturbance can cause harbor seals to stop using a traditional or favored haulout.
- 4) Repeated disturbance may result in lower overall fitness of individuals through increased energetic demands.
- 5) Disruption of haulouts may interfere with social interactions of seals.

METHODS

Study Area

Spider Island is located in the central region of the Beardslee Islands, an area readily accessible to kayakers from Park headquarters in Bartlett Cove (Figure 1). Three tidally influenced reefs west of Spider Island are typically occupied by resting harbor seals during low tide cycles, especially in spring and summer months. These three reefs are the focus of this study. I have observed seals at other sand bars, spits, and reefs nearby, but no haulouts have been used as predictably or extensively as these three since I began conducting aerial surveys and making observations in 1991.

Aerial Surveys and Photographic Slide Analysis

Every August since 1992, with the exception of 1993, aerial surveys for harbor seals in Glacier Bay have been flown during monthly low tides in August when seals molt (shed). This period is optimal for censusing, since seals spend more time out of the water and so a higher proportion of the population is available for counting.

We survey in single engine, fixed-wing aircraft (most often a Cessna 172 or 185). While looking for haulouts, we maintained a survey altitude of about 303 m (1000 ft). When an occupied haulout is located, we descend to 210-240 m (700-800 ft) and take several photographs of each haulout. Our flight path is about ¼ mile (horizontally) from the haulout, both to allow the photographer to aim the camera out the window and to avoid flushing the seals. Aerial surveys are conducted under a NMFS, MMPA Level B Research Permit (No. 698). We use a Nikon camera (8008S or 6006) equipped with either an 80-200 mm zoom lens or a fixed 300mm lens. Slide film (400 ASA Sensia-Fujichrome or Ectachrome-Kodak) is used and the majority of frames are shot at 1/250 - 1/1000 second at aperture settings of f4-f16.

On about half of the flights an observer accompanied the photographer; on most flights the pilot has also assisted as an observer. For each haulout, the following information is

recorded: location, time, frame numbers, camera settings, altitude, and a visual estimate of seal numbers, or a '0' entry if no seals are present.

We select the slide or two slides with the clearest view of seals for each haulout and then project them onto white paper so that seals can be counted by marking their images. We count each haulout at least twice, and use the higher of the two counts. If the two counts are not within a few percent of one another, we recount until we determine the source of the discrepancy.

I compared the mean value for the 15 counts from the four survey years prior to 1997 to the 6 counts from August, 1997 (Mann-Whitney U test, SPSS). For each of the survey years from 1992-1997, I plotted the mean number of seals counted from aerial photographs. The daily high counts from land-based observations of the Spider Island reefs for 23-25 July, 1997 were included in this figure.

Land-based Observations of Seals and Disturbance

On July 23, 1997 Braun Lowry (NPS Biotechnician) and I kayaked out to an island about 1 km west of Spider Island where we camped and made observations for three days (Field Site, Figure 1). On July 24 at 07:00, four hours before the -1.9 ft low tide, I began observations and counts of seals at the Spider Island reefs. All of the main reefs commonly used as haulouts can be covered by higher tides, and seals typically begin to mingle near the haulout as the water drops until a portion of a reef becomes exposed, although some seals haul out on sand bars which are still awash. We had planned to monitor the haulout for five days, however only two days of continuous observations were possible due to illness.

We observed and counted seals hauled out and in the water using Zeiss 20 X 60 binoculars mounted on a tripod. We counted seals approximately every 30 minutes for an entire haulout cycle (until the last seal was forced off a reef by the rising tide or by a disturbance), which lasted about 9 hours. On 24 July, I was not able to count seals after 16:12 due to obscured visibility from heavy fog and rain. However, there were only three seals remaining on the nearly submerged haulouts, so this was close to the end of the haulout session.

A disturbance is defined as any event that changes the behavior of the seals from resting to active or vigilant, or causes some or all of them to enter the water in a short period of time. All four of the disturbances that we observed involved some seals moving rapidly in a group, or stampeding, toward and/or into the water.

Because this was a pilot study, the methods used evolved with time. On the second day, instead of a straight count, we began using instantaneous scan sampling (Altmann 1973) to score seals on shore as either vigilant or non-vigilant. Seals classified as **vigilant** are those that are actively looking around or scanning at the instant that the observer scores them. All other behaviors are considered as **non-vigilant**. We counted seals beginning on the far left (north) of our field of view and moved systematically to the right (south). At the end of each observation session, the observer scanned the nearby water for seals

and recorded the total in the water. Seals that entered the water on their own or after a disturbance dispersed quickly from the haulout beyond our view. Consequently, the numbers of seals counted in the water often dropped steeply between 30-minute scans.

