

SEALS

SANCTUARY EDUCATION

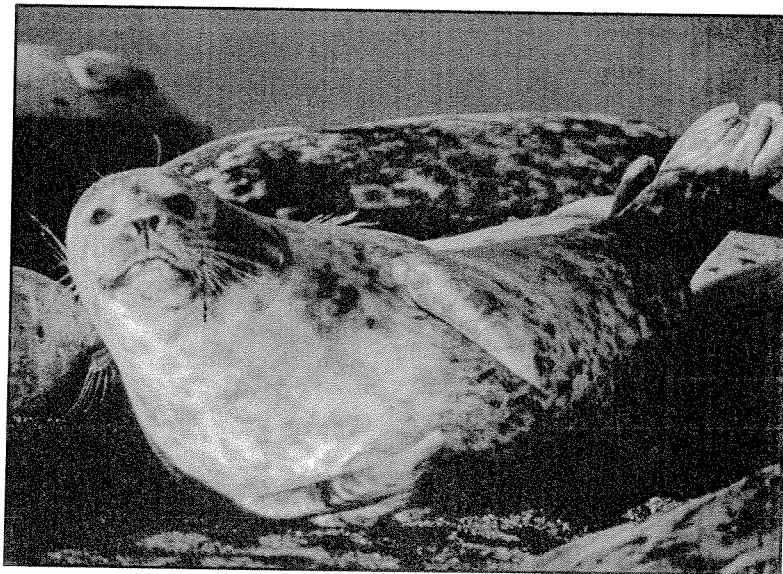
AWARENESS AND LONG-TERM STEWARDSHIP

ANNUAL REPORT

JULY 1999 – JUNE 2000

by

Joseph Mortenson, Maria Brown, Jan Roletto,
Leslie Grella, and Leah Culp



San Francisco, CA
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EXECUTIVE SUMMARY

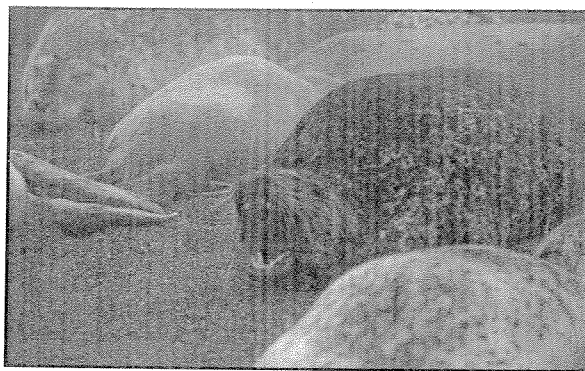
In 1996, the Farallones Marine Sanctuary Association (FMSA) in collaboration with the Gulf of the Farallones National Marine Sanctuary (GFNMS) started SEALS, a harbor seal monitoring and interpretation program along the central California coast. The SEALS program was developed to respond to high levels of disturbance to harbor seals and strives to achieve the following goals:

- Minimize disturbance to harbor seals and help maintain the integrity of rookery sites in the Gulf of the Farallones National Marine Sanctuary;
- Preserve the harbor seal colony size in the Gulf of the Farallones National Marine Sanctuary;
- Increase stewardship in the Gulf of the Farallones National Marine Sanctuary;
- Educate the general public about harbor seals and their habitat in the Gulf of the Farallones National Marine Sanctuary.

In order to achieve these goals, FMSA and GFNMS train local citizens to interpret and monitor harbor seals. SEALS volunteers complete an intensive 33 hour training course on harbor seal natural history, bay and lagoon ecology, interpretation and monitoring techniques, research protocols, and the history of the GFNMS.

From February 1997 to June 2000 in Marin County, California, FMSA has managed a harbor seal interpretation site on Clam and Seal Islands in Tomales Bay and two harbor seal monitoring sites, one on the east shore of Bolinas Lagoon and the other on the cliffs of Tomales Point overlooking Clam and Seal Islands. Volunteers with staff supervision conducted the interpretation and monitoring.

In 1998, 1999, and 2000 GFNMS coordinated a central California seal census, and FMSA collated, entered, and analyzed the data. Volunteers from Point Reyes National Seashore (PRNS),



Harbor seals (*P. vitulina*) hauled out in the GFNMS.



SEALS volunteers learn about tidal ecosystems.



Children watch harbor seals (*P. vitulina*) with SEALS staff.

Golden Gate National Recreation Area (GGNRA), GFNMS, FMSA, Seal Watch Jenner, and Seal Watch Sea Ranch simultaneously counted seals at a number of haul-outs from the southern border of San Mateo County to the northern border of Sonoma County.

TOMALES BAY, CLAM & SEAL ISLANDS HAUL-OUTS

The objective of establishing interpretation sites on Clam and Seal Islands was to reduce the number of disturbances to pupping harbor seals from clammers (clam diggers). During previous harbor seal studies in the PRNS area it was found that the seals on Clam and Seal Islands were disturbed on 81% of the observation days—almost double the percent noted a decade earlier. Clammers and fishers were associated with 51% of the disturbances (Allen and King 1992). Overall, humans were associated with 1.33 disturbances per hour in 1991, which was the highest rate of disturbance ever reported on the West Coast (Mortenson, 1996).

During the 2000 pupping season, teams of SEALS docents spent 89 volunteer hours on the Islands. The objective of establishing a monitoring program on the Tomales Point cliffs above Clam and Seal Islands was to measure the effectiveness of docents and the visible buffer at the seal haul-outs. During the 2000 monitoring season, the maximum number of seals recorded by Tomales Point observers was 462 in May compared to the 1999 maximum of 397 seals and to the 1998 maximum of 493 seals. The maximum number of pups recorded was 81 in May 2000 compared to 87 pups in 1999 and to 27 pups in 1998.

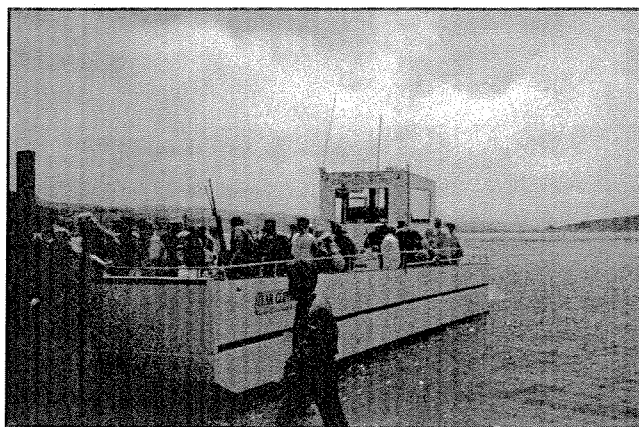
There was 161% more activity on the Islands during the 2000 monitoring season compared to the 1999 monitoring season (53.15 activities/hour in 2000, 20.33 activities/hour in 1999, 93.48 activities/hour during 1998). The increase in activities represented continued changes in Tomales Bay user patterns following the 1999 cancellation of the *CLAM CLIPPER*, a specialized vessel that traditionally transported clammers to and from the Islands. More people operated motorboats in the Bay in 2000 compared to the previous monitoring

years. The observation rate for motorboats seen in the Bay nearly doubled in the 2000 monitoring season (13.71 motorboats/hour in 2000, 6.79 motorboats/hour in 1999, and 7.36 motorboats/hour in 1998). The frequency of clambers in 2000 increased 230% (38.49 clambers/hour) from 1999 (11.65 clambers/hour), when the *CLAM CLIPPER* first stopped operating. However, the frequency of clambers per hour in 2000 was still less than the frequency in 1998, the last year the *CLAM CLIPPER* operated (83.53 clambers/hour). The number of flushes per hour rose 191% in the 2000 season (1.72 flushes/hour in 2000, 0.90/hour in 1999, 0.70/hour in 1998).

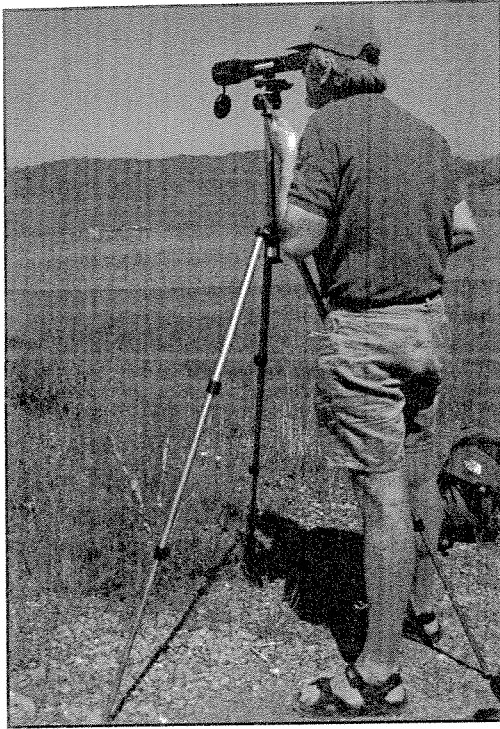
Some key results regarding harbor seal flushes remained constant over the three years. Despite the variation in their numbers, clambers were still the most frequent activity in 2000, yet they retained a low flush rate—less than 1% of clambers were associated with flushes in each monitoring season. Motorboats were the leading activity associated with flushes all three years (1.24 flushes/hour in 2000, 0.24 flushes/hour in 1999, 0.28 flushes/hour in 1998).

During 1999, a PRNS enforcement boat patrolled Tomales Bay, which may have reduced disturbance rates from motorboats that year. Park rangers often approached violators of the Marine Mammal Protection Act, issued warnings or citations, and encouraged boaters to be more cautious around the harbor seal haul-outs. During 2000, the boat was in dry dock until the end of the clamming season; the reduced presence of wildlife enforcement may have been a factor in the increased rate of disturbance observed.

When human related activities were analyzed separately, the flush rate for 2000 was 1.51 flushes/hour, compared to 0.53 flushes/hour in 1999 and 0.62 flushes/hour in 1998. The flush rates associated with human activities during both 1998 and 1999 were much lower than the rate (1.33 flushes/hour) reported by Allen and King in 1991, but the 2000 flush rate exceeded this value. The decommissioning of the *CLAM CLIPPER* may have caused an increase in motor vessel traffic and related harbor seal disturbances in Tomales Bay.



Prior to 1999, the *CLAM CLIPPER* transported clambers to Clam and Seal Islands.



SEALS volunteer counts harbor seals (*P. vitulina*) on Channel haul-out in Bolinas Lagoon.

The objectives of the Bolinas Lagoon monitoring program were to determine what activities are associated with harbor seal disturbances, to determine if the rate of disturbance is increasing, and to monitor harbor seal population changes. In 1978 and 1979, Allen et al. (1984) found that harbor seals were flushed 0.09 times/hour at Kent Island and 0.05 times/hour at Pickleweed mudflat in Bolinas Lagoon. In 1992, Morgan and Swift observed 0.41 flushes/hour on Kent and Pickleweed mudflat combined.

In Bolinas Lagoon, SEALS observation teams monitored Pickleweed and Channel mudflats year-round. The observation teams conducted 60 baseline studies in 2000. The seals were monitored during three-hour shifts from either 1000 to 1300 hours or from 1300 to 1600 hours. Observation teams also surveyed and mapped the distribution of seals throughout the entire Lagoon once each shift.

During the monitoring year from July 1999 to June 2000, the highest monthly mean number of seals recorded in the Lagoon was 169 (maximum 234) in July 1999 compared to the previous monitoring year's maximum monthly mean of 128 (maximum 235) during July 1998 and 152 (maximum 212) during July 1997. The lowest monthly mean number of seals recorded in the Lagoon was 24 during December 1999, compared to 14 during December 1998 and 9 during December 1997. The highest mean number of pups recorded was 26 during April 2000 compared to 22 during May 1999 and to 19 during April 1998.

