Effects of Human Visitors on the Behavior of Harbor Seals (*Phoca vitulina richardsi*) at McBride Glacier Fjord, Glacier Bay National Park

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INTRODUCTION

Icebergs calved from tidewater glaciers in Glacier Bay, Alaska, serve as haulouts for 5000-8000 harbor seals (*Phoca vitulina richardsi*) during the spring pupping and summer molting seasons (Mathews and Pendleton 1997). Visitors seek these very same locations during the summer tourist season for purposes of experiencing wilderness, taking photographs, and viewing glaciers and wildlife. Harbor seals are most sensitive to human disturbance when hauled out during pupping and molting, and repeated disturbances of hauled out seals increases the chances of mother/pup separations and possibly decreases the overall fitness of individuals (Steveler, 1979; Calambokidis, 1987; Mathews, 1997b). The potential for human disturbance of harbor seals increases as tourism grows in Glacier Bay, part of the Federal National Park Service (NPS).

Harbor seals are protected by the Marine Mammal Protection Act, which prohibits "taking" a marine mammal without a permit. To "take" is defined as to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal…". Harassment is further defined as "negligent or intentional acts which result in disturbing or molesting a marine mammal…" (50 CRF 216.3, MMPA, 1972). The National Marine Fisheries Service clarifies the definition of harassment as any "activity that disrupts the normal movement of a seal or sea lion." An example of disruption of behavior includes "diving or fleeing into the water from a haulout or rookery." In order to reduce harassment, the National Marine Fisheries Service recommends a 100 yard minimum approach distance to seals and sea lions hauled out on land or ice (NMFS, 1992).

Harbor seal numbers at a beach haulout on Tugidak Island in the Gulf of Alaska declined from more than 9,300 to 1,437 seals (an 85% decline) between 1976 and 1988. Similarly alarming declines in numbers of Steller sea lions (*Eumetopias jubatus*) and northern fur seals (*Callorhinus ursinus*) have been documented in the Gulf of Alaska and Bering Sea (Pitcher, 1990). Harbor seal numbers in southeastern Alaska appear stable, and numbers in Johns Hopkins Inlet of Glacier Bay have increased since 1975 (Streveler, 1979; Mathews, 1992; Mathews and Pendleton, 1997), but they appear to have declined by 24-34% between 1992-1998 (Mathews and Pendleton 1999).

The largest aggregation of seals in Glacier Bay is in Johns Hopkins Inlet (Calambokidis et al. 1987; Mathews, 1992; Mathews, 1995; Streveler, 1979) (Figure 1) where 3000-5000 seals haul out on icebergs during pupping and molting seasons. Johns Hopkins Inlet is currently closed to all vessels from May 1 to June 31 to protect seals from human disturbance during the sensitive times of parturition, nursing, weaning and mating (Glacier Bay National Park and Preserve Compendium, May 31, 1994, pp. 9-10). Park regulations also mandate that during July and August vessels within Johns Hopkins

Inlet stay at least ¼ mile away from hauled out seals unless safe navigation is compromised. These NPS regulations are the most restrictive of vessels in the region, and should afford the most protection to harbor seals from human disturbance, if they are widely observed.

Around 1000 harbor seals used ice haulouts from Muir Glacier in Muir Inlet, Glacier Bay (Figure 1) until sometime between 1992 and 1994 when the glacier grounded and no longer produced icebergs (Mathews, 1992). McBride Glacier (Figure 2), now the only tidewater glacier remaining in Muir Inlet, provides ice haulouts to 40-220 harbor seals in a semi-enclosed inlet. Aerial surveys of McBride Inlet for harbor seals have been conducted mainly in August since 1992 (Mathews 1992, 1995, 1997), but no daily monitoring of seal numbers, distribution, or human use had been conducted at McBride Inlet prior to this study. McBride Inlet has a narrow, shallow entrance, so large boats generally cannot enter the inlet. Visitors to the inlet come by kayak, skiff, rubber inflatable, or they may leave their vessels outside the mouth of the inlet and walk in along the north or south shore.

The objectives of this study were:

1) to determine the numbers of harbor seals that use McBride Fjord during the pupping season,
2) to monitor the amount and type of human use in the inlet during this time,
3) to determine if seal behavior was changed by human activities,
4) and to determine visitor compliance with the MMPA harassment regulations and the effectiveness of the NMFS distance recommendations.

METHODS

Study Site

One of us (T. Lewis) conducted research at McBride Glacier Fjord (59 02N, 136 08W), a 1.25 mile long by 0.5 mile wide inlet connecting the tidewater face of McBride Glacier to Muir Inlet in Glacier Bay, Alaska (Figure 2). Harbor seals use the waters in and around McBride Inlet to haul out on icebergs from the calving tidewater glacier. An island reef approximately 1 mile from the glacier face also serves as a haulout for a small number of harbor seals at low tide, although the majority of seals in McBride haul out on drifting icebergs.

I observed seals from an approximately 50 m high knoll located on the south side of the inlet, 1 mile from the glacier face (Figure 2). The observation site afforded a view of the entire inlet, as well the inlet's entrance and into Muir Inlet from approximately 0.5 miles north to 0.5 miles south of the entrance.

Monitoring Seal Behavior

I monitored McBride Inlet between 11 May and 22 June, 1998 for a total of 37 days. Observations usually began between 08:00 and 10:00, and continued until between

16:00 and 18:00, depending on seal numbers, human presence, and weather conditions. I conducted counts of harbor seals in the inlet approximately every 2 hours and instantaneous behavioral scan sampling (Altman, 1974) of hauled out seals three times daily. Swarovski 8x30 binoculars or a Swarovski 30x75 twin spotting telescope were used for all observations.

I began monitoring a human/harbor seal encounter when a person, or group of people, was observed in, or heading towards, the vicinity of harbor seals hauled out on ice or land. On a hand held tape recorder, I recorded the following data: time, estimated distance between human(s) and seal(s), number of seals hauled out per iceberg, number of seals leaving the haul out to enter the water. I also observed and recorded human and harbor seal behaviors. As mother/pup pairs abandoned their ice berg haul outs due to human disturbance, I noted which seal led the abandonment. I later transferred all information to data sheets. Each group of people, monitored for any amount of time, was considered an 'encounter' and given an individual encounter number. Within each encounter, each separate group of hauled out seals was given an individual iceberg number. Monitoring of an encounter ended when the people were no longer in the general vicinity of harbor seals, or when they left the inlet, or when all seals had departed the area.