I graphed the ½ hourly counts of seals ashore and seals in the water for 24-25 July, 1997. Included on this graph are the times of the low tide +/- 1 hour and observed disturbances.

Recovery time and Percent of Seals Disturbed

To address the degree that seals re-hauled after a disturbance, I plotted the proportion of seals hauled out beginning with the times of the first two disturbances observed on July 24, 1997. (The disturbance on July 25 occurred at the end of the haulout cycle, so recovery could not be assessed.) The count immediately prior to the first and second disturbances was used as the initial 100% level.

I also calculated the percent of the seals disturbed for each disturbance. The number of seals on the haulout during the scanning session immediately prior to a disturbance was considered the pre-disturbance level and the high count following a disturbance was evaluated as a percent of the pre-disturbance count.

RESULTS

Counts of Seals from Aerial Photographic Surveys

There were significantly fewer ($p < 0.0001$, Mann-Whitney U test, SPSS) seals at the Spider Island reefs in August, 1997 than in any of the other years when surveys were conducted (Figure 2). The average number of seals during August surveys for 1992-1996 was 1,001 (SD = 362, $n = 15$) compared to 56 in 1997. The mean and maximal counts of harbor seals on reefs near Spider Island during low tide aerial surveys in August were 20 to 5 times, respectively, lower in 1997 than in all previous years (Table 1). In 1997, seals were observed on the Spider Island reefs on only 2 of 6 survey days.

More than 1,000 seals were observed at the three reefs on all survey days prior to 1996 (Table 1). No seals were on the reefs on five of the six survey days in August 1997, despite very low tides (-4.0 to -1.3 ft) at the time of the surveys (Figure 3). Campers were observed at the south tip of Spider Island on the first morning, and on a low island immediately northwest of Spider Island on the second survey day.

Table 1. Mean and maximal counts of harbor seals at reefs near Spider Island from aerial photographic surveys during low tide cycles in August, 1992-1997.

Year	Dates	Max	Mean	SD	n
1992	27-29	1094	1056	54	2
1994	8-12	1522	1384	142	4
1995	1-10	1163	1092	64	3
1996	11-31	1008	769	267	5
1997	17-22	203	46	82	6

Land-based Observations of Seals and Disturbance

During about 17 hours of observations on July 24 and 25, we observed four cases of disturbance in which a proportion or all of the seals on the Spider Island reefs were flushed into the water. One case was clearly caused by human activity nearby, a second was most likely caused by my activities near our observation site, and two others appeared to be triggered by natural events near the haulouts. I will briefly describe each situation below.

Disturbance 1: On July 24 at about 14:55 while Braun was observing the seals, I began walking back toward our observation site to relieve him of his duties. When I crossed from a sandy section onto an area with larger rocks, I heard some of the seals begin stampeding into the water. I realized that my walking on the rocks was potentially audible to the seals more than 1 km away. I was southwest of the haulout, and it was raining lightly with little to no wind. When I arrived at the observation site, Braun noted that at least 132 of the 242 seals had entered the water during the previous observation session. At 14:50 he had noted that a group of killer whales (*Orcinus orca*) had surfaced near the south end of the island we occupied, approximately 1.5 km from the seals, also southwest of the haulout, but further away than where I'd been walking. During this scanning session, Braun noted that many of the seals became active and looked in the direction where the whales had surfaced. At this same time he observed a commercial crab boat maneuvering more than 1.5 km away, but the seals appeared to be looking toward the whales or me.

Disturbance 2: On July 25 at 11:00, Braun noted that he could hear a boat approaching and that the seals became alert and looked toward the boat noise. During this scan he counted a total of 577 seals, including 84 which were vigilant. The boat remained at a distance of about 3 km northeast of the haulout while the operator checked several crab pots. During these maneuvers, there was little observable change in behavior of the seals; they seemed to settle back down after the initial wave of awareness. At 11:13, the vessel's engine RPMs increased as the boat began motoring toward the reefs. At 11:46 the crabber was pulling a pot only 200 m from the reef which now had 460 seals on it. A minute later the crabber moved to within 40 m of the seals, and all of the seals became vigilant, but only a few more entered the water. At 11:52 the boat was estimated to be about 100 m from the haulout. By 11:55 all of the seals had moved to the water's edge, but most were no longer vigilant. The boat then motored close to and behind the haulout, but I did not see any seals enter the water, nor did the seals become vigilant as the boat passed within 50 m of the haulout. Based on our counts before and just after the crab boat's approach, at least 107 seals entered the water. The crabber's engine – which is rather loud – was running the entire time, and we could hear it from a distance of at least 5 km.