Observers recorded 15 different activities over 163 observation hours. The most numerous activities were roadside visitors to the Lagoon (2,321) followed by shoreside hikers (366). The roadside visitors were associated with no flushes; the hikers, who tended to stay longer, were associated with three flushes (0.02 flushes/hour). Out of nine canoes recorded, four were associated with harbor seals flushing into the water (0.03 flushes/hour). Out of eight kayaks recorded near the haul-outs, one was associated with seals flushing into the water (0.01 flushes/hour). The rate of flushes

per hour associated with the relatively few water-borne human activities (0.03 flushes/hour) was higher than the rate for the far more numerous land based hikers and roadside visitors (0.02 flushes/hour).

Harbor seals were flushed at a rate of 0.09 per hour in the 1999/00 monitoring season, 0.14 per hour during the 1998/99 monitoring season, and 0.19 per hour during the 1997/98 monitoring season at Pickleweed and Channel mudflats. This disturbance rate cannot be directly compared to the 0.41 flush rate of Morgan and Swift's 1992 study because the current observation sites do not include the Kent Island haul-out. However, the flush rate for 2000 seems relatively low compared to Morgan and King's flush rate.

CENTRAL CALIFORNIA HARBOR SEAL CENSUS

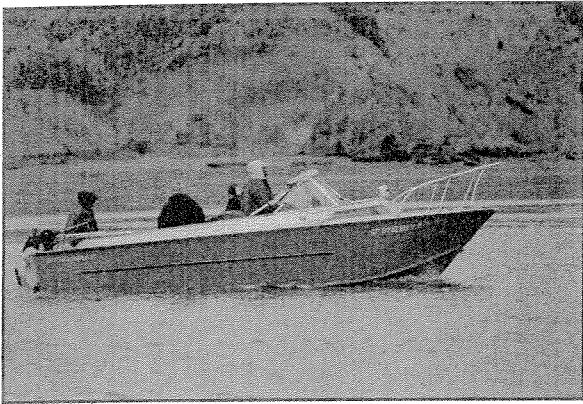
The objectives of the Central California Harbor Seal Census were to ascertain and detect changes in overall harbor seal numbers and to gauge reproductive success at different types of haul-outs along the coast. The 2000 census included haul-outs from the southern border of San Mateo County to the northern border of Sonoma County, and added new sites in the GGNRA and northern San Francisco Bay. There was no evidence for substantial changes in seal numbers in central California, although the size of haul-outs varied across the region.

BOATER EDUCATION CAMPAIGN

The information collected from the SEALS program has been used to develop educational materials for kayakers and boaters. FMSA in cooperation with the GFNMS, Marin County Open Space District, Sierra Club, California Department of Fish and Game, and Bay Area Sea Kayakers has developed a Paddler's Etiquette placard that outlines responsible wildlife viewing guidelines. Our goal is to have the placard distributed with all kayaks sold. FMSA is also working with kayaking outfitters and recreational groups to spread the



Sign on Bolinas Lagoon advising boaters to use a different launch site and to be cautious around resting harbor seals (*P. vitulina*).



Motorboat drives around Clam and Seal Islands in Tomales Bay.

FMSA's new challenge is to reduce the rate of disturbance to harbor seals from motorboats. FMSA will be forming a committee to develop a plan on how to address the increase in disturbance from motorboats. Data collected from the SEALS program will be used to evaluate the effectiveness of FMSA's educational materials and programs.

FUTURE PROJECTS

In July 2000, FMSA expanded the SEALS program to Kent Island in Bolinas Lagoon. Volunteers will monitor harbor seal behavior and human activities around the Island. This information will provide a clearer picture of human activities and harbor seal disturbances in the Lagoon. FMSA can then compare the present harbor seal disturbance rate to past studies and evaluate if the rate is increasing or decreasing.

FMSA has been asked by the GGNRA and the Marin Headlands Institute to help address harbor seal disturbance at Point Bonita in the Marin Headlands. FMSA will work with the Park and the Institute to develop a harbor seal monitoring program for students. We believe that through education people will begin to make the connection between their actions and a healthy, thriving marine environment.

INTRODUCTION

THE PROBLEM: HIGH LEVELS OF DISTURBANCE

The Gulf of the Farallones National Marine Sanctuary (GFNMS) was established to provide a secure habitat for marine species. The Sanctuary encompasses 949 square nautical miles of water off the California coast west of San Francisco (Figure 1).

In the GFNMS, Point Reyes National Seashore (PRNS) and the Sonoma coast state beaches, there is a long history of concern that humans are disturbing resting harbor seals (Allen, Ainley and Page, 1984). When the number of flushes per hour was compared for haul-outs on the North American west coast (Mortenson, 1996), observations at Tomales Bay, Bolinas Lagoon, and the Russian River spits showed the highest rates of disturbance.

In California, the human population is projected to nearly double from 1990 to the year 2040 (Heim, 1998, Figure 2), and recreational use of the coast is anticipated to steadily and substantially increase. With the growing number of Californians, how much disturbance can harbor seals tolerate along the shoreline, especially at heavily visited haul-outs? How can recreational use be managed so that people and seals can share the coast?

The conflict between increased recreational use of the coast and undisturbed resting areas for wildlife is worldwide. Already half the people in the country and the world (Weber, 1994) live along the coasts. By 2050 it is projected that more than 70% of the nearly 400 million Americans (U.S. Bureau of the Census, 1995) will live near the ocean. How will coastal species tolerate the millions of new shoreline dwellers? Perhaps successful programs to conserve seal colonies can help guide us in protecting all coastal species in the future.

THE SOLUTION: SEALS

In 1996, the Farallones Marine Sanctuary Association (FMSA) initiated a harbor seal advi-

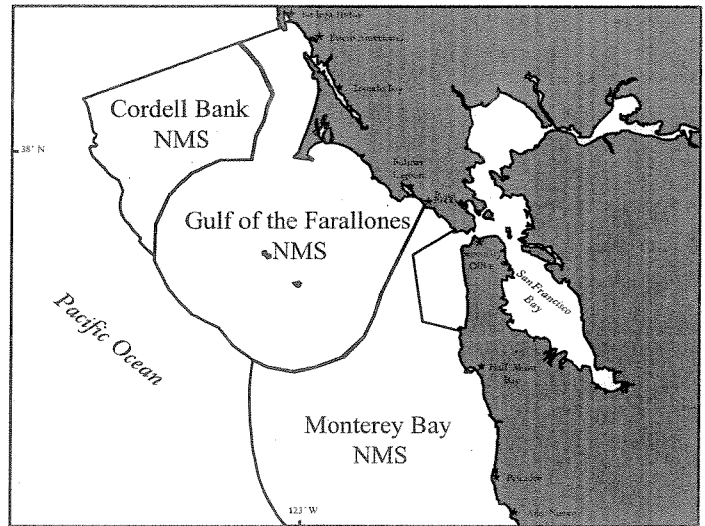


Figure 1. Map of Gulf of the Farallones National Marine Sanctuary.

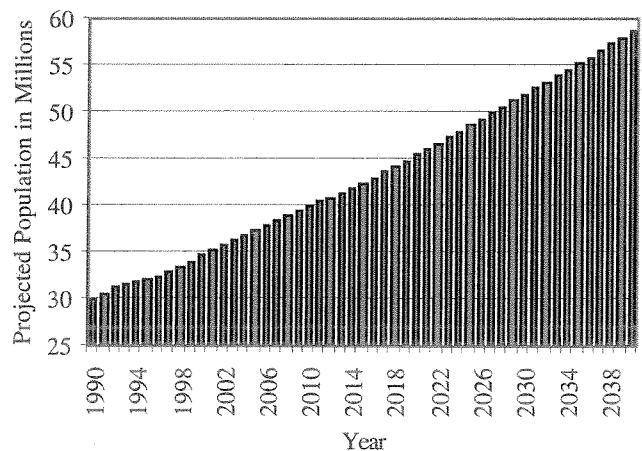
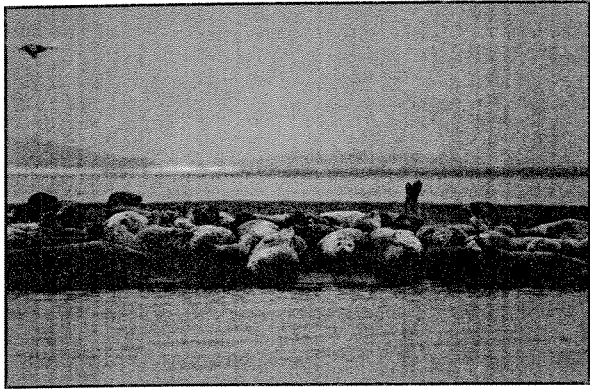


Figure 2. Projection of California population to the year 2040. Drawn from data in Heim, 1998.



Harbor seals (*P. vitulina*) hauled out in Tomales Bay.

sory committee consisting of representatives from GFNMS, PRNS, Audubon Canyon Ranch, Marin Open Space District, and the Golden Gate National Recreation Area (GGNRA) to determine what type of program was needed to protect harbor seals and their habitat in Bolinas Lagoon. The recommendations from the advisory committee were to develop a harbor seal monitoring program in Bolinas Lagoon and combine the Bolinas Lagoon efforts with the GFNMS Tomales Bay harbor seal docent program. In 1996, GFNMS had begun an interpretive program to reduce disturbance of harbor seals on the Tomales Bay mudflats.

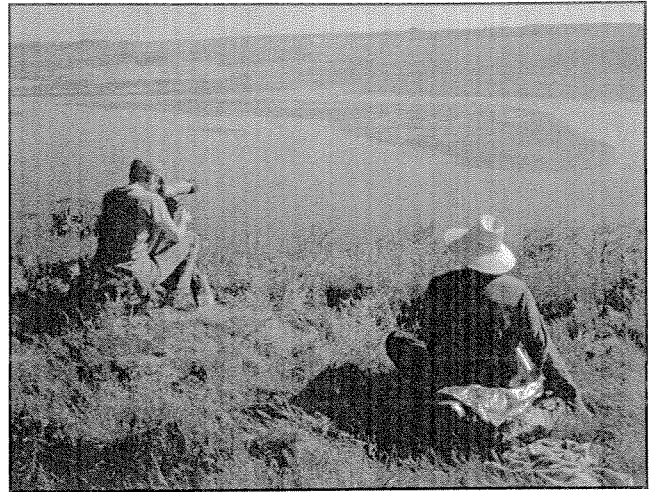
In 1997, FMSA in collaboration with the GFNMS developed SEALS (Sanctuary Education Awareness and Long-term Stewardship), a volunteer harbor seal monitoring and interpretation program. Volunteers were recruited and trained in natural history and interpretation techniques. In the spring of 1997, the SEALS program started to schedule docents for Clam and Seal Islands in Tomales Bay during the pupping season, and in the summer of 1997 commenced year-round monitoring of Channel and Pickleweed mudflats in Bolinas Lagoon. In the spring of 1998, the SEALS program added a harbor seal monitoring site at Tomales Point to evaluate the effectiveness of the volunteers on Clam and Seal Islands. During 1999, FMSA collaborated with Fitzgerald Marine Reserve (FMR) to extend the harbor seal monitoring and protection program into San Mateo County. In 1998, GFNMS and FMSA began coordinating a harbor seal census to evaluate the harbor seal population size and distribution along the central California coast.