Estimating Distances

I visually estimated distances between humans and seals in meters, miles or boat lengths. Boat lengths were used if the encounter involved a vessel that was in close enough proximity to the seals that I could estimate the number of boat lengths between them. I recognized the brand of most kayaks and knew their exact length. For those kayak brands I did not recognize, I estimated their length in comparison to known kayaks. I estimated the length of small auxiliary vessels such as Zodiacs and skiffs relative to the size of the people within them. Meters were used if the people were not in a vessel when they were relatively close to the seals. Miles were used if the distance between people and seals was great enough that I could use the dimensions of the inlet and my vantage point above it to estimate distance in 1/12 (440 feet) mile or greater increments. All distance estimates were entered into a database and later converted to yards.

Encounter Type Categories

Human/harbor seal encounters were categorized by the human's method of transportation in the inlet. Groups of people or vessels traveling together were considered a single encounter. Three encounter categories were defined as follows:

Auxiliary power vessels were 12-18 foot skiffs or inflatables with outboard motors that had been launched from a larger private power vessel observed outside the inlet.

Kayak(s) included 15-21 foot single and double kayaks, in group sizes ranging from 1 to 4 vessels carrying 1 to 8 people.

Pedestrians were individuals or groups of people whose interactions with harbor seals occurred while the people were on shore.

Disturbance Variables

I defined human '**disturbance**' as any human activity that appeared to cause seals to abandon their haulout and enter the water.

The disturbance variables that we evaluated were the same as those evaluated in a previous vessel/seal disturbance study conducted in Johns Hopkins (Mathews 1994). These variables include: mean number of seals that entered the water per encounter, mean percent of seals that entered the water per encounter, and mean number of seals that entered the water per hour of monitoring. The disturbance variables were calculated for each encounter type (auxiliary vessel, kayak(s) or pedestrian), as well as for all categories combined. Kruskal Wallis non-parametric statistical analysis was used to test for differences in disturbance between encounter categories. We used a significance level of $p<0.05$.

Observance and Effectiveness of Distance Recommendations

The minimal distance between humans and harbor seals was determined for each encounter to test for observance of the 100 yard minimal approach distance suggested by the National Marine Fisheries Service (1992). We calculated a mean minimal encounter distance for each of the 3 encounter types and a combined total, then we used a Kruskal Wallis test to test for differences in minimal approach distances by encounter type.

The mean maximal distances at which disturbance took place was also calculated for each encounter category, and for all categories combined, to determine the effectiveness of the 100 yard recommended minimum in preventing disturbance. Kruskal-Wallis analysis was applied to test for differences in maximal distances of disturbance by encounter categories.

Human Behavior

Human behavior was recorded at the time of human/seal interactions whenever possible. Human behavior was divided into 4 categories of increasing rank based on our assumptions of their potential effects on seals:

1. Stationary - people not changing location
2. Steady movement – people maintaining a steady course and direction
3. Observing seals – people paying obvious attention to seals, includes pointing, taking photographs, or slowing and stopping to observe seals
4. Talking – people talking or shouting at levels audible to me, and therefore presumably to the nearest seals as well

Because these categories are not mutually exclusive, the most noticeable (higher ranking) human behavior was the one recorded. For example, a person sitting watching seals through binoculars would be considered "observing seals" and a person paddling steadily while singing would be considered "talking". Thus human behavior recorded as "stationary" or "steady movement" can be presumed to not include behaviors of "observing seals" or "talking" within them.

The mean percent of seals disturbed (= number disturbed/total number observed for the category) per human behavior was calculated for each human behavior category.

Percent Changes in Total Counts

We calculated the percent change between each consecutive count during the period of the study when seal pups were present: 25 May- 22 June. We categorized the percent change between seal counts by type of human presence in the inlet between the two counts. The human presence categories were:

1) No humans
2) Pedestrians
3) Vessels (including kayaks and auxiliary vessels)

We used a Kruskal-Wallis statistical analysis to test for differences between human presence categories.

RESULTS

Daily Counts

The number of seals counted in McBride Inlet varied greatly from day to day. Daily peak counts of all seals hauled out and in the water ranged from a low of 3 seals counted on both 16 May and 22 May, 1998, to a high of 92 seals on 20 June, 1998. Pup numbers ranged from 0 on all days prior to 25 May, to a high of 26 pups (out of 92 total) on 20 June, 1998. The highest proportion of pups was 38% (21 pups/ 51 total) observed on 17 June, 1998.

Thirty-six mother and pup pairs were observed leaving their haul out in the presence of humans during the study. In 20 cases the mother led and the pup either immediately followed, or the mother waited for, sniffed noses with, and/or splashed at the pup until the pup followed. Most mother and pup pairs were observed swimming off together after being disturbed, but in one case a pup called repeatedly for almost an hour immediately after and in the same vicinity as an observed disturbance of a mother and pup pair.

On four occassions, the pup left the berg first and the mother immediately followed. In one of these cases, two pups were hauled out with one presumed mother when a disturbance by a human occurred. One pup entered the water first, then the mother left and turned to wait for the other pup who followed immediately. It was not clear which pup belonged to this female. For the remaining 12 mother/pup pairs, I did not observe the sequence for departure.

Disturbance Variables

Twenty-nine encounters between humans and harbor seals were recorded (Table 1). Twenty-seven out of 29 (93%) of these encounters caused an observed disturbance consisting of at least one seal fleeing their haulout.

Table 1: Total numbers of encounters, icebergs monitored, and seals disturbed by encounter category in McBride Inlet, 11 May - 22 June, 1998. People or vessels traveling together were considered a single encounter.

Encounter Category	#Encounters	#Icebergs	#Seals into Water	Total # seals monitored
Auxiliary vessels	5	23	22	42
Kayak(s)	17	59	147	210
Pedestrians	7	12	51	54
TOTAL	29	94	220	301

For all encounter categories combined, the mean number of seals disturbed per encounter was 7.6 (Standard Deviation=7.0, n=29). Kayakers disturbed 8.6 seals per encounter (SD=8.0, n=17), pedestrians disturbed an average of 7.3 seals (SD=6.4, n=7), and auxiliary vessels disturbed 4.4 seals (SD=3.3, n=5) (Figure 3). However, there was no statistical difference in the mean number of seals disturbed by encounter category (p=0.76, H=0.54, Kruskal-Wallis test).