Disturbance 3: On July 25 at 13:58 during my watch, 460 seals suddenly stampeded toward the water. At least 67 of them abandoned the haulout within the next minute. There were no boats nearby, and I did not hear any loud noises. Seconds before the

stampede, an adult Bald Eagle (*Haliaeetus leucocephalus*) landed along the upper ridge of the reef, about 150 m from the seals. At 14:00 there was another stampede, and another 310 seals left the haulout. During this time, most of the seals were looking toward the eagle, including some of the animals as they moved toward the water.

Disturbance 4: On July 25 at 15:56 Braun observed about half of the 217 seals on the haulout stampede into the water. At first he could not determine if there was any clear trigger for the disturbance, but at 15:59 he saw a large male Steller sea lion (*Eumetopias jubatus*) attacking a small harbor seal by biting its head and flinging it violently in a tight arc until it was killed. The bull then ripped off the skin using a similar flinging method, and he dismembered the seal into large pieces that he then swallowed. Two sub-adult sea lions approached and appeared to watch and possibly scavenge pieces of flesh. Several gulls tracked the activity and picked up entrails and flesh from the water. The sea lion finished consuming the seal and left the area at 16:35. No seals were remaining on the haulout, and the tide was almost covering the main reefs.

Percent of Seals Disturbed and Recovery from Disturbance

Seal counts and observations of disturbance throughout the low tide cycles on July 24 and 25 are presented in Figures 4 and 5. Numbers of seals counted after a disturbance never reached pre-disturbance levels (Figures 4 and 5). When I walked along the beach during the time that killer whales were in the vicinity, about 76% of the 267 seals entered the water (Figure 4). Approximately 20% of the seals entered the water during the maneuvering of the crab boat that came to within about 50 m of the seals (Figure 5). The Bald Eagle appeared to have startled 80% of the 461 seals on the haulout (Figure 5). At 15:38, just before the sea lion began attacking the harbor seal, 203 seals remained on two of the reefs. During the 15:56 count, an additional 163 (81%) seals flushed into the water, and by 15:59 there were no seals remaining. Thus, of the four disturbances observed, the motorized vessel resulted in the lowest proportion of seals entering the water, whereas the sea lion attacking the seal culminated with 100% of the seals in the water (Figure 6). The human disturbance inferred during the aerial survey on 17 August, 1997 left no seals on the reefs, and there were 75 seals remaining on the haulout on 18 August when campers were observed nearby.

CONCLUSIONS

The lack of seals at the Spider Island reefs during the August 1997 surveys and observations of campers on or near Spider Island on the first two days of these surveys suggest that disturbances by humans may have resulted in at least short term displacement of harbor seals from the main reefs west of Spider Island. However, it is not possible to rule out alternative sources of disturbance, such as predators (killer whales and Steller sea lions) and scavengers (Bald Eagles). The high count of seals at the Spider Island reefs from aerial surveys in 1997 was 203 seals, a count 5 times lower than in any previous year since surveys began in 1992 (Table 1). In 1997, we did not observe any other haulouts in Glacier Bay with comparably higher numbers of seals, so it did not appear that displaced seals had moved to a new haulout within Glacier Bay.

In addition, our observations of the Spider Island reefs from an adjacent island on July 24 and 25, indicate that harbor seals are extremely wary, and that there are 'natural' causes (Bald Eagles and Steller sea lions) of disturbance as well as human causes. Although it is possible that seals are experiencing more natural disturbance in the Spider Island area, it seems more likely that an increase in the number of kayakers, possibly coupled with nearby activity of crab boats, is the primary cause of the reduced usage of a traditional haulout. Harbor seals exhibit strong site fidelity for breeding and resting areas. Thus, it would be unusual for seals to stop using a traditional resting area without some provocation or strong enticement, such as better access to food, to another area.

On July 24 and 25, the days we observed seals from land, there was almost no wind. On July 25, rain mixed with heavy fog defined the day. In these conditions, sound travels extremely well over water. Seals may be more susceptible to disturbances by people on nearby beaches when it is calm. Conversely, the higher ambient noise levels in rougher waters may mask these sounds and reduce the likelihood of startling seals.