TOMALES BAY

Clam and Seal Islands near the head of Tomales Bay are home to a colony of harbor seals, whose numbers have rebounded since the passage of the Marine Mammal Protection Act in 1972. Since 1982 Allen and her colleagues have studied the harbor seals of Tomales Bay as part of a region-wide inventory of pinnipeds (Allen et al., 1984, Allen, 1988). Seal numbers on the mudflats were highest during the winter (mean 194) and lowest during the breeding season (mean 156), unlike the pattern at other PRNS haul-outs, where peaks were highest during breeding and molting periods. The winter peak seal counts coincided with herring spawning in Tomales Bay, and the low summer counts coincided with the clamming season and high summer recreational use of Clam and Seal Islands. The percentage of pups seen in Tomales Bay was less than at other sites in the PRNS. Seals at Clam and Seal Islands in Tomales Bay had the highest disturbance rate of all haul-outs in the Seashore. Seals were flushed on 49% of the observation days compared with 29% at Double Point on the more remote outer coast of PRNS.

Allen and Huber's 1984 analysis of the original data from 1983 and 1984 showed that 51% of the disturbances were caused by clammers and fishers, followed by boaters (30%), hikers (14%), and dogs (5%). Seals rehailed more than half the time (58%) but were much more likely to shift sandbars (28%) than at other haul-outs. The number of seals that rehailed was also lower than at less disturbed areas, such as Double Point.

In 1991, Allen and King (1992) began an observational study of Clam and Seal Islands from Tom's Point on the eastern shore of Tomales Bay. They counted seals and recorded disturbances associated with humans as part of a regional, long-term monitoring program. Human disturbances were defined as cases in which seals left the haul-out in response to people. They noted that on 81% of the observation days seals were disturbed. This was more than 1.5 times the disturbance level noted during the 1980's. The average number of people



SEALS volunteers observe Clam and Seal Islands from Tomales Point.

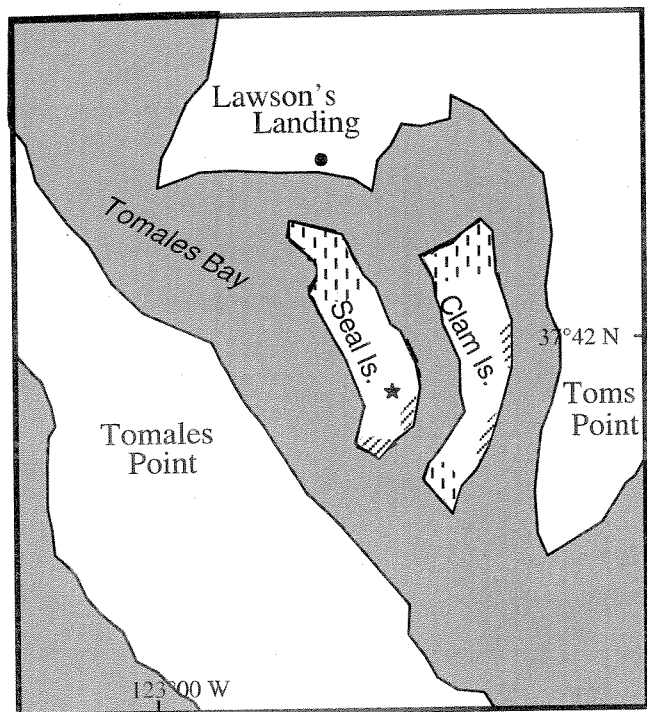


Figure 3. Map of the mouth of Tomales Bay. Star marks location of docents, lines show frequent harbor seal haul-outs, and dashes show common clamming areas.

counted during 1991 was 350 per day; the maximum was 1,225 in one day. Overall, 1.33 disturbances associated with humans were recorded every hour during 1991, which was the highest rate of disturbance ever reported on the North American west coast (Mortenson, 1996). A significant finding of this study was the near abandonment by seals of Hog Island just to the south of Clam and Seal Islands in Tomales Bay.

In 1996, GFNMS trained volunteers to serve as docents on Clam and Seal Islands in Tomales Bay. The purpose of the program was to reduce and possibly eliminate the disturbance to harbor seals by clambers during the pupping season. Docents marked the colony location and offered interpretation to visitors. In the first two years the docents reported a low incidence of disturbance by clambers suggesting that the program was effective. However, accurate seal counts and disturbance observations could not be made from the Islands' mudflats due to the slope of their banks. Therefore, in 1998, GFNMS and FMSA established a monitoring site at Tomales Point, which overlooks Clam and Seal Islands, to accurately assess the effectiveness of the docent program.

METHOD

CLAM & SEAL ISLANDS DOCENTS

Docents were present on Clam and Seal Islands during the harbor seal pupping season between the months of March and June, 1996-1999. During 1996-1998, the volunteers arrived at the Islands on the *CLAM CLIPPER*, a specialized transport and landing vessel run by Lawson's Landing. Two docents were stationed on each island (Figure 3). In 1999, Lawson's Landing suspended the *CLAM CLIPPER* trips. Thus, arrangements were made to transport the volunteers to the islands initially by skiff and later by PRNS patrol boat. Early in the 1999 season volunteers went to both Clam and Seal Islands as in the past. However, the National Seashore boat could not land on Clam Island, and after mid-April only a single team on Seal Island was present.

For the first seven observation days of the 2000 season, teams of docents went out to Seal Island (Figure 3) on skiffs departing from Lawson's Landing. The PRNS Service Patrol boat was out of service in the early part of the season but transported SEALS docents during the last two observation days. In all docents were present on 9 days, spending a total of 28 observation hours and 89 volunteer hours (Table 1). In addition, Tomales Bay docents traveled a total of 2,545 miles and spent 57 hours to reach the launch sites for the Islands.

Once on the Islands, SEALS volunteers marked a visual boundary using cones or flags at least 90 m (300 ft) around the seal haul-outs and set up an interpretive station with a spotting scope and educational materials. Since 1997, the docents have tallied all interpretations, counted all human activities they could see from their position on the mudflats, counted any dogs on the Islands, and recorded observations of the seals. Human activity categories were clam digging, jet skiing, motorboating, kayaking, sailboating, and other. In the 1998 season, almost all clammers arrived on the *CLAM CLIPPER*, which discharged all of its passengers at once. Thus clammers were initially concentrated at one point of an island, away from typical haul-out sites, and then spread around the Islands. In 1999 and 2000, clammers arrived at many points on the Islands from small boats.

CLAM & SEAL ISLANDS MONITORING PROGRAM

A two to four person team monitored Clam and Seal Islands from Tomales Point (Figure 4) on the western side of Tomales Bay. The dates and times of observations corresponded with the days docents were scheduled to visit the Islands—typically, negative and zero tide weekends and holidays. The monitoring sessions from the Point began 30 minutes before the docents arrived on the Islands and ended 30 minutes after they left, lasting approximately 4 hours per session. In the 2000 season, 11 days were monitored totaling 48 observation hours and 149 volunteer hours (Table 2). Tomales Point volunteers traveled a total of 2,014 miles and spent 53 hours to reach the monitoring site.

Table 1. Total number of observation days, volunteers, observation hours, and volunteer hours at Seal Island during 2000.

Month	Observation Days	Number of Volunteers	Observation Hours	Volunteer Hours
April	3	10	8	26
May	2	5	7	17
June	4	14	13	46
Total	9	29	28	89

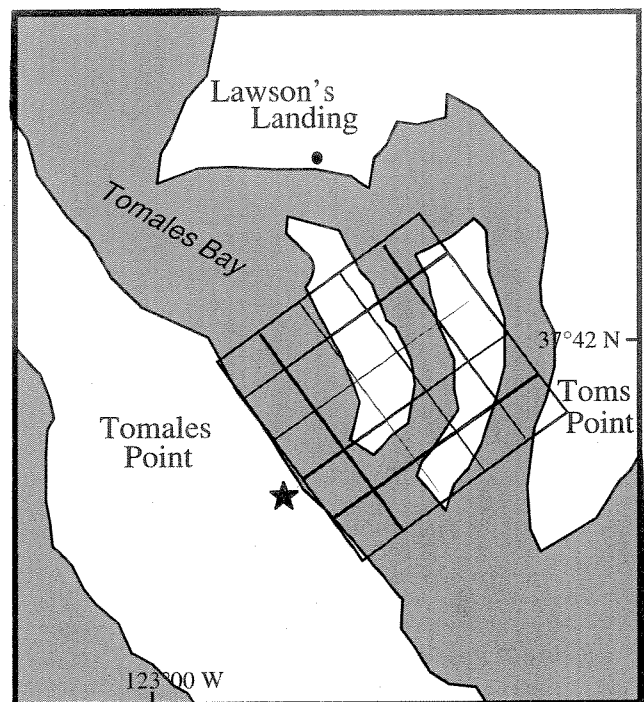


Figure 4. Map of the mouth of Tomales Bay. Grid encloses the observation area around Clam and Seal Islands. Star marks the Tomales Point monitoring location.

Table 2. Total number of observation days, volunteers, observation hours, and volunteer hours at the Tomales Point monitoring site during 2000.

Month	Observation Days	Number of Volunteers	Observation Hours	Volunteer Hours
March	1	4	3	12
April	3	11	12	46
May	3	10	15	47
June	4	10	18	44
Total	11	35	48	149

The observation area was 1,260 m by 1,260 m (4,200 ft by 4,200 ft) and encompassed most of Clam and Seal Islands and a portion of the surrounding waterways (Figure 4). To estimate distance within the monitoring area a grid was laid over a map of Tomales Bay, which was accurate within an error of ± 90 m (300 ft). Spotting scopes were used to monitor seal behavior and human activities within the grid.

At half-hour intervals, volunteers counted the number of seals hauled out on the Islands and noted their locations. Pups were counted from the beginning of March to June 15. After mid June it becomes hard to discriminate between small, newly molted yearlings and large, older pups. The number of red pelage seals and wounded seals were also noted. Following these counts, observers recorded the number of head alerts for a focal group of seals during a 3 minute period to measure the seals' vigilance (Terhune, 1985). A head alert was defined as a seal raising its head and clearly looking around.

In addition to the half-hour counts, volunteers collected environmental data, monitored harbor seal behavior, and enumerated human and other activities within the monitoring area. Environmental data recorded included tide height, wind speed, cloud cover, precipitation, and temperature. Seal behavioral data included head alert, approach water (seal movement towards the water but not completely into the water), and flush (seal entering the water in one continuous movement). Time, duration, and location of the seal behavior and activity type were logged. Seal behaviors were recorded regardless of human or other activities and vice-versa. Any association observed between an activity and a seal behavior was noted. The "unknown" activity classification was special; it served as the default category when seals were observed flushing or approaching the water for reasons unknown to the observer. Unknown was different from other activity types in that it was defined by the seal's behavior, and 100% of unknowns were associated with flushes and/or approach waters. All recorded seal disturbance behaviors were associated with an activity, known or unknown.

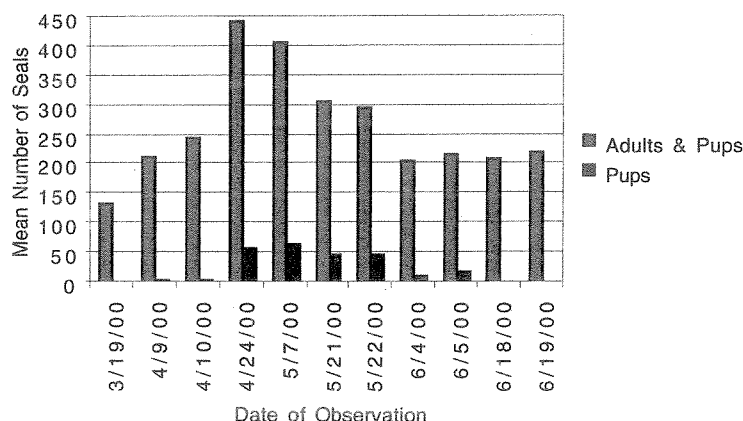


Figure 5. Mean daily seal counts on Clam and Seal Islands observed from Tomales Point, 2000.

Conventional descriptive statistics were performed on the data. Most relationships are described as correlations (R) while the strengths of the relationships are reported as proportions of variances (R^2).