The mean percent of seals disturbed per encounter was 73% (SD=36%, n=29) for all encounter categories. Pedestrians disturbed the highest percent of seals at 95% (SD=13%, n=7). Kayakers disturbed 70% (SD=36%, n=17) and auxiliary vessels disturbed 52% (SD=45%, n=5) of the seals encountered (Figure 4). There was no significant difference between encounter categories (p=0.11, H=4.3, Kruskal-Wallis test).

The average rate of disturbance was 41.4 (SD=53.0, n=29) seals per hour for all encounter categories. Pedestrians had the greatest average rate of disturbance of 84.4 seals per hour (SD=66.8, n=7). Kayakers disturbed 33.5 seals per hour (SD=44.8, n=17), and auxiliary vessels disturbed 7.8 seals per hour (SD=5.3, n=5) (Figure 5). Differences in the 3 encounter category disturbance rates were significant (p=0.02, H=7.7, Kruskal-Wallis test).

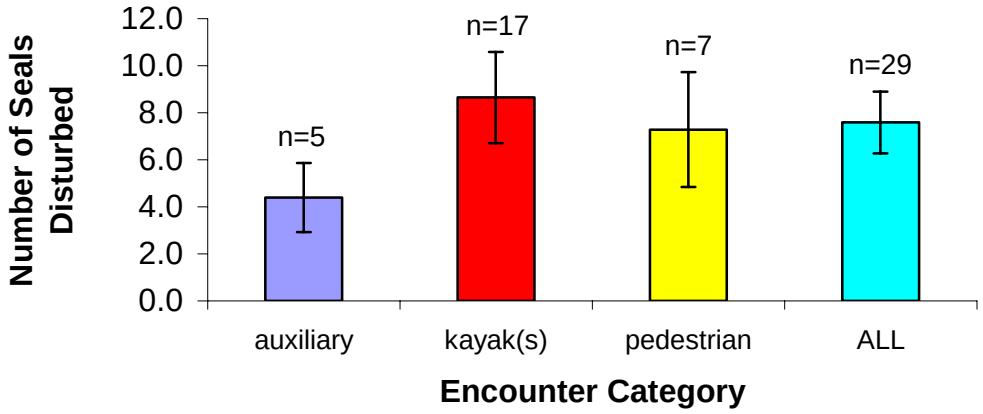

Figure 3. Mean number of seals disturbed by encounter category at McBride Inlet, 11 May–22 June, 1998. We found no difference between the 3 encounter categories (Kruskal-Wallis p=0.76, H=0.54). Error bars are one standard error around the mean.

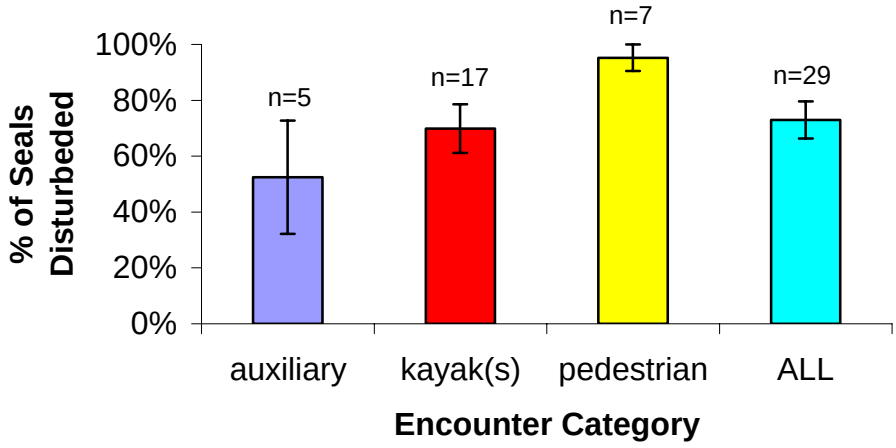

Figure 4: Mean percent of seals disturbed by encounter category at McBride Inlet, 11 May–22 June, 1998. We found no difference between the 3 encounter categories (Kruskal-Wallis p=0.11, H=4.3). Error bars are one standard error around mean.

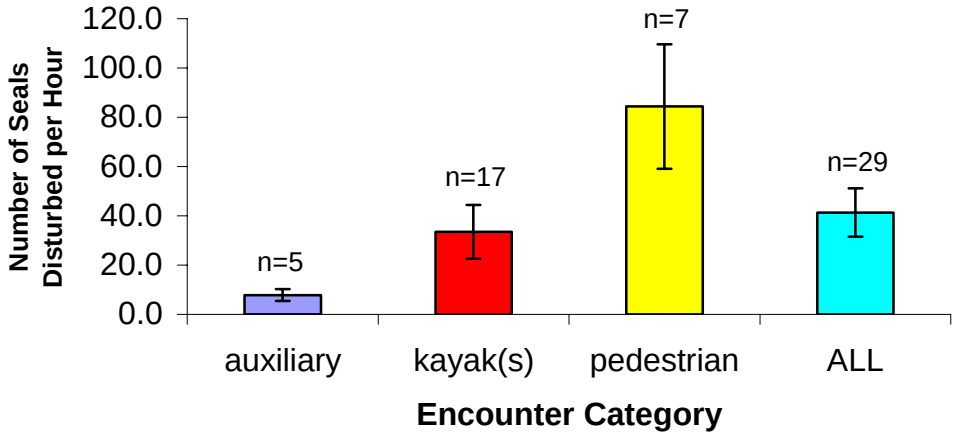

Figure 5: Mean rate of seal disturbance (seals disturbed per hour) by encounter category at McBride Inlet, 11 May–22 June, 1998. Seal disturbance rates were significantly different by encounter category (Kruskal-Wallis p=0.02, H=7.7). Error bars are one standard error around the mean.

Average encounter duration differed only slightly between auxiliary vessels (32 minutes, SD=26, n=5) and kayak(s) (35 minutes, SD=46, n=17), whereas the average encounter duration of pedestrians was lower (9 minutes, SD=9, n=7).