RECOMMENDATIONS

Proposed Studies to Determine Levels and Sources of Disturbance

The observation period in July 1997 was too short to draw any conclusions regarding the nature and degree of disturbances at the Spider Island reefs, although it provided some information on types of natural and human disturbance that may be occurring.

Three possibilities exist for a more thorough assessment of haulout patterns and disturbance at the Spider Island reefs. The first approach would be to have two people, count and record the behavior of seals for at least two, 7- 10 periods during peak visitation in Glacier Bay. Controlled experiments could also be used to determine specifically what activities or boater distances are likely to cause seals to flush from a haulout. This second option would not, however, be optimal if assessing levels of ongoing disturbance were a primary or concurrent goal. A third possibility would be to mount a weatherized camera that could be programmed to record the number of seals on the haulout every 10-30 minutes (Allen et al. 1984). The drawback of this approach is that the cause of disturbances would not necessarily be known, since they could easily occur outside of the field of view.

Enforcement of Distance and Camping Regulations

One obvious source of disturbance of seals at the Spider Island reefs is nearby campers. In 1997, when campers were observed near the Spider Island reefs during aerial surveys, no seals were on the haulouts on the first day when depressions in the sand from seals were still visible and only 75 seals were present the next morning. Under certain circumstances, seals may react to human activities further than 1 km away, more than six times the distance of the campsites we observed.

As of 1997, all visitors to Glacier Bay who are planning on camping in the Beardslee Islands are required to go through a visitor orientation with NPS staff. Prior to 1997, most kayakers attended these orientations voluntarily, but now they are required to do so, since they now must have a backcountry permit. During the backcountry orientation, visitors receive information on wildlife closures, as well as a safety orientation. Yet, campers were observed on Spider Island or a nearby reef on two of the six days when we flew in August of this year, and in 1996 I observed a party of two kayakers land on Spider Island to hike. This suggests the following non-exclusive possibilities: 1) some proportion of visitors destined for the Beardslee Island area does not understand that camping is prohibited on or near Spider Island, 2) some campers understand this regulation, but do not know where they are, or 3) some campers chose to ignore NPS regulations. To determine which of these factors are at the heart of this problem, all individuals observed camping in restricted areas could be questioned to determine why they violated the regulation. It would be useful to determine if the campers observed on or near Spider Island on August 17 and 18, 1997 correctly recorded their campsite on the map provided to them by NPS.

In my experience, the vast majority of kayakers and visitors to national parks prefer not to disturb wildlife. Most disturbances occur because people are not aware of aggregating animals, or they underestimate the animal's awareness and sensitivity. We have observed several cases of disturbance of Steller sea lions by kayakers at a haulout in Glacier Bay (Mathews, 1996; unpublished data). In at least half of the cases, it appeared that the visitors felt badly about the disturbance and tried to alleviate the problem by back paddling. With this in mind, information on how to minimize disturbance at haulouts may be well received by most visitors to Glacier Bay National Park.

The second source of human disturbance of seals on haulouts is from boaters who pass too close to the reefs when seals are resting. NPS regulations prohibit vessels from approaching Spider Island or the four small islets to the west of Spider Island any closer than $\frac{1}{4}$ nm. We observed two clear violations of this distance restriction by crab fishermen within our three-day study. I counted 22 crab pots set by two different fishermen well within $\frac{1}{4}$ nm of the reefs, including five buoys (4 from one boat) that were within about 100 m of the haulouts. In these cases it is clear that the operators of the vessels knew that they were closer than $\frac{1}{4}$ nm, so the question is whether this was done in ignorance of, or regardless of, NPS regulations. Since 1991, I had never previously observed crab pots set this close to the reefs, although my coverage of the area has been limited to 1-3 weeks per summer and observations from the air. An obvious solution to this source of disturbance is to remind captains of commercial fishing vessels in the Beardslees that there are distance and disturbance restrictions and to enforce the regulations.

Visitor Education

From this and other studies (Calambokidis, Steiger et al. 1984; Mathews 1994; Mathews 1996), it is evident that captains of private, tour, and commercial fishing boats and kayakers in Glacier Bay disturb harbor seals and sea lions by approaching too closely or by operating in a manner that causes animals to flee into the water--violations of the

Marine Mammal Protection Act as well as NPS regulations. The 1997 Alaska Marine Mammal Viewing Guidelines published by the NMFS are ambiguous on the subject of safe approach distances for harbor seals and Steller sea lions. These guidelines state that boats should “remain at least 100 yards from ... seals and sea lions that are on land, rock or ice.” They also note that boaters should “use caution when viewing seals and sea lions that are on land, 100 yards may not be sufficient distance to prevent harassment.” From research conducted in Glacier Bay, 100 m is known to be too close for approaching harbor seals without disturbing them in most cases (Calambokidis et al. 1984).