RESULTS

SEAL NUMBERS & VISITORS

In 2000, harbor seal numbers peaked during May with a maximum of 462 seals observed. Numbers of pups peaked during May with a maximum of 81 pups observed. The first pup of the 2000 season was seen on April 9. The mean counts for the 2000 pupping season were 262.1 total seals and 27.7 pups (Figure 5).

Figure 6 shows that in 2000 there was no strong relationship between the number of seals hauled out and the overall rate of human activities.

ACTIVITIES & FLUSHES

In 2000, clammer was the most frequent activity at the Islands, at a rate of 38.49 clammers/hour, followed by 13.71 motorboats/hour, 0.61 docents/hour and 0.36 kayaks/hour (Table 3). Seals reacted 12 times to unknown causes at a rate of 0.21/hour. All other activities had less than 10 occurrences. Less than 1% of clammers were associated with flushes, while 9% of motorboats and 29% of kayaks were associated with flushes. There were a total of 82 flushes in 2000, at a rate of 1.72 flushes an hour.

The data for 2000 revealed little correlation between the rate of waterborne activities and the flush rate ($R = 0.01$, $R^2 = 0.00$) but a negative relationship between the pedestrian activity rate and the flush rate ($R = -0.29$, $R^2 = 0.08$). Waterborne activities included kayak and motorboat; pedestrian activities included clammer, docent, and dog.

In 2000, distances at which flushes occurred from activities ranged from 0-382 m (0-1,272 ft). The mean distance at which flushes occurred was 110 m $\pm$ SD 66 m (368 ft $\pm$ 219 ft). Figure 7 shows the mean distances between flushes

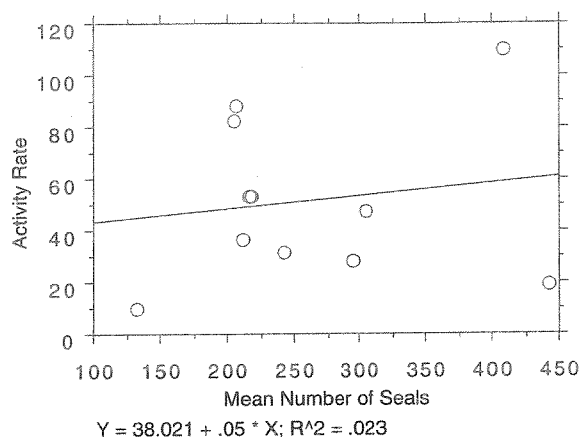


Figure 6. Mean number of seals and number of human activities per hour observed from Tomales Point, 2000.

Table 3. Total number of occurrences, occurrence rate, number of associated flushes, associated flush rate, and percentage of activity occurrences associated with flushes for all activity types observed at Clam and Seal Islands, 2000.

Activity Type	Number of Occurrences	Occurrence Rate	Number of Associated Flushes	Associated Flush Rate	% Occurrence Associated with Flushes
Aircraft	2	0.04	2	0.04	100%
Clammer	1,833	38.49	4	0.08	< 1%
Docent	29	0.61	1	0.02	3%
Dog	9	0.19	0	0.00	0%
Fisher	1	0.02	0	0.00	0%
Kayak	17	0.36	5	0.11	29%
Motorboat	653	13.71	59	1.24	9%
Rowboat	2	0.04	1	0.02	50%
Sailboat	1	0.02	0	0.00	0%
Unknown	12	0.25	10	0.21	83%
Totals	2,559	53.15	82	1.72	3%

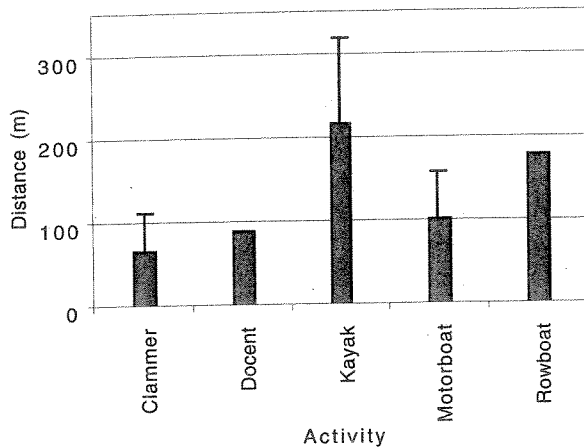


Figure 7. Mean distance between flushing seals and associated activities at Clam and Seal Islands, 2000. T-bars show standard deviations (Docent and Rowboat SD = 0).

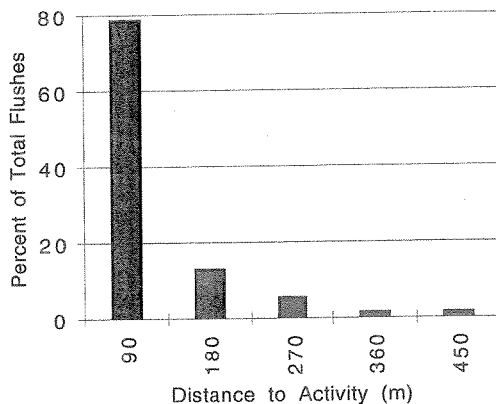


Figure 8. Percentage of flushes occurring between 90 and 450 m at Clam and Seal Islands, 2000.

and different activities. All flushes occurred within 450 m (1,500 ft) and most were within 90 m (300 ft, Figure 8). The number of seals that flushed was higher the closer the associated activity (Figure 9).

HARBOR SEAL HEAD ALERTS

In 2000, the head alert rate showed a negative relationship to the number of seals ($R = -0.41$, $R^2 = 0.17$). The head alert rate revealed no strong relation with flush rate ($R = 0.12$, $R^2 = 0.01$).

DISCUSSION

SEAL NUMBERS & VISITORS

The pattern observed in harbor seal numbers during the 2000 pupping season was consistent with that observed during 1999 (Mortenson et al., 2000) and 1998 (Mortenson et al., 1999). Harbor seal numbers peaked at the end of April or beginning of May when pups were most abundant and peaked again in mid-June at the start of the molting season. There was little difference in the mean number of seals observed over the three years (238.7 in 1998, 245.9 in 1999, and 262.1 in 2000). However, the mean number of pups varied each year (8.8 in 1998, 34.2 in 1999, 27.7 in 2000). The weather in the 1998 season was affected by the strong 1997/98 El Niño-Southern Oscillation (ENSO) Event which may explain the low pup numbers that year. During El Niño, increased pup mortality, low pup weights, less maternal attendance, and female out-migration have been observed in California sea lions (Bonness et al., 1991, Francis and Heath, 1991, Huber, 1991). If such effects occurred in harbor seals, lower pup counts might be expected.

Beginning in 1982 and ending in 1995, the California Department of Fish and Game (CDFG) conducted an annual census of harbor seals in California. The CDFG counts were based on aerial photographs from fly-overs during the last two weeks of June and were supplemented by ground counts during the census week. The most comparable data from the SEALS study were collected in late June 1998, 1999, and 2000 (maximum 366, 377, and 292 harbor seals, respectively). Although

the methods varied and a direct comparison is not possible, any radical shifts in population trends should be evident from the two data sets. The SEALS counts fall within the range of the most recent CDFG counts for Tomales Bay (196 to 431 harbor seals, Fluharty 1999) suggesting that the Tomales Bay harbor seal population is stable.

The unclear relationship between the overall rate of human activities and the number of seals hauled out in 2000 ($R = 0.15$, $R^2 = 0.02$) was similar to previous years (1999, $R = 0.00$, $R^2 = 0.00$, 1998, $R = 0.14$, $R^2 = 0.02$).

In 2000, there was a positive correlation between the pedestrian activity rate and the number of seals ($R = 0.34$, $R^2 = 0.12$) possibly resulting from both sharing preferences for low tides. Clammers may be landing at the lower tides strictly to clam and not to view the seals.

ACTIVITIES & FLUSHES

In 2000, the overall human activity rate was 53.15 activities/hour, in 1999 it was 20.33/hour, and in 1998 it was 93.48/hour (Figure 10). In 1998, clammers constituted the overwhelming majority of human activities at the Islands and nearly all the pedestrian visitors. In 1999, during the absence of the *CLAM CLIPPER*, the pattern of recreational use on and around Clam and Seal Islands changed. The Islands often had dozens of pedestrian visitors each day instead of the hundreds observed in past years (daily means of 45.2 visitors in 1999 and 366.1 in 1998). Rather than being dominated by clammers, the Islands were more equally visited by motorboats and clammers. With the suspension of the *CLAM CLIPPER* the frequency of activities decreased in the monitoring area, but human related activities other than clamming, such as motorboating and kayaking, showed little change over the first two years (daily means of 29.6 motorboats in 1999 and 35.7 in 1998). In 2000, the daily mean number of pedestrian visitors increased to 166.6, and the daily mean number of motorboats increased to 59.4. More clammers arranged independent boat travel to the Islands during 2000. Recreational use patterns continue to shift each year in response to the absence of the *CLAM CLIPPER*.

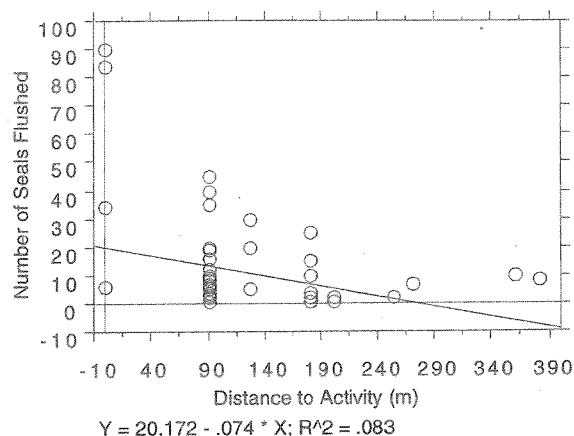


Figure 9. Number of seals involved in a flush and the distance from the associated activity, Clam and Seal Island, 2000.

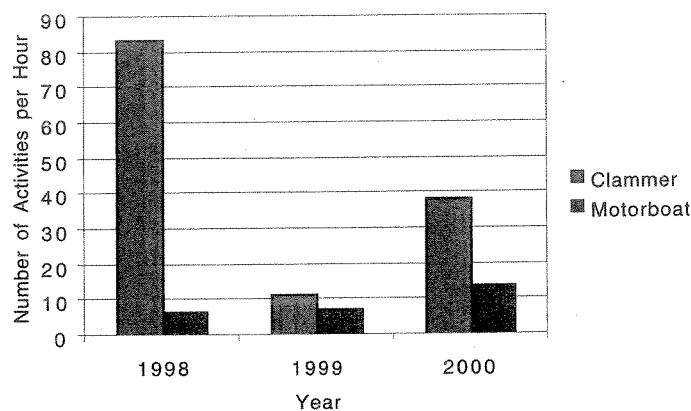
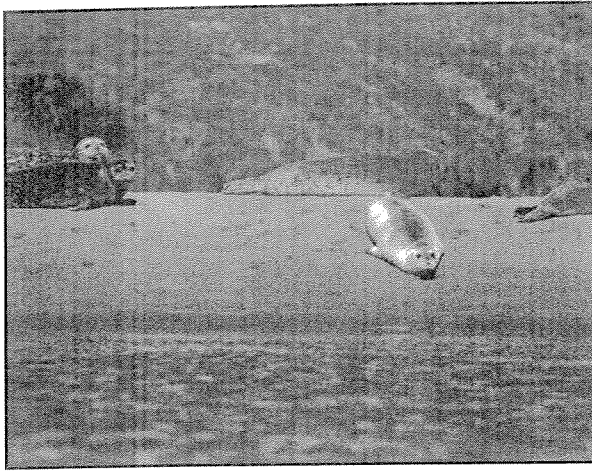
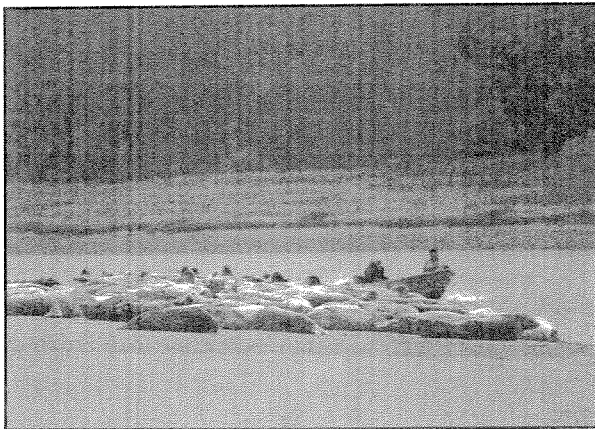


Figure 10. Clamming and Motorboat occurrence rates observed during 1998, 1999, and 2000 at Tomales Point.