Minimal Approach Distances: Observance of Distance Regulations

In 17 out of the 29 encounters (59%), it appeared that humans approached closer than the recommended 100 yard distance. Four out of the 5 auxiliary vessels (80%) approached closer than 100 yards; one skiff came as close as 20 yards from seals on ice. Ten out of 17 kayaks (59%) approached closer than 100 yards; the closest approach distance for this category was about 50 yards. Three out of 7 pedestrian groups (43%) approached closer than 100 yards; the closest pedestrian approach was approximately 17 yards.

The average minimal approach distance for all encounter categories combined was 124 yards (SD=115, n=29). Auxiliary vessels approached seals to an average distance of 70 yards (SD=74, n=5). Kayakers approached to an average of 131 yards (SD=109, n=17) and pedestrians averaged 147 yards (SD=151, n=7) from hauled out seals (Figure 6). Minimal approach distances were not statistically different for these encounter categories (Kruskal Wallis, p=0.22, H=3.0).

Maximal Distance of Disturbance: Effectiveness of Distance Regulation

The mean of the estimated maximal distances of disturbance for all encounter categories together was 188 yards (SD=128, n=27). Kayakers had the greatest average maximal distance of disturbance (221 yards, SD=127, n=16). The average maximal distance of disturbance for pedestrians was 156 yards (SD=149, n=7) and 115 yards (SD=51, n=4) for people operating motorized vessels (Figure 7). Maximal disturbance distances were not statistically different for the encounter categories (Kruskal-Wallis, p=0.23, H=3.0).

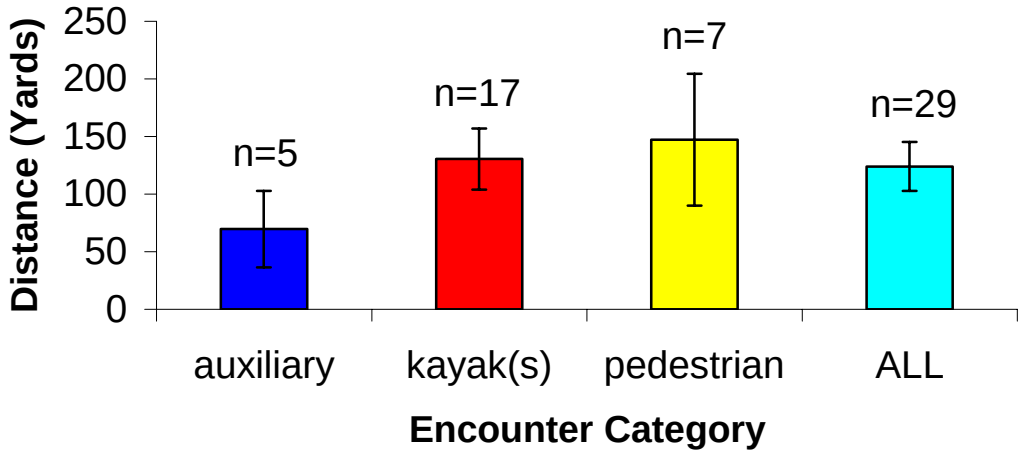

Figure 6. Mean minimal approach distances by encounter category at McBride Inlet, 11 May-22 June, 1998. We found no difference between the 3 encounter categories (Kruskal-Wallis p=0.22, H=3.0). Error bars are one standard error around the mean.

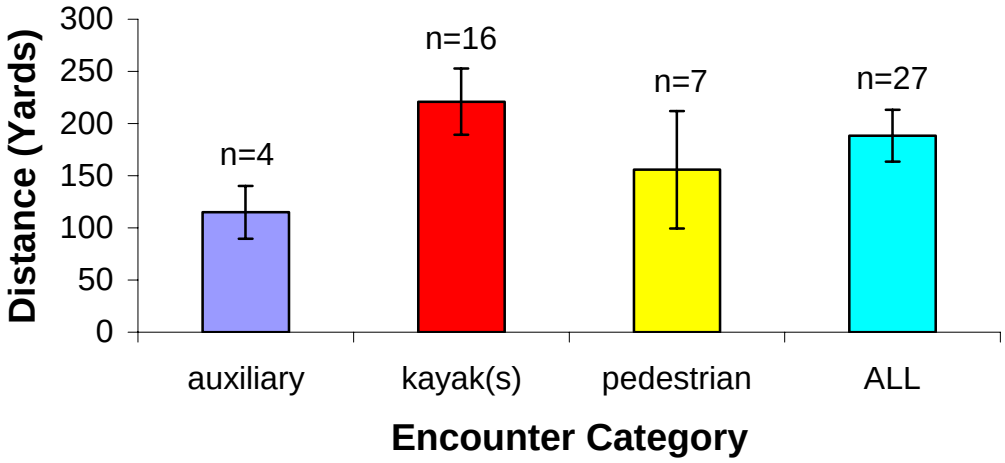

Figure 7. Mean maximal distance at which disturbances were observed by encounter category at McBride Inlet, 11 May-22 June, 1998. We found no difference between the 3 encounter categories (Kruskal-Wallis p=0.23, H=3.0). Error bars are one standard error around the mean.

The closest encounter distance observed between humans and harbor seals was 17 yards at which 2 out of 3 seals (67%) abandoned the iceberg. The greatest encounter distance at which a seal disturbance was observed occurred at 443 yards; 9 out of 10 seals (90%) abandoned the iceberg. Both the closest and farthest cases of observed disturbance involved pedestrians.

Human behavior

People who talked disturbed an average of 41% of the seals observed. People who actively observed seals disturbed 32%, and visitors who moved steadily disturbed 19% of nearby seals. People who remained stationary were the least disruptive to seals; they disturbed only 10% of the seals monitored (Figure 8). We did not test for statistical differences in these variables, but the data suggests that visitors who remain stationary and quiet are less likely to disturb seals.