Most boaters (with the exception of commercial fishermen?) receive written information and/or a verbal orientation to Park regulations. Although this approach is effective in many cases, alternative approaches appear to be needed. One possibility is to develop an educational video on how to avoid disturbing pinnipeds (seals and sea lions) and other wildlife in the Park. Such an effort is already underway in the Channel Island National Marine Sanctuary (John Brooks, NPS, Santa Fe, NM), and Glacier Bay National Park might be able to work with the producers of this video to develop one with local applicability. In another study, tour boat operators were significantly less likely to disturb resting sea lions, and one possible explanation of this observation is that they have had multiple opportunities to learn how to approach haulouts without altering the behavior of the animals. ‘Naïve’ visitors might also benefit from viewing a program that shows boaters what happens when a haulout is approached too closely or rapidly, as well as how to approach marine wildlife for viewing while minimizing the chances for disturbance.

In addition to reducing the energetic drains and social disruption of harbor seals and sea lions, minimizing disturbance of pinnipeds at haulouts also allows subsequent visitors to fully experience Glacier Bay’s wildlife. The National Park Service is a leader in wildlife protection, and efforts to promote responsible wildlife viewing will have positive repercussions throughout the region if NPS visitors export their knowledge to other areas.

Acknowledgements

I thank Glacier Bay National Park for supporting this study. Braun Lowry helped with the fieldwork. A draft of this report was improved by comments from Mary Beth Moss, Lewis Sharman, Rusty Yerxa, and Mary Kralovec.

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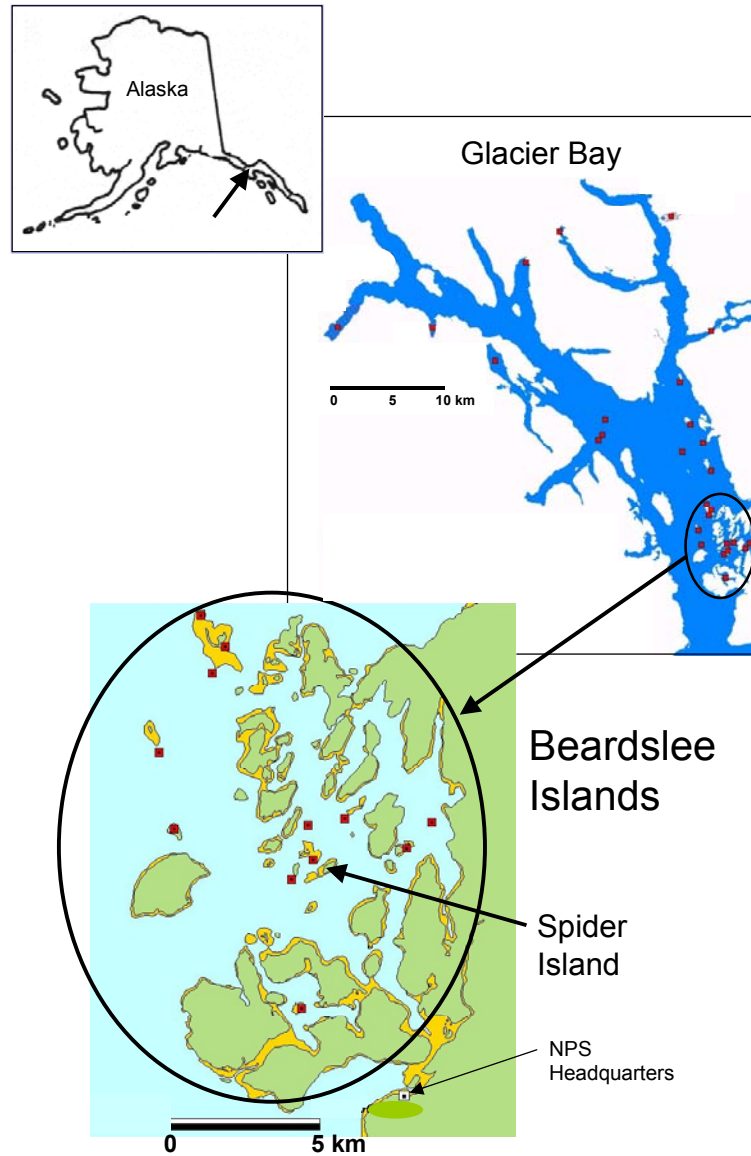


Figure 1. Spider Island and reefs used by harbor seals to the northwest in the Beardslee Islands, Glacier Bay National Park.