A harbor seal (*P. vitulina*) moves towards the water in an approach water or flush.



Harbor seals (*P. vitulina*) raise their heads as a motorboat moves past their haul-out in Tomales Bay.

There was a total of 82 flushes in 2000, with a rate of 1.72 flushes an hour. Most were associated with motorboats (59 flushes at 1.24/hour), then with unknown sources (10 flushes at 0.21/hour) and then with kayaks (5 at 0.11/hour). In contrast, 41 flushes were observed during the 1999 season at a flush rate of 0.90/hour. In 1999, fourteen unknown activities were the highest contributors to the flush rate at 0.31/hour, followed by eleven motorboats at 0.24/hour, and six kayaks and clambers, both at 0.13/hour. In 1998, the rate was even lower: 43 flushes were observed at a rate of 0.70/hour, and the leading causes were motorboats (17 at 0.24/hour) and kayaks (11 at 0.13/hour).

Despite the changes in their numbers, clamming has been the most frequent activity in all years (38.49/hour in 2000, 11.65/hour in 1999, 83.53/hour in 1998). Clammers were associated with a low flush rate in all three years (0.08 flushes/hour in 2000, 0.13 in 1999, and 0.08 in 1998). In all three years, 1% or less of the clammer's occurrences were associated with flushes. Once the major cause of harbor seal disturbance, clambers now seem to have little effect on the seals. The Tomales Bay docent program appears to have been successful in this regard. However, although clambers were associated with flush events only 4 times during 2000, these events flushed the entire haul-out. Often seals did not return to the haul-out for the remainder of the shift. Docents were unable to prevent these flushes because they occurred on Clam Island (2 times) where the docents were not present and on Seal Island (2 times) from a motorboat drop-off inside the cone boundary set up by the docents. In these cases, motorboats initially flushed all of one haul-out, and then clambers got off the vessel and flushed the neighboring haul-out. Designing an outreach program to target visitors who arrive from individual vessels and dock at many points on the Islands is much different from addressing groups of visitors who arrive on a single vessel at a standard landing point. A new education strategy may be necessary to address disturbance from motorboats.

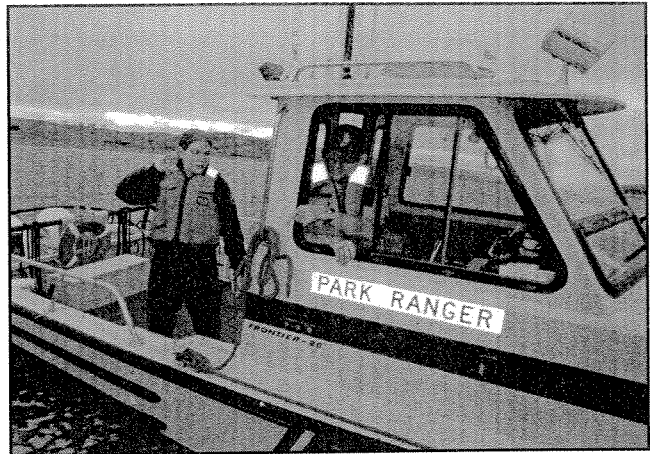
Each year waterborne sources (kayak and motorboat), despite being far fewer in number, were associated with more flushes than pedestrian

sources (clammers, dogs, and docents). During all 3 years, motorboats were associated with the highest rate of flushes (59 at 1.24/hour in 2000, 11 at 0.24/hour in 1999, and 17 at 0.28/hour in 1998). During 1999 the PRNS rangers patrolled Tomales Bay and may have helped lower the motorboat flush rate. In 2000 the PRNS patrol boat was not operating for most of the clamming season, and its absence may have contributed to the rise in the motorboat flush rate. In addition the number of motorboats recorded each hour almost doubled (13.71/hour in 2000 and 7.36/hour in 1999). This increased rate of boats most likely contributed to the large increase in motorboats associated with flushes.

Although far fewer in number than motorboats, kayaks have been associated with a high flushing rate compared to all sources. During the past 3 years, though, the percentage of kayaks associated with flushes has decreased from 48% to 29%. In 2000, 29% of the 17 kayaks were associated with flushes (0.11/hour), in 1999, 38% of the 16 kayaks were associated flushes (0.35/hour), and in 1998, 48% of 23 kayaks were associated with flushes (0.38/hour).

When human related activities were analyzed separately, the flush rate for 2000 was 1.51 flushes an hour, for 1999 0.53 flushes/hour and for 1998 0.62 flushes/hour. In 1999 and 1998, the human related flush rates were lower than the 1.33/hour reported by Allen and King in 1991. However, the 2000 human related flush rate exceeds Allen and King's rate from a decade ago and may represent what might be expected with the increase in motorboat activity without the *CLAM CLIPPER*.

Although the average flush rate was high during 2000, it should be noted that there were two days on which an extraordinary number of flushes were seen (Figure 11) and which influenced the season average. There was no obvious reason for the increased reactivity observed in the seals on these two days. High reactivity in seals has been noted after a shooting or shark attack (Mortenson, personal communication), but there was no evidence of either of these types of events.



The Point Reyes National Seashore (PRNS) boat on Tomales Bay.

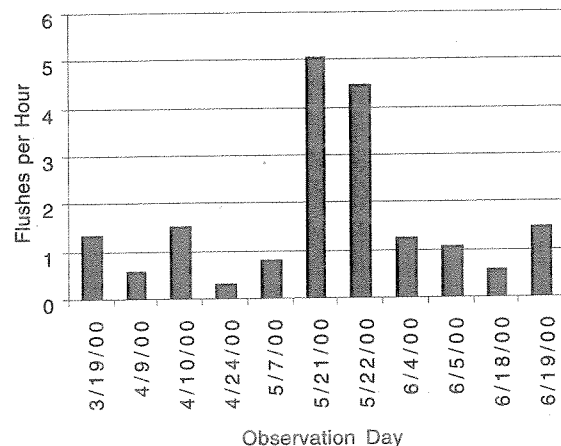
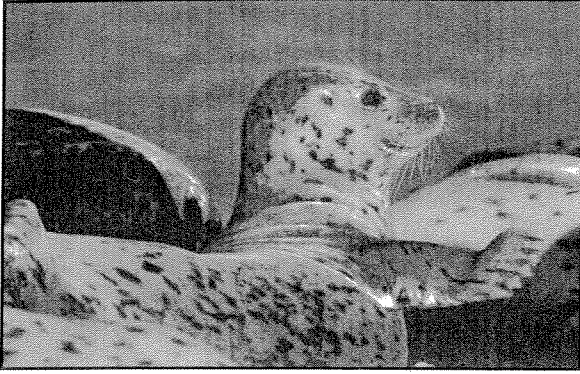


Figure 11. Daily flush rates observed from Tomales Point, 2000.



A harbor seal (*P. vitulina*) head alerting.

The mean head alert rate for the 2000 season was 0.48 alerts/seal/minute, for 1999 0.66 head alerts/seal/minute, and for 1998 0.48 head alerts/seal/minute. In 2000, the head alert rate showed a clear negative relationship to the number of seals ($R = -0.41$, $R^2 = 0.17$). The head alert rate revealed no strong relation to the flush rate ($R = 0.16$, $R^2 = 0.01$). During 1999, there was a weaker negative correlation between the number of harbor seals hauled out and the head alert rate ($R = -0.29$, $R^2 = 0.08$). In 1999, when the head alert rate was compared with the flush rate, a weak positive correlation was found ($R = 0.26$, $R^2 = 0.07$). Likewise, data from 1998 were similar to 1999 with weak trends for both of these comparisons.

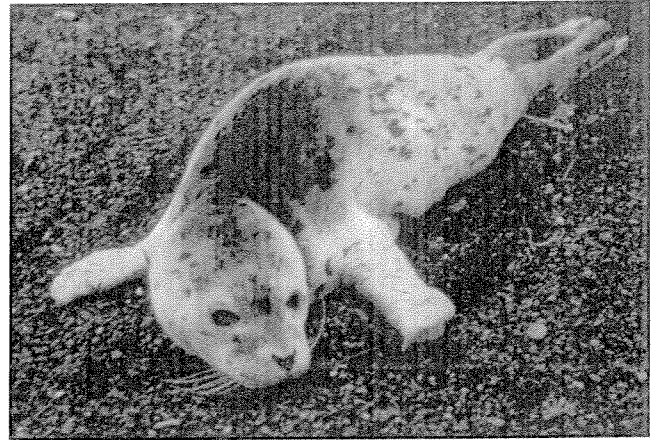
In all three years, higher harbor seal counts were correlated with lower head alert rates. This is expected from vigilance theory (Terhune, 1985) and indicates that individual harbor seals may be less wary in large groups. Finally, SEALS data suggest that the head alert rate may not be a good indicator of harbor seal disturbance since the alert rate and flush rate were only weakly correlated if at all.

BOLINAS LAGOON

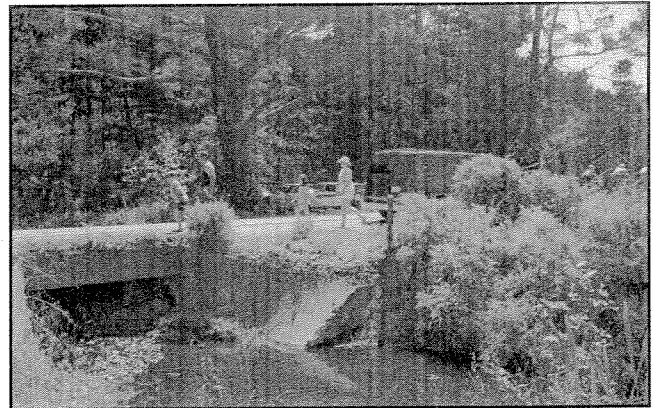
Bolinas Lagoon lies on the San Andreas Fault where it emerges from the sea north of San Francisco. Roads, fields, and houses surround this triangular lagoon. Allen et al. (1984) studied seal disturbance at Pickleweed mudflat and Kent Island in Bolinas Lagoon in 1978 and 1979. Time lapse movie cameras recorded activities near the haul-outs, and the movie data were supplemented by daylong monitoring sessions each month. At the largest haul-out on Kent Island, the seals were disturbed on 71% of the days monitored. Canoes were the greatest source of known disturbance. At Kent Island most known cases of disturbances occurred within 100 m of the seals. Statistical analysis indicated the closer the people, the more probable a reaction. In all, seals were flushed 0.09 times an hour at Kent Island and 0.05 per hour at Pickleweed mudflat.

In 1992, Morgan and Swift of The Marine Mammal Center briefly studied seal disturbances at Bolinas Lagoon. Volunteers observed the seals at Kent Island and Pickleweed mudflat on weekends during the fall. The observers were asked to note all human activities within 500 m of the haul-outs regardless of whether a flush occurred, the type of response made by the seals, the number of seals flushed, the distance at which the flush occurred, and the amount of time it took the seals to rehaul. During the 109 hours of observation 68 possible causes for disturbances were noted. Flushes were seen in 45 of the 68 potential occasions and on 21 out of 23 weekend days. Canoes and kayaks accounted for more than half of the disturbances. Most flushes were caused by human activities occurring near the seals (< 100 m). Overall, Morgan and Swift observed 0.41 flushes/hour from all causes.