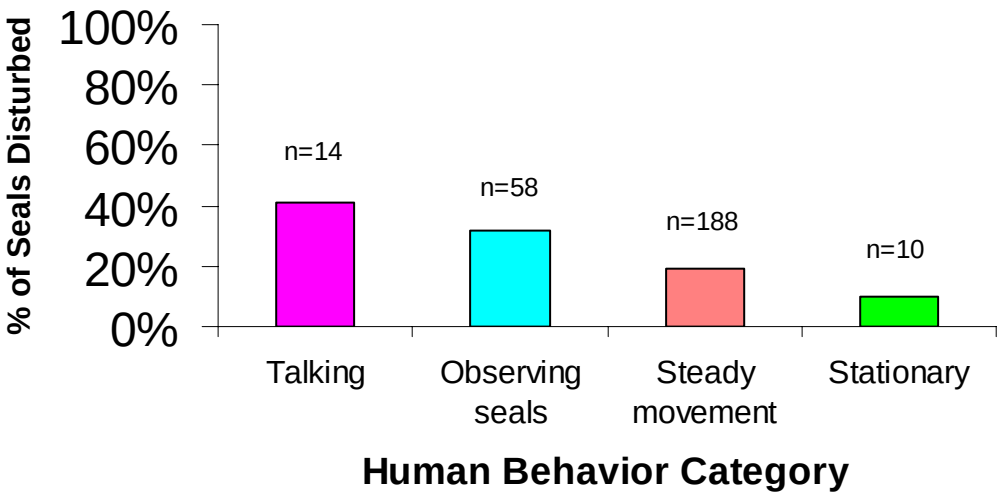

Figure 8. Percent of harbor seals disturbed by human behavior category at McBride Inlet, 11 May-22 June, 1998.

Percent Changes in Total Counts

The mean percent change in total numbers of seals between consecutive counts from 25 May to 22 June, the period when pups were present, was an increase of 13% (SD=65%, n=42) when no humans entered the inlet between counts. When humans were present in the inlet between counts, average seal numbers decreased 22% (SD=10%, n=4) by pedestrians and 42% (SD=37%, n=14) by vessels (Figure 10). Differences between human presence categories were statistically significant (Kruskal Wallis, p=0.002, H=12.9).

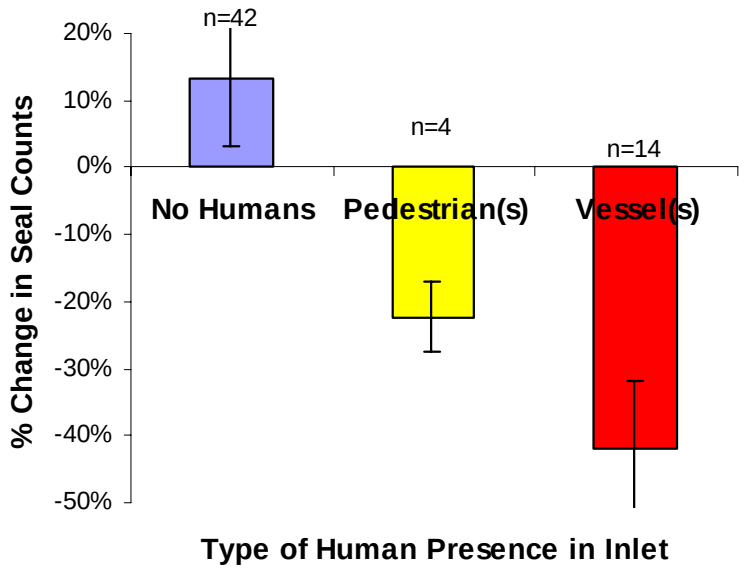

Figure 10: Mean percent change in total numbers of seals between consecutive counts during pupping, by type of human presence in the inlet between counts at McBride Inlet, 25 May-22 June, 1998. Percent change in seal numbers between consecutive counts were significantly different by type of human presence. (Kruskal-Wallis p=0.002, H=12.9) Error bars are one standard error around the mean.

DISCUSSION

Ninety-three percent of the groups of people monitored in McBride Glacier Fjord by boat or land disturbed harbor seals, and many of these disturbances occurred when dependant pups were present. The first seal pup was observed on May 25th and 27 out of the 29 encounters occurred after that date. During pupping, total numbers of seals in the inlet decreased by an average of 42% when a vessel entered the inlet, while seal numbers averaged a 13% increase when no vessels entered the inlet. The high percentage of disturbance (in violation of the Marine Mammal Protection Act, 1972) and potential for increased energetic demands on pups and lactating females indicates that visitor impacts are much greater than previously known, and warrants Glacier Bay National Park Service Resource Management concern and consideration.

On average, 7.6 seals were disturbed per encounter and 73% of monitored seals were disturbed. We detected no statistical difference between auxiliary vessels, kayak(s), or pedestrians for either of these variables. The mean number of seals disturbed per hour, however, was highest when pedestrians were involved .

Strong reaction to potential predatory threats from shore in a population of seals currently utilizing ice haulouts may stem from historic (or concurrent) use of terrestrial haulouts (Streveler, 1979). One female gave birth during the study on the mid-channel reef at McBride and a second female had her pup on an iceberg. The use of the reef for parturition as well as the occasional use of the reef as haulout substrate when exposed at low tide demonstrates the ability of harbor seals in this population to utilize land or ice haulouts, and possibly both.

While their disturbance rate was higher, pedestrians' encounter durations were notably shorter, indicating that pedestrians spent less time in the vicinity of the seals due to their shoreline limitations. Vessels (both motorized and non-motorized) tended to be monitored longer than pedestrians because they were in the general vicinity of seals for a longer time. Because vessels typically moved throughout the inlet, they had a much greater potential to come into contact with seals than pedestrians did. Vessels also had a larger negative effect on seal numbers counted in the inlet.

Auxiliary vessels had a significantly lower rate of disturbance than kayakers. Some possible reasons why kayaks disturbed more seals per hour include: 1) kayakers may tend to "spook" seals more often because there is no acoustic warning, whereas the engine sound of auxiliary outboards alerts seals to their presence, 2) a person in a kayak may resemble a killer whale (*Orcinus orca*), the main predator of harbor seals (Hoover-Miller, 1994), or 3) harbor seals in Glacier Bay may be wary of kayaks from being hunted traditionally from silent, human powered, kayaks or canoes. However, harbor seals are presently hunted in Southeast Alaska (although not in Glacier Bay) from motorized boats.