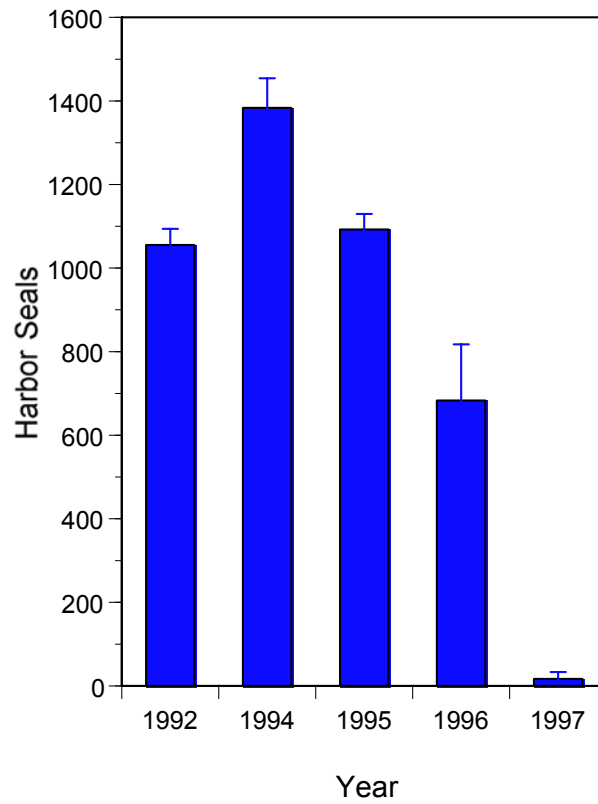


Figure 2. Mean number (± 1 SE) of harbor seals counted at three reefs west of Spider Island during low tides in August, 1992-1997 in Glacier Bay, Alaska. Counts from 1997 were significantly different from those in the previous four years ($P < 0.0001$, Mann-Whitney U test, SPSS).

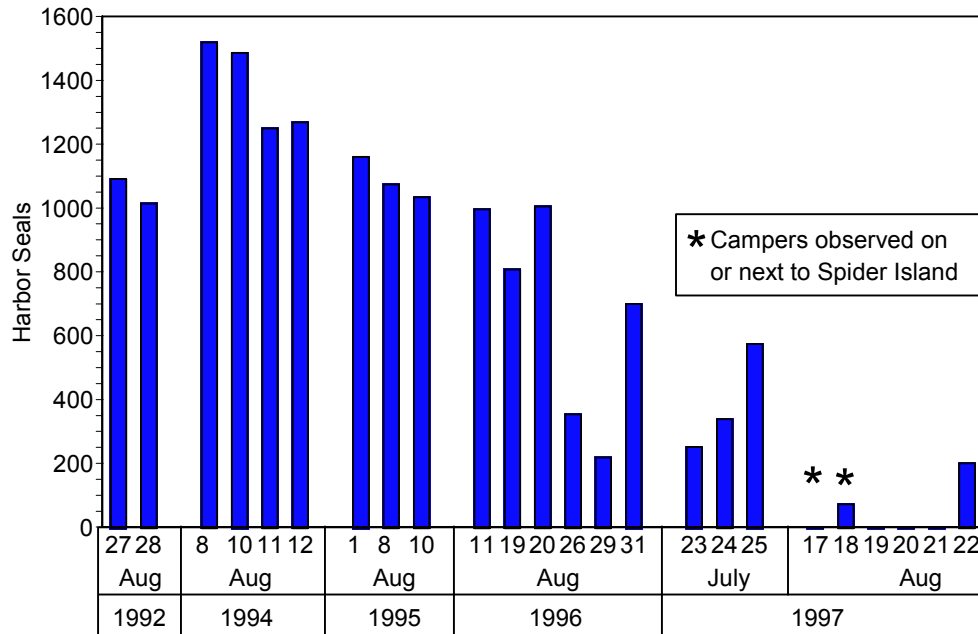


Figure 3. Number of harbor seals counted at the three main reefs west and south of Spider Island, Glacier Bay National Park, during low tide surveys. All August counts are from aerial photographs taken within two hours of low tide; the July, 1997 counts are daily high counts made from land.