Residents of the Bolinas Lagoon area have recently been concerned about the numerous cars stopping alongside Highway 1. Many of these motorists leave their vehicles to walk along the Lagoon shore. Are these visitors disturbing the seals? If they are, is the level of disturbance at the Lagoon severe enough to merit intervention?



Harbor seal (*P. vitulina*) pup in the GFNMS.



Visitors stop along Highway 1 and approach a vantagepoint to view harbor seals (*P. vitulina*) in Bolinas Lagoon.

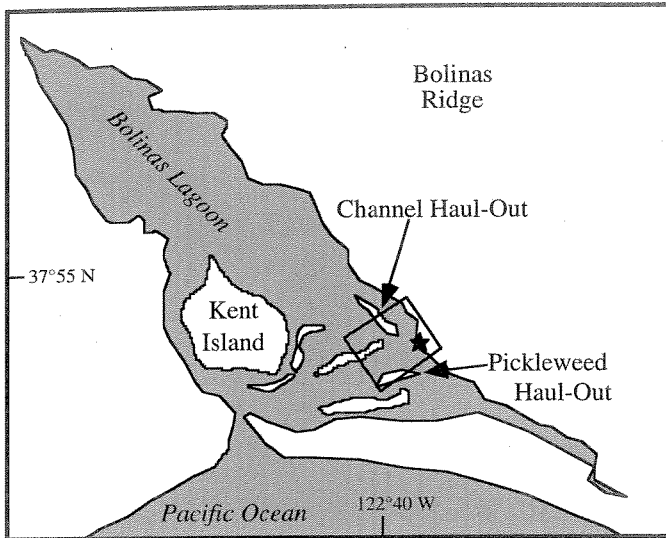


Figure 12. Map of Bolinas Lagoon. Star marks point of observation at McKinnan Gulch, box indicates area monitored for seal and human behavior.

Table 4. Total number of observation days, volunteers, observation hours, and volunteer hours at Bolinas Lagoon, July 1999-June 2000.

Month	Observation Days	Number of Volunteers	Observation Hours	Volunteer Hours
July	9	23	23	59
August	6	14	18	42
September	1	2	3	6
October	5	11	15	34
November	6	13	11	27
December	6	13	17	38
January	4	7	12	21
February	1	2	3	6
March	6	15	18	45
April	5	10	15	30
May	6	14	15	35
June	5	12	13	33
Total	60	136	163	376

To further the preservation of harbor seal rookeries and to develop methods to reduce disturbance, the SEALS program launched an investigation of activities along Highway 1 near the Lagoon and their relation to seal numbers and behaviors. The first two study years (Mortenson et al., 1999, 2000) suggested that land-based activities were associated with few flushes, while aquatic activities were associated with more flushes. It appeared that the seals were attracting visitors and determining a major usage pattern at the Lagoon. The SEALS program continues to study the effects of human recreation on harbor seals in Bolinas Lagoon and now has expanded to include the haul-outs near Kent Island in 2000-2001.

METHOD

Teams of two to four observers were posted year round at a small spit of land by McKinnan Gulch (Figure 12). The monitoring area included the Channel mudflat from its eastern curve north-westward to the line perpendicular to Mile Marker 14.47 on Highway 1. If a haul-out remained exposed for two hours, an observation took place for three hours; if the haul-out was not exposed, observations were made for an hour. At half-hour intervals, the observers counted the seals on Pickleweed and Channel mudflats within the monitoring area. Pickleweed counts were conducted on the northeast side of the mudflat. Protocol was similar to that at Tomales Point. Observers recorded head alerts for a focal group of seals, collected environmental data, and enumerated and timed human activities along the east shore of Bolinas Lagoon. Hikers were a special category defined to include anyone who visited the Observation Spit or who came in close proximity to the shore between the Observation Spit and Mile Marker 14.47. Visitors were classified as people in or out of cars east of the hiking area and further away from the seals. Seal behaviors were logged and activities noted. Compass bearings and rangefinder readings were taken to determine the distance of activities from the seals. Volunteers also censused the entire Lagoon once each shift and mapped the distribution of seals. From March

15 through June 15 pups were counted.

Data were collected from July through June each research year, beginning in 1997. The first year of data collection (Mortenson et al., 1999) took place during the strong ENSO event of 1997/98; the second year of monitoring was largely conducted during the La Niña years of 1998/99 (Mortenson et al., 2000).

Volunteers monitored Bolinas Lagoon 65 times in 1999/00, which represented 163 observer hours and 376 volunteer hours (Table 4). In addition Bolinas Lagoon volunteers traveled 10,770 miles and spent 246 hours to reach the Observation Spit.

RESULTS

SEAL NUMBERS & VISITORS

The annual pattern of seal numbers counted within Bolinas Lagoon is illustrated in Figure 13. These monthly mean seal numbers were generated from censuses conducted once during each shift and represent the entire Lagoon. There was a peak in summer counts during July (monthly mean 168.9 seals, monthly maximum 234) followed by a winter low during December (monthly mean 23.8 seals, monthly maximum 34), increasing to a spring high during April (monthly mean 129.2 seals, monthly maximum 206). The mean seal count for the entire Lagoon for the 1999/00 research year was 90.7 seals, obtained by averaging the means for each month.

Figure 14 shows the monthly mean overall seal and pup counts for the study area at Channel and Pickleweed mudflats. The average number of seals was 26.7, again calculated by averaging the means for each month. The maximum number of pups (Channel and Pickleweed haul-outs combined) was 23.

As Figure 15 shows, the number of roadside visitors per hour in 1999/00 tended to be higher when more seals were present at Channel mudflat ($R = 0.61$, $R^2 = 0.37$), but the relationship of visitor rate to seals at Pickleweed mudflat was weak ($R = 0.13$, $R^2 = 0.02$). The number of hikers walking along the shoreline at Bolinas Lagoon was positively related to the number of seals at Chan-

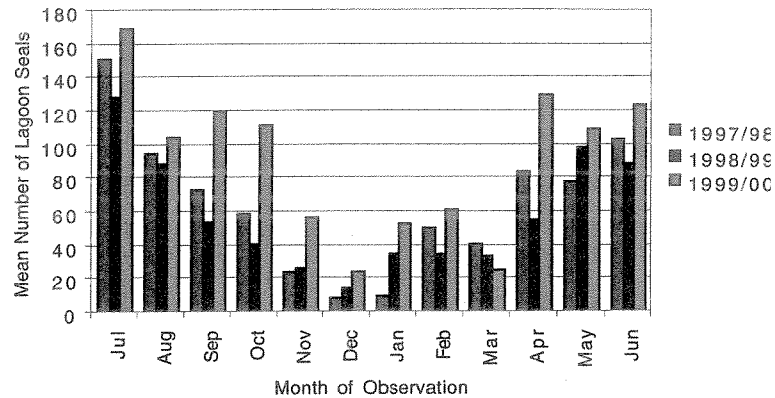


Figure 13. Mean monthly seal counts for all of Bolinas Lagoon, July 1997–June 2000.

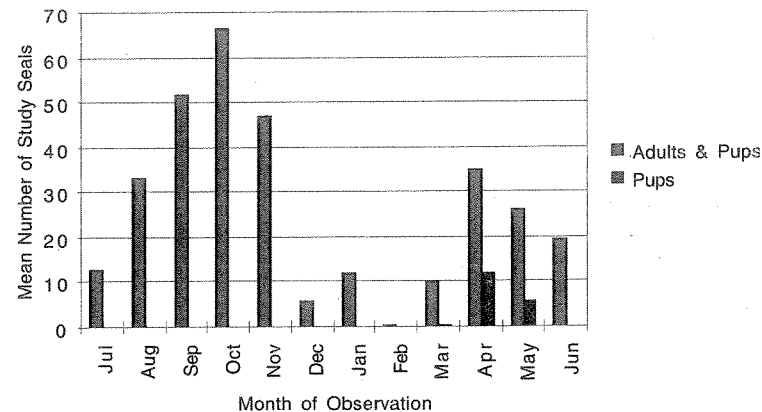


Figure 14. Monthly mean seal counts at Channel and Pickleweed haul-outs, July 1999–June 2000 (pups counted 15 March–15 June).

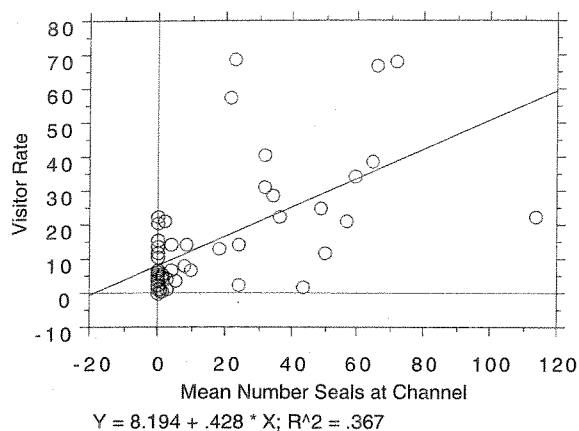


Figure 15. The roadside visitor rate and the average number of seals at Channel haul-out, July 1999–June 2000.

Table 5. Total number of occurrences, occurrence rate, number of associated flushes, associated flush rate, and percentage of occurrences associated with flushes for all activity types observed near Channel and Pickleweed haul-outs, July 1999–June 2000.

Activity	Number of Occurrences	Occurrence Rate	Number of Associated Flushes	Associated Flush Rate	% Occurrence Associated with Flushes
Aircraft	3	0.02	0	0.00	0%
Ambulance	1	0.01	0	0.00	0%
Automobile	37	0.23	0	0.00	0%
Bird	2	0.01	0	0.00	0%
Canoe	9	0.06	4	0.02	44%
Chainsaw	7	0.04	0	0.00	0%
Dog	14	0.09	0	0.00	0%
Fisher	38	0.23	1	0.01	3%
Harbor Seal	2	0.01	0	0.00	0%
Hiker	366	2.25	3	0.02	1%
Horn	28	0.17	0	0.00	0%
Kayak	8	0.05	1	0.01	12%
Loud Noise	1	0.01	0	0.00	0%
Motorcycle	43	0.26	0	0.00	0%
Unknown	13	0.08	5	0.03	38%
Total	572	3.51	14	0.09	0.98

nel mudflat in 1999/00 ($R = 0.35$, $R^2 = 0.12$) but not clearly related to Pickleweed mudflat ($R = 0.09$, $R^2 = 0.01$).

In the 1999/00 research year, the number of seals at the Channel mudflat and the hourly rate of visitors were both negatively related to tide ($R = -0.19$ and -0.26 , $R^2 = 0.04$ and 0.07 respectively).

ACTIVITIES & FLUSHES

Table 5 lists all activities observed within the monitoring area including those associated (14) with seal flushes. Most activities associated with flushes were human related (9), while all the other flushes had no observable cause (5) and were classified as unknown. There were no flushes associated with other animals, as in the two previous research years. Large percentages of canoes and kayaks were associated with flushes, 44% and 12% respectively. Only 3% of fishing activities were associated with flushes, and 1% of hikers, the most common shoreside activity, were associated with flushes. Roadside visitors to the Lagoon were associated with no flushes in 1999/00.

The mean distances at which flushing occurred during various activities ranged from 60 to 117 m (195 to 380 ft). The mean distance between an activity and flushing seals was $89 \text{ m} \pm \text{SD } 21 \text{ m}$ ($290 \text{ ft} \pm \text{SD } 69 \text{ ft}$).