The majority (59%) of humans entering McBride Fjord either by land or by water did not observe the National Marine Fisheries Service 100 yard minimum approach distance to hauled out seals. Auxiliary vessels were the least likely to observe these recommendations. Four out of 5 auxiliary vessel operators violated the 100-yard minimum.

People may not observe the distance recommendation for one or more of the following reasons: 1) they do not know about the regulation, 2) they do not see the seals, 3) they do not realize how close they are to the seals, or 4) they chose not to observe the recommendation.

All kayakers and at least one person from every power boat that enters Glacier Bay during the summer months is required to attend a backcountry orientation by the Park Service. The orientation is conducted through personal communication, an information packet, as well as videos. Topics include park regulations on marine mammal harassment and low impact wildlife viewing. This orientation presents a large amount of information to boaters at one time, and due to time constraints of either the boaters or the Park Service employees facilitating the orientation, may at times be rushed. It is possible that some boaters are not able to retain all the Park Service information presented at one time, particularly if it is their first time in Glacier Bay and if they are rushed or distracted.

A common scenario which I saw repeatedly was a person or group of people paddling their kayak and not appearing to see a group of seals on an iceberg or a reef until they were within 100 yards because of ice blocking the view or possibly because of their low aspect on the water. When the people finally noticed the seals, they usually stopped to look, point, and/or take a picture. By this time the seals were generally very vigilant, and usually fled from their iceberg.

In five instances (3 kayak, 1 pedestrian and 1 auxiliary), people were observed taking photographs of the seals while closer than 100 yards. In these cases it is obvious that the people saw the seals, but whether or not the people were aware of distance regulations or of how close they were to the seals is unknown. These cases of picture taking suggest a possible motivation for intentionally disregarding the minimum distance regulation for the purpose of obtaining a good photograph.

In one instance, a group of 5 people in 3 kayaks were heard making loud hooting and grunting sounds (presumably a poor imitation of a seal vocalization) while closer than 100 yards to a mother and pup who rapidly vacated their ice haulout. This group spent 45 minutes in the inlet and disturbed 9 mother and pup pairs off of 8 different icebergs throughout the inlet, heading straight for hauled out seals and making noise. This case suggests not only ignorance or disregard for distance recommendations, but also intentional harassment of marine mammals.

The average maximal estimated distance at which disturbance was observed was approximately 190 yards. A study on vessels and harbor seals in Muir Inlet, in which seal to vessel distances were measured with a surveyor's theodolite, found 167 yards to be the average distance at which over half the seals were disturbed by vessels (Calambokidis, *et al.* 1983). These similar results suggest that the 100 yard minimal approach distance recommended by the NMFS is insufficient to prevent human disturbance of seals from their haulouts. Glacier Bay National Park regulations (GBNPP Compendium, 1994) require vessels to remain ¼ mile from seals hauled out on ice in Johns Hopkins Inlet during the August molting time as well as ¼ mile from the land haulout of Spider Island reefs from May 1-August 31. A ¼ mile minimum approach distance at McBride Fjord, if observed, would drastically decrease the disturbance of seals by humans: out of the 220 disturbed seals observed in this study, only 10 were disturbed by people over ¼ mile away. However, maintaining a ¼ mile minimal distance from seals on ice would be difficult to impossible for vessels in McBride Inlet because the inlet is only ½ mile wide in most places and the seals are often spread on icebergs throughout the inlet.

Human behavior seemed to influence the degree of disturbance of seals on haulouts. People's voices alerted seals to their presence and seemed to increase their levels of vigilance and rate of entering the water. People observing seals were more disruptive than those not observing seals, because they tended to attempt to get closer to the seals for viewing or photographing seals, and possibly because their approach or behavior resembled that of a terrestrial or marine predator. People who maintained a steady course either in the water or along the shore were less disruptive to seals if they were quiet and provided they did not approach the seals too close. People who remained stationary and quiet caused the least disturbance, because either they were not noticed by the seals, or if they were, the seals may not have identified them as a threat.

Two disturbances exemplified the effects of humans on shore on hauled out seals. I generally was very quiet and moved slowly and minimally around the 50-meter high site, and I observed no reaction from the seals on icebergs below. On one day, a gust of wind blew my tarp over and I jumped up to grab it. My sudden actions appeared to cause a group of seals on an iceberg within approximately 200 yards of the site to abandon their haulout. Another time a visitor at the site was talking very loudly. During her visit I noticed several seals on bergs within several hundred yards of us entering the water from their haulouts.

Research done in the Gulf of St. Lawrence, Canada, demonstrated that female harp seals (*Phoca groenlandica*) with pups spent significantly more time alert and less time nursing their pups when tourists were present, compared to periods when no tourists were present (Kovacs and Innes, 1989). Our results are consistent with these, although unlike harp seal females who remain on the ice until their pups are weaned, harbor seal females often respond to disturbance by entering the water. This behavioral difference means that the energetic costs of human disturbance to harbor seals, particularly to pups, is potentially greater than that to harp seals.

Harbor seal mothers and pups are susceptible to becoming separated when disturbed suddenly from a haulout, and if they remain separated, the pups will most likely starve (Streveler, 1979) unless they happen to be close to weaning. Mother seals and their pups were disturbed quite often at McBride Inlet as numbers of human visitors along with numbers of newborn pups increased during June. Thirty-six mother-pup pairs were disturbed during this time with one possible separation occurring on June 16. Two adult seals and one pup were hauled out on a berg near the north entrance to the inlet when two people on shore walked over a slight rise and into view of the seals. They continued to walk directly toward the water, until they were about 20 yards from the seals. At this point, they began to take pictures. The two adult seals dove immediately into the water, neither appeared to wait for the pup. The pup dove into the water after several seconds and disappeared from view. Within five minutes a lone pup was observed vocalizing and swimming in a circular pattern in the area of the disturbance. I did not see the pup reunite with an adult, but the vocalizations stopped after an hour.

The small size of McBride Inlet and low density of seals relative to Johns Hopkins Inlet, a glacier fjord in Glacier Bay where 3,000-5,000 harbor seals rest and breed, has possible advantages and disadvantages in terms of human disturbance and mother-pup separations. Because of low ice and seal densities and because the fjord is short with a very narrow mouth, it seems that separated mothers and pups should be able to find one another provided they both remain in the inlet and continue searching. It is unknown how long a mother seal will search for a missing pup or how long a pup can survive alone if it is not ready to be weaned. A disadvantage of the small size of the inlet is that the likelihood of a mother and a pup being disturbed in the first place are greater than in a larger inlet, such as Johns Hopkins Inlet, because of the small surface area of water that seals and vessels must share.