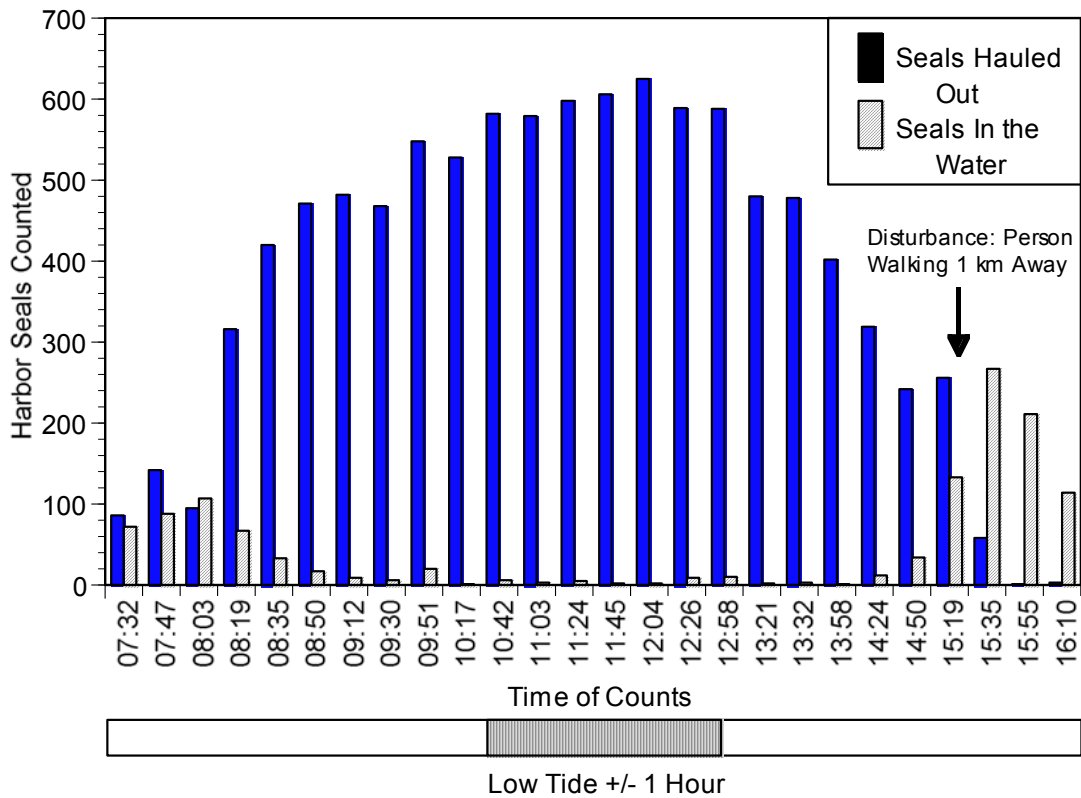


Figure 4. Haulout patterns of harbor seals at reefs west of Spider Island, Glacier Bay National Park on July 24, 1997. The disturbance appeared to be caused by the author walking along a beach 1 km from the seals.