Although few flushes were associated with individual pedestrian activity types (hikers and fishers), there was a positive correlation between the hourly rate of all pedestrians combined and the rate of flushes ($R = 0.59$, $R^2 = 0.35$). The data also revealed a positive correlation between the hourly rate of waterborne activity and flush rate ($R = 0.58$, $R^2 = 0.33$). Waterborne activities were comprised of canoes and kayaks; no motorcraft were observed.

HARBOR SEAL HEAD ALERTS

Head alert rates did not show obvious correlations to the numbers of recreationists and seals in the 1999/00 data set. Data from all three study years were combined to increase the sensitivity of analysis and better detect any relationships. The mean head alert rate at Channel mudflat was 1.02/

seal/minute and at Pickleweed mudflat was 0.85/seal/minute. Daily head alert rates at Channel and Pickleweed mudflats showed no clear relationship to the daily rate of pedestrian (Channel, $R = -0.09$, $R^2 = 0.01$, Pickleweed, $R = -0.01$, $R^2 = 0.00$) or aquatic activities (Channel, $R = -0.06$, $R^2 = 0.00$, Pickleweed, $R = 0.16$, $R^2 = 0.03$). The average head alert rate was inversely related to the number of seals present at Channel ($R = -0.17$, $R^2 = 0.03$) and Pickleweed ($R = -0.16$, $R^2 = 0.03$). However, these relationships between head alert rate and number of seals were not strong.

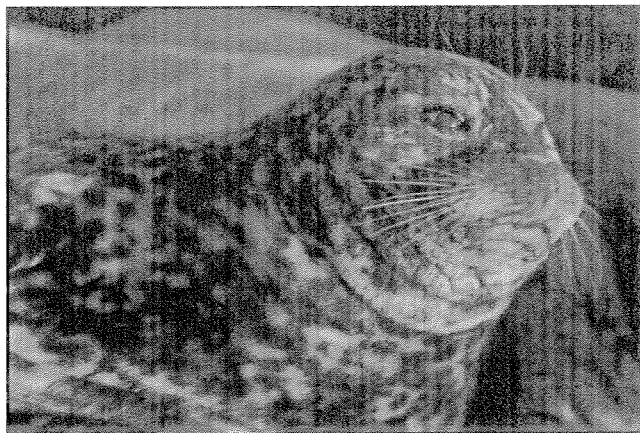
DISCUSSION

SEAL NUMBERS & VISITORS

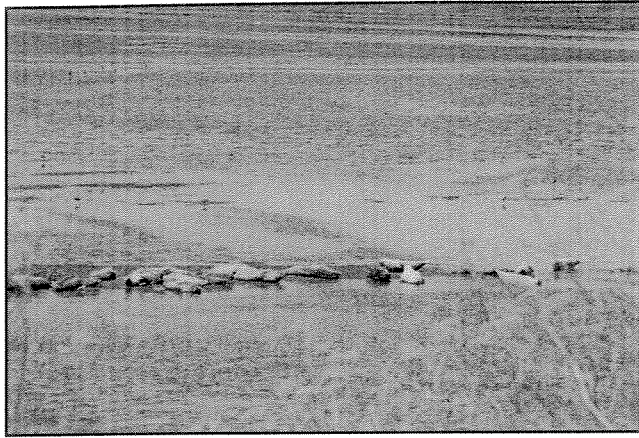
The monthly mean number of seals and pups counted for the Lagoon in 1999/00 followed the patterns reported for the previous research years (Mortenson et al., 1999, 2000). There was a peak during summer, a decline during fall, and a minimum during the winter. The highest monthly averages were in July each year (1999/00, 168.9 seals, 1998/99, 128.1 seals, and 1997/98, 151.6 seals). The lowest monthly averages were in December or January (1999/00, 23.8 seals, 1998/99, 14.8 seals, and 1997/98, 9.0 seals).

The mean count of 90.7 seals (maximum 234) for the entire Lagoon during the 1999/00 research year was greater than the mean count of 58.2 during 1998/99 (maximum 235) and 64.8 during 1997/98 (maximum 212). However, the mean number of pups remained similar in all three years (11.7 pups in 1999/00, 10.8 pups in 1998/99, and 10.1 pups in 1997/98, all averages weighted by months).

Three years of SEALS data are not enough to establish a trend for Bolinas Lagoon, especially given the variability of seal numbers and the two recent weather extremes. However, a rough comparison can be made with past CDFG census counts at Bolinas Lagoon. SEALS maximum counts for June 1998 (102 seals), June 1999 (168 seals), and June 2000 (188 seals) fall within the recent range of values obtained from CDFG censuses (54 to 319 seals between 1982-1995, Fluharty, 1999). Thus, there is no compelling evidence of any recent ma-



Harbor seal (*P. vitulina*) scanning its surroundings.



The harbor seal (*P. vitulina*) haul-out on Channel mudflat in Bolinas Lagoon.

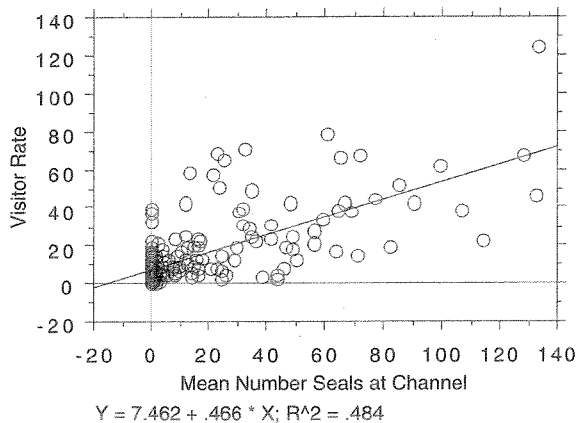


Figure 16. The roadside visitor rate and mean number of seals at Channel haul-out, July 1997-June 2000.

for increases or decreases in harbor seal numbers in Bolinas Lagoon.

The mean seal count for the study area at Channel and Pickleweed mudflats (26.7 seals) more than doubled from the preceding research year (10.4 seals), reaching a level similar to the first research year (24.1 seals, all averages weighted by months). This indicates that seal haul-out preferences within the Lagoon vary from year to year.

As in the previous research years (Mortenson et al., 1999, 2000), the number of roadside visitors in the observation area was highly correlated with the number of seals at Channel mudflat ($R = 0.61$, $R^2 = 0.37$) but to a lesser degree with the seals at Pickleweed mudflat ($R = 0.14$, $R^2 = 0.02$). When the three research years are combined, nearly half the variance in visitor rate is accounted for by the number of seals at Channel mudflat ($R = 0.70$, $R^2 = 0.48$, Figure 16).

The number of shoreside hikers this study year was also positively related to the number of seals at Channel mudflat, just as in previous years. When data for all three study years are pooled, there is a moderate relationship ($R = 0.34$, $R^2 = 0.12$). However, the number of fishers counted over the three years bears no apparent relationship to the number of seals ($R = 0.00$, $R^2 = 0.00$).

The number of aquatic recreationists (boaters of all types) is also related to the presence of seals in the study area. To test this relationship, all three research years were pooled and a Chi-square was computed which showed that the presence of aquatic recreationists was highly, significantly related to the presence of seals ($\phi = 0.252$, Chi-square $P = 0.0001$). The same trend appeared when the presence of kayakers and seals were compared ($P = 0.001$, $\phi = 0.211$), and when the presence of canoeists and seals were compared ($P = 0.011$, $\phi = 0.167$).

Three years of consistent, positive correlations between the number of recreationists at Channel mudflat and the number of seals suggest that seals may attract recreationists to Bolinas Lagoon. This theory is further supported by the negative correlation between the number of visitors and tide height. Seals tend to haul out when low tides make the mudflats accessible. Visitors also tend

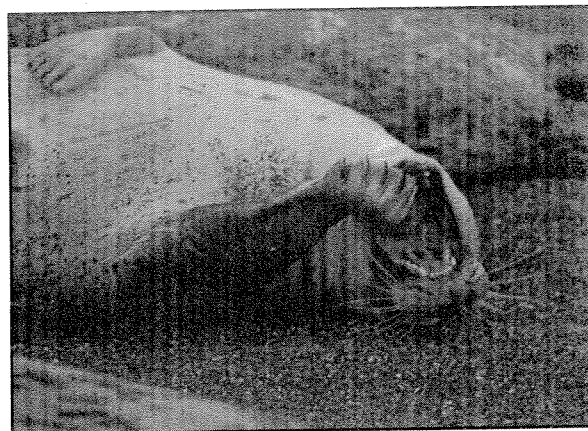
to appear at low tides when seals tend to be present. These inverse relationships to tide have been seen in all three research years and also when all three years' data are pooled for analysis for seals ($R = -0.19$, $R^2 = 0.04$) and for visitors ($R = -0.28$, $R^2 = 0.08$). The presence or absence of harbor seals may determine some of the major spatial and temporal patterns of recreational use in Bolinas Lagoon.

ACTIVITIES & FLUSHES

This year's study replicates the key findings of the preceding research years. Shoreside activities were associated with few flushes, and waterborne activities were more likely to be associated with flushes. Five out of 9 canoes (44%) were associated with flushes at a rate of 0.06 flushes/hour, and 1 out of 8 kayaks (12%) was associated with a flush at 0.01 flushes/hour. In 1998/99, 3 out of 9 canoes (33%) were associated with flushes at 0.01 flushes/hour, and 7 out of 27 kayaks (29%) were associated with flushes at 0.03/hour. In 1997/98, 2 out of 7 canoes (29%) were associated with flushes at 0.01/hour, and 11 out of 41 kayaks (27%) were associated with flushes at 0.06/hour (Mortenson et al, 1999, 2000).

In this year's study, hiking, the most common shoreside activity, was associated with flushes in 1% of the cases (0.02 flushes/hour), compared to 3% of the cases in 1998/99 (0.03 flushes/hour) and 2% of the cases in 1997/98 (0.02 flushes/hour). Roadside visitors to the Lagoon were associated with zero flushes in 1999/00 and with a single flush during each of the two previous research years (0.04% of all visitors in 1998/99 at 0.005 flushes/hour, 0.03% of all visitors in 1997/98 at 0.005 flushes/hour). The low rate of disturbance associated with land-based recreationists along the eastern shore of Bolinas Lagoon is impressive. The presence of SEALS volunteers may cause recreationists to be cautious around the seals resulting in low disturbance rates. The degree to which shoreside visitors disturb seals when volunteers are not present is unknown.

Over the last three years there has been a decline in the number of flushes observed/hour. The overall flush rate in 1999/00 was 0.09/hour,



A harbor seal (*P. vitulina*) rests in the GFNMS.

in 1998/99 it was 0.14/hour, and in 1997/98 it was 0.16 times/hour.

The flushing rate during each research cycle was slightly higher than or similar to what Allen and her colleagues recorded separately for Pickleweed mudflat (0.05/hour) and Kent Islands (0.09/hour) in 1978/79 (Allen et al., 1984). The flush rates from the SEALS studies were lower than the 0.41/hour recorded in 1992 by Morgan and Swift for Pickleweed mudflat and Kent Island combined. Again, it is difficult to compare the flushing rates, since the sites in the Lagoon were different and the methods varied. Nonetheless, Morgan and Swift's study suggests that flushing rates may have been higher in 1992. It could be that the rate of disturbance has fallen over the years, as people have become more sensitive to wildlife. It could also be that the seals have become more habituated to people in the last two decades. Finally, it could be that the presence of SEALS monitoring teams inhibited recreationists from boisterous activities and thus lowered the flush rate.

HARBOR SEAL HEAD ALERTS

The average head alert ratio was inversely related to the number of seals present at Channel mudflat ($R = -0.17$, $R^2 = 0.03$) and at Pickleweed mudflat ($R = -0.16$, $R^2 = 0.03$) when data for all three research years were pooled. However, this relationship accounted for only a small fraction of the variance. The tendency for lower head alert rates to be associated with higher seal numbers is to be expected based on the theoretical concept of vigilance. According to vigilance theory, larger groups spot predators more readily, since more animals scan their surroundings. Individuals can scan less and conserve energy, since overall the group scans more.