The small size of the inlet and smaller numbers of seals (compared to Johns Hopkins Inlet), may also increase the likelihood of the same animals being repeatedly disturbed over the course of the pupping season, due to almost daily visitation (sometimes several per day) by people in vessels who can easily cover the entire inlet in less than an hour. It is not known what effect repeated disturbance might have on the reproductive fitness of harbor seals, but it is presumably detrimental due to reduced time for nursing and resting and increased caloric demands on both mothers and pups.

Kayakers had the most detrimental effect on harbor seal counts at McBride Fjord. For example, on 26 June, one double kayak disturbed 21of the 21 (100%) seals the vessel was observed passing in 9 minutes. The total count of seals in McBride Inlet before and after this vessel's visit decreased from 44 to 4 (91%). Drastic decreases in counts were common when several kayakers were moving through the inlet at once but not in close proximity to each other, as was often the case. These groups tended to clear many seals from the ice because they covered a large area of the inlet, and talked and shouted loudly among themselves from great distances. In contrast, two groups of 4 kayaks each guided by Alaska Discovery (the Glacier Bay National Park kayaking concessionaire) stayed close to each other, avoided areas of ice and hauled out seals, and traveled quietly through the inlet. These two encounters caused minimal disturbance to the seals on ice at the time, (although in one instance one group of seals was disturbed when the Alaska

Discovery group quietly approached, apparently unaware of the seals). A similar effect was observed when kayakers grouped together by holding onto adjacent boats and then approached Steller sea lions on a haulout by drifting on tidal currents, without paddling (Mathews 1997).

Although less commonly observed than kayakers or pedestrians, auxiliary vessels also have a great potential for clearing large numbers of seals from the ice. On 14 June, one inflatable auxiliary vessel moved slowly throughout the majority of the inlet, often approaching seals on ice to take pictures. Nine of the 41 (22%) seals the vessel was observed passing were disturbed. The total count of seals in McBride Inlet before and after this vessel's visit decreased from 51 to 25 (49%).

Pedestrians disturbed high numbers of seals per hour when they approached hauled out seals, but they spent much less time near seals compared to vessels. Pedestrians caused an average decrease of 22% in seal numbers, much less than that of vessels, probably due to pedestrians' shoreline limitations.

Conclusions

1) Humans visited McBride Inlet on 20 of the 37 (54%) days studied. Harbor seals were disturbed on 18 of these 20 (90%) visitor use days and 15 out of 18 (83%) of these disturbances occurred after the first pup was observed in the inlet.

2) The time of parturition, nursing, weaning and mating is critical for the reproductive success of harbor seal populations

3) Repeated disturbance of harbor seals during the pupping and nursing periods in McBride Inlet indicates that current levels of visitor education and/or enforcement by the NPS are inadequate for preventing disturbances and that a majority of visitors to the inlet are violating the MMPA.

4) Most visitors monitored in McBride Inlet (93%) disturbed hauled out seals; kayakers disturbed the largest number of seals overall.

5) The average number of seals disturbed was 7.6 per encounter. The average percent disturbance was 73% per encounter. The average rate of disturbance was 41.4 seals per hour and pedestrians had the highest disturbance rate (84.4 seals/hr).

6) The numbers of visitors to McBride Inlet are likely to increase, considering that Glacier Bay National Park is increasing in popularity and McBride Glacier is the only tidewater glacier left in Muir Inlet. There are currently no restrictions on numbers of visitors to McBride Inlet, nor are there any seasonal closures of this inlet.

7) Despite educational programs by Glacier Bay National Park Visitor Center and kayak rental and guiding concessionaires, the majority (59%) of visitors do not comply with the NMFS's 100 yard minimum approach distance to hauled out seals, and in many

cases the 100 yard minimum distance is insufficient to prevent behavioral disturbances to seals.

8) The NMFS is concerned with and responsible for upholding the Marine Mammal Protection Act's prohibition of marine mammal harassment and the NPS is mandated to uphold federal regulations. Yet there is no known enforcement of these regulations designed to minimize disturbance by either the NPS or the NMFS. At McBride Inlet, the MMPA was violated in 27 out of the 29 encounters observed.

9) The NPS's ¼ mile minimum approach distance for harbor seals hauled out on ice in Johns Hopkins Inlet during molting could not be realistically maintained by vessels entering a fjord ½ mile wide with seals on ice spread throughout the inlet.

Recommendations

We recommend that McBride Glacier Fjord be closed to all vessel traffic from 15 May through 31 June. The time between parturition and weaning for harbor seals lasts 3-6 weeks (Hoover-Miller, 1994). I saw the first and second pups at McBride on 25 May and 31 May, and I documented an increase in pup numbers until 20 June. A six-week closure from 15 May – 31 June would protect the majority of the newborn pups and their mothers from potentially detrimental disturbances.

We suggest that visitors be allowed to leave their vessels at the mouth of the inlet and walk in along the south shore to view the glacier for these reasons:

1) McBride Glacier is the only remaining tidewater glacier in the East Arm of Glacier Bay and most visitors of Glacier Bay National Park seek views of tidewater glaciers.

2) While pedestrians can disturb harbor seals, their limited access to seals on ice and restricting them to the south shore should keep disturbance levels at a minimum while allowing access to the inlet.

3) Fewer seals haul out on ice along the south shore of McBride Inlet than on ice along the north shore.

During this study, the northern shoreline of McBride Inlet tended to have more ice used by seals near it for longer periods of time than the southern shoreline. We believe that this is the prevailing pattern because wind off the glacier regularly blows to the west, and a rocky outcropping on the north shore near the face of the glacier protects the eastern half of the north shoreline from this wind (Figure 2). Seals tended to be able to haul out for the longest amount of time along the north shore, and thus, seal density was usually greatest in this area of the inlet. The northern shoreline is also quite steep, forcing people to walk close to the water, and increasing the likelihood of seal disturbance. The south shore has shallow sloping wider beaches. In addition, there is a

large colony of arctic terns (*Sterna paradisaea*) on the north spit of the entrance of McBride Inlet that should be avoided by pedestrians during nesting season.