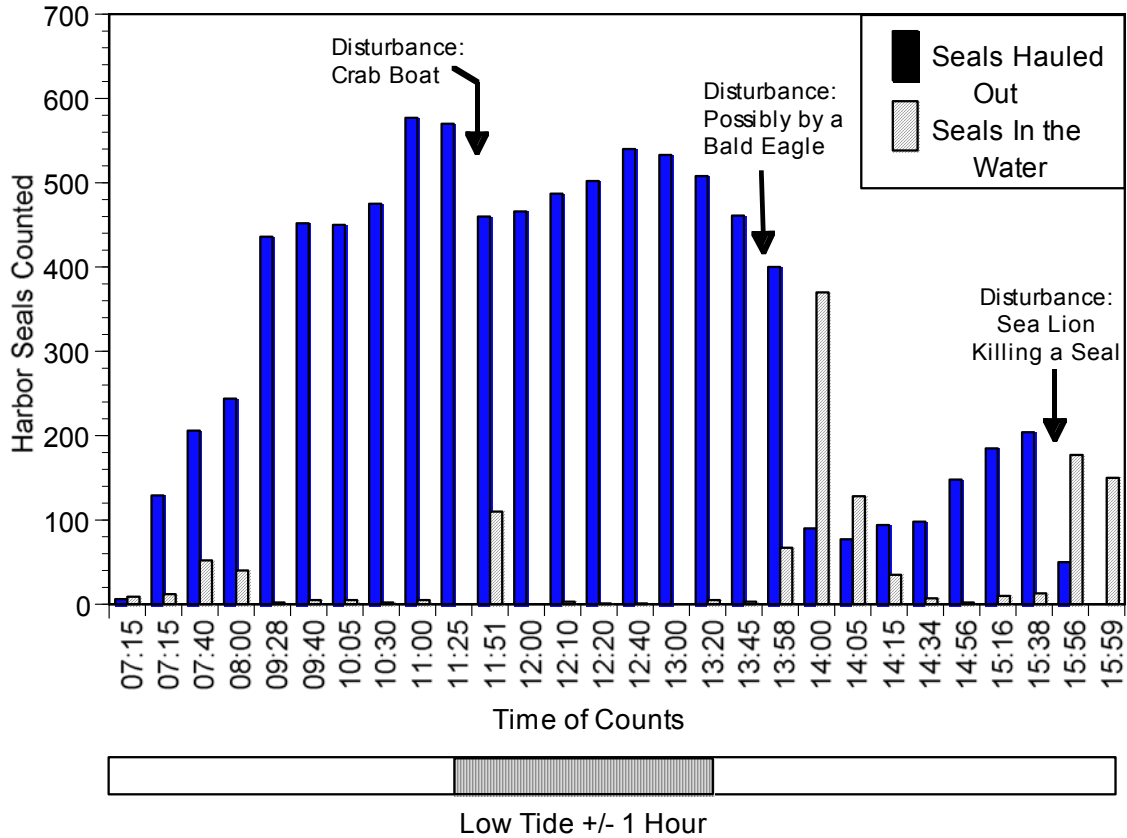


Figure 5. Haulout patterns of harbor seals at reefs west of Spider Island, Glacier Bay National Park on July 25, 1997. Three disturbances were observed: 1) a crab fisherman pulling pots within 100 m of the haulout, 2) a Bald Eagle landing on the haulout, and 3) a Steller sea lion attacking and consuming a small seal near the haulout.

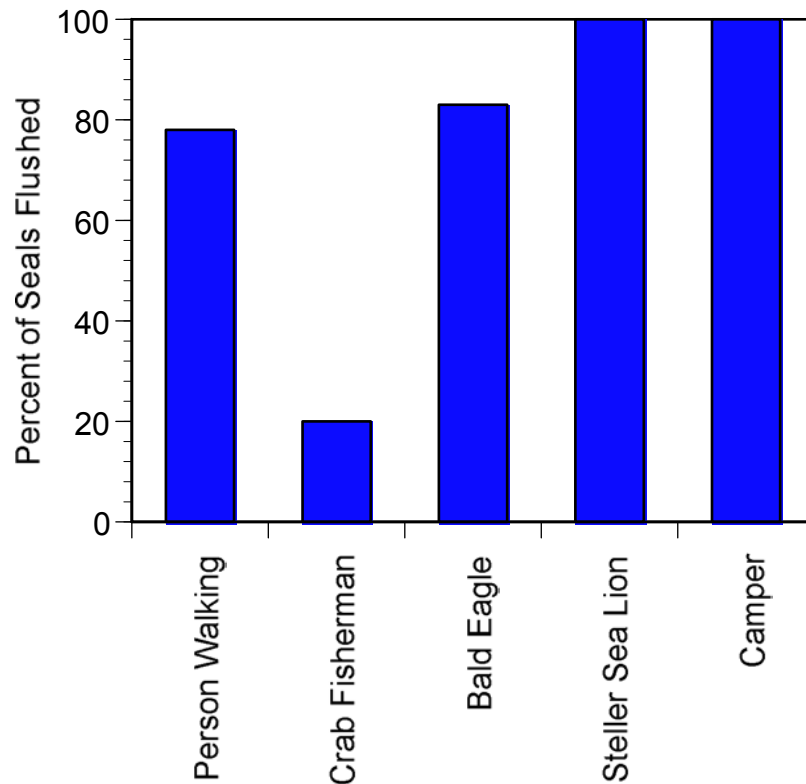


Figure 6. Percent of seals on Spider Island reefs that were flushed into the water during 4 observed disturbances and one inferred disturbance (camper). The initial numbers of seals on shore were 267, 577, 461, and 203, beginning with the person walking on the beach 1 km from the haulouts. The original number of seals on the haulout was not known for the situation involving campers.