Visitors wanting to visit McBride Inlet and view the glacier on foot should be advised to walk in along the south shore and stay as far inland as possible when seals on ice are close to that shore. The ice along the western half of the southern shoreline of McBride is rarely suitable as haulout substrate, due to the close proximity to the mouth of the inlet and the strong tidal currents that occur there. I rarely saw seals hauled out in this area and documented only one human disturbance there. At low tide, however, seals did haul out on the center reef which is exposed for 1-2 hours per tide cycle, and these animals are at risk of being disturbed from people on either shore due to the narrowness of the inlet. People should be advised to watch for seals and move slowly and quietly if they see seals nearby. The observation site used for this study is an excellent platform for viewing the glacier and seals on the ice with minimal disturbance. Mew Gulls (*Larus canus*) nest along the south shore of McBride and this impact should be considered, but I saw no sign of Arctic Terns nesting on the south spit as had been previously thought. There is ample camping along the south shore and people can walk to within ½ mile of the glacier face with little effort.

Finally, we strongly support continuing expansion of visitor education programs, particularly concerning low impact/non-disruptive wildlife viewing. Visitors to McBride Inlet, by vessel or on shore, should be informed on harbor seal pupping and molting times, and the importance of not disturbing seals on ice haulouts during these times. Large groups of pedestrians or kayakers should be encouraged to stay together when traveling in the inlet, and visitors should be encouraged to continually look for seals on ice. If seals are present, people need to stay as far as possible from them and remain as still and quiet as possible.

Further monitoring of seals and visitors at McBride Inlet is crucial to test the effectiveness of current visitor education programs on minimizing seal disturbance, particularly during the early summer pupping and August molting seasons. Monitoring of seal and human behavior during set periods when amplified visitor education was implemented (=experimental periods) could be compared to periods when normal (historic) levels of visitor education (=control) were applied. One or two week blocks of ‘experimental’ and ‘control’ periods could be alternated randomly such that the field observers did not know when ‘control’ or ‘experimental’ sessions were in effect. This approach should control for any observer bias.

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LITERATURE CITED

Altmann, J. 1974. Observational study of behavior: sampling methods. Behaviour 49:227-265.

Calambokidis, J., G.T. Steiger and L.E. Healey. 1983 Behavior of harbor seals and their reaction to vessels in Muir Inlet, Glacier Bay, Alaska. 5th Biennial Conference on the Biology of Marine Mammals, Boston, MA, 10 pp.

Calambokidis, J., G.T. Steiger and L.E. Healey. 1985 Reactions of harbor seals (*Phoca vitulina*) to boats in Glacier Bay, Alaska. (unpublished)

Calambokidis, J., B.L. Taylor, S.D. Carter, G.H. Steiger, P.K. Dawson, and L.D. Antrim, 1987. Distribution and haul-out behavior of harbor seals in Glacier Bay, Alaska. Canadian Journal of Zoology 65, 1391-1396.

Glacier Bay National Park and Preserve Compendium. May 31, 1994. pp. 9-10.

Hoover-Miller, A. 1994. "Harbor seal (*Phoca vitulina*) biology and management in Alaska." Marine Mammal Commission, 1825 Connecticut Avenue, N.W. Washington, D.C. 20009

Kovacs, K.M. and S. Innes. 1990. The impact of tourism on harp seals (*Phoca groenlandica*) in the Gulf of St. Lawrence, Canada. Applied Animal Behavior 26(1990), 15-26.

Marine Mammal Commision. 1997. Annual Report to Congress. 4340 East-West Highway, Room 905, Bethesda, Maryland 20814.

Mathews, E.A. 1992. Harbor seal (*Phoca vitulina*) censuses in Glacier Bay National Park and Preserve:a comparison of land-based and aerial censusing. NMFS, NMML and U.S. National Park Service, Glacier Bay National Park and Preserve, Seattle, WA.

Mathews, E.A. 1994. The effects of seismic reflection surveys and vessel traffic on harbor seals in Johns Hopkins Inlet, Glacier Bay National Park: A preliminary assessment. Glacier Bay National Park Service, Gustavus, AK.

Mathews, E.A. 1995. Long-term trends in abundance of harbor seals (*Phoca vitulina richardsi*) and development of monitoring methods in Glacier Bay National Park, Southeast Alaska. Third Glacier Bay Science Symposium, D.R. Engstrom, ed., U.S. National Park Service, Glacier Bay National Park and Preserve, AK, 254-263.

Mathews, E.A. 1997a. Effects of vessel traffic on the behavior of Steller sea lions (*Eumetopias jubatus*) at a haulout in Glacier Bay National Park. Glacier Bay National Park, Gustavus, AK.

Mathews, E.A. 1997b. Preliminary assessment of harbor seal haulout behavior and sources of disturbance at the Spider Island Reefs in Glacier Bay National Park. Glacier Bay National Park, Gustavus, Alaska, 99826.

Mathews, E.A. and G.W. Pendleton 1997. Estimation of trends in abundance of harbor seals at terrestrial and glacial haulouts in Glacier Bay National Park, Southeast Alaska, 1975-1996. Harbor Seal Investigations in Alaska, Annual Report, R.J. Small, ed. ADF&G, NOAA Grant NA57FX0367

Mathews, E.A. and G.W. Pendleton 1999. Declining trends in Harbor Seals at Glacial Ice and Terrestrial Haulouts in Glacier Bay National Park, 1992-1999. Abstract from: 13th Biennial Conference on the Biology of Marine Mammals, Maui, HI. p. 117.

National Marine Fisheries Service. 1992. Marine Mammal Protection Act of 1972: Annual Report: July 1, 1988 to Dec. 31, 1989." U.S. Dept. of Commerce, NOAA, NMFS.

Pitcher, K.W. 1990. Major decline in the number of seals, *Phoca vitulina richsrdsi*, on Tugidak Island, Gulf of Alaska. Marine Mammal Science 6(2):121-134.

Streveler, G.P. 1979. Distribution, population ecology, and impact susceptibility of the harbor seal in Glacier Bay, Alaska. Final Report to the U.S. National Park Service, Juneau, AK. (Glacier Bay National Park and Preserve, Gustavus, AK 99826), 49 pp.