Harbor seals (*P. vitulina*) alert to something in their environment.

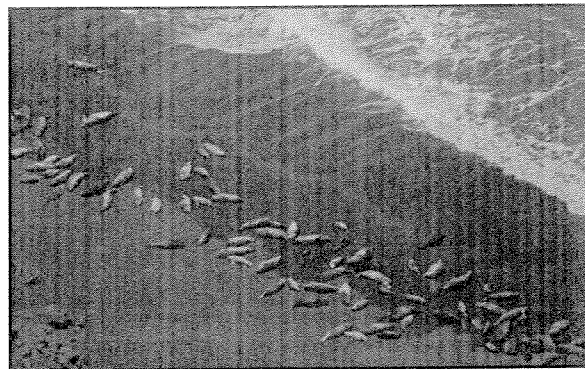
CENTRAL CALIFORNIA COOPERATIVE HARBOR SEAL CENSUS

One of the objectives of the SEALS program is to determine harbor seal population trends within and around the GFNMS. The first census was organized by the GFNMS and was conducted during the 1998 pupping season. These counts provided estimates of the number of adult seals and pups from southern San Mateo County to northern Sonoma County. In 1999, sites in San Francisco Bay were included and the time for the census was extended into the summer molting period when seal counts can be highest (Allen and Huber, 1983). In 2000, sites at Point Bonita in the GGNRA and at Corte Madera in northern San Francisco Bay were added. The central California breeding and molting counts provide essential information on trends in harbor seal populations. Fitzgerald Marine Reserve (FMR), GFNMS, GGNRA, PRNS, FMSA, Seal Watch at Jenner, and Seal Watch at Sea Ranch collected data. PRNS and GFNMS coordinated the counts, and FMSA provided data entry and analysis.

METHOD

Ground counts of harbor seals during 1998 were made from April 18 through June 14. Semi-monthly counts were made during the breeding season at prominent harbor seal haul-out areas from San Mateo to Sonoma Counties.

Counts during 1999 were made on selected days from April 18 through July 28. Count days were chosen to maximize the number of personnel available in order to allow the best coastal coverage and to include a low rising tide. Teams were asked to census at times when they would expect numbers to be highest. In general, seal numbers are highest in early afternoon during a low tide. However, this is not always the case. At some sites like the Russian River in Sonoma County, human disturbance can lower numbers during mid-day (Mortenson, 1996, 1997, and 1998). These haul-outs were censused early in the day.



Harbor seals (*P. vitulina*) hauled out on a beach in PRNS.

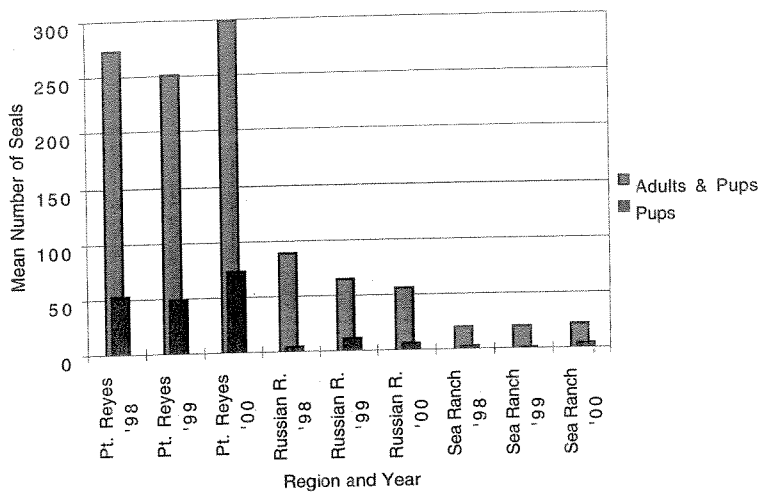


Figure 17. Mean seal counts at consistently monitored haul-outs, 1998–2000. Pups counted April–May.

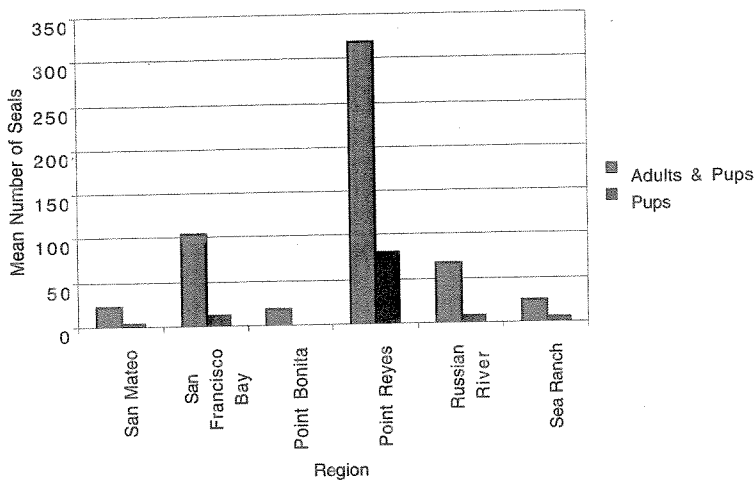


Figure 18. Mean seal counts for various regions of the Central California Cooperative Census, 1998–2000 (all years combined). Pups counted April–May (1 pup was observed at Bonita Point in June, outside the range of this graph).

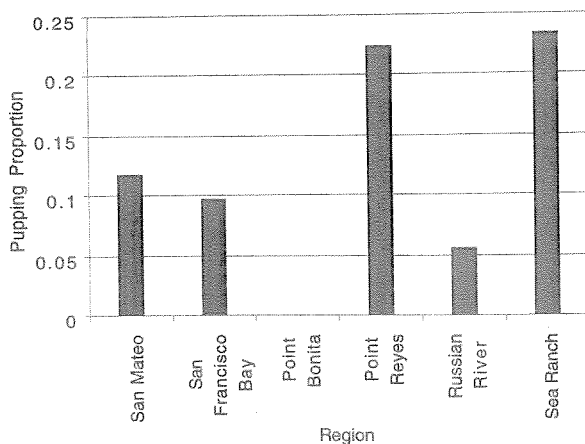


Figure 19. Proportion of the total number of seals represented by pups at consistently monitored haul-outs, 1998–2000 (all years combined). Pups counted April–May.

Counts for 2000 were made on selected days from April 30 through July 7. Again the days were selected to optimize personnel available and to include a low tide. (In some cases, counts were included that were made on other days in the census weeks).

RESULTS

Sites that were consistently monitored for all three years were compared for total seals and pups (Figure 17). These sites were separated into three regions: Point Reyes, the Russian River, and Sea Ranch. The data showed evidence of stability in the total number of seals and pups.

The size of the haul-outs varied between different regions of the census (Figure 18). Point Reyes National Seashore haul-outs were the largest on average, San Francisco haul-outs were intermediate, and Point Bonita, San Mateo, Russian River, and Sea Ranch haul-outs were smallest. PRNS haul-outs had more pups than any other region, and Point Bonita had the least, only one pup having been seen in the 2000 census late in the count period. The regions differed in the average proportion of pups observed at haul-outs in April and May, which are the primary pupping months (Figure 19). The mean proportion of pups was highest for haul-outs surveyed at Point Reyes and Sea Ranch and was lowest for the Russian River haul-outs.

Table 6 presents the seasonal mean number of seals and pups, maximum number of seals and pups, and percentage of pups seen at all regularly censused sites during the census.

DISCUSSION

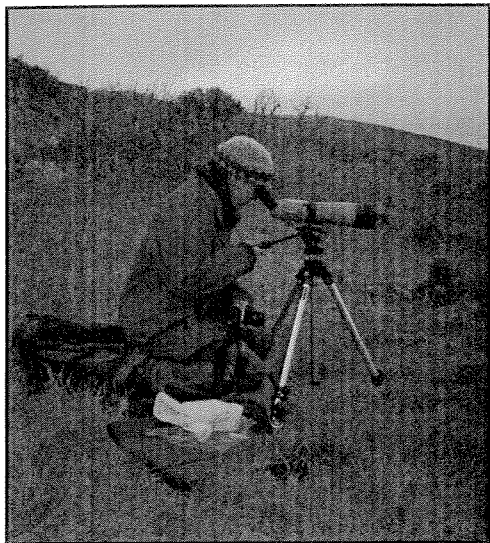
There was no obvious trend in overall seal numbers from 1998 to 2000 at the consistently counted sites, despite the successive ENSO and La Niña years represented in the census. It could be that harbor seals may not be as severely affected as other pinnipeds during ENSO events. The harbor seal population appears to be stable in central California (comparison of the current values with long-term data from Fuharty, 1999; Mortenson and

Table 6. Mean and maximum number of seals and pups, including pup percentages, observed at census sites during March–July, 1998–2000. Pups counted April–May.

Census Site	Maximum Number Seals			Maximum Number Pups			Mean Number Seals			Mean Number Pups			Mean Pup Percentage		
	1998	1999	2000	1998	1999	2000	1998	1999	2000	1998	1999	2000	1998	1999	2000
San Mateo															
Bean Hollow	—	0	1	—	0	0	—	0	0.2	—	0	0	—	0%	0%
Pescadero South	—	0	1	—	0	0	—	0	0.4	—	0	0	—	0%	0%
Pescadero North	—	39	58	—	3	11	—	25.2	46.8	—	3.0	7.0	—	13%	15%
Cowell Ranch	—	178	190	—	10	19	—	95.0	154.2	—	6.5	15.0	—	10%	9%
San Pedro	—	50	31	—	3	4	—	28.8	21.8	—	2.3	2.0	—	9%	13%
Devil's Slide	—	27	—	—	1	—	—	27.0	—	—	1.0	—	—	4%	—
San Francisco Bay															
Mowry Slough	—	243	210	—	78	54	—	136.8	144.3	—	30.4	22.5	—	22%	17%
Yerba Buena Island	—	198	117	—	7	7	—	119.9	88.8	—	2.8	4.7	—	3%	5%
Castro Rocks	—	139	163	—	21	21	—	107.7	120.2	—	14.2	14.0	—	14%	12%
Corte Madera	—	7	6	—	1	0	—	7.0	3.3	—	1.0	0	—	14%	0%
Point Bonita															
Zone 1	—	—	64	—	—	0	—	—	14.4	—	—	0	—	—	0%
Zone 2	—	—	30	—	—	0	—	—	21.8	—	—	0	—	—	0%
Zone 3	—	—	61	—	—	0	—	—	22.4	—	—	0	—	—	0%
Point Reyes															
Bolinas Lagoon	149	288	387	47	50	104	116.0	177.4	235.8	36.7	37.8	72.8	29%	27%	37%
Duxbury Reef	—	98	112	—	0	20	—	97.0	35.2	—	0	5.5	—	0%	10%
Double Point	847	890	918	160	283	254	675.3	458.9	642.3	121.0	171.2	172.0	18%	28%	26%
Drakes/Limantour	853	922	1020	192	237	265	715.0	505.2	776.2	133.7	140.4	163.5	19%	26%	22%
Point Reyes Headlands	77	431	149	23	38	45	63.7	131.8	75.5	15.7	20.2	27.3	25%	28%	32%
Tomaes Point	485	478	451	68	75	189	345.3	211.6	246.7	56.0	34.0	67.8	16%	21%	26%
South Sonoma Coast															
Chalanchawi	11	9	9	0	0	0	6.5	3.9	4.3	0	0	0	0%	0%	0%
Jenner	249	300	254	13	35	30	147.8	184.1	216.3	7.4	20.6	23.7	5%	11%	12%
North Jenner	1	34	8	0	0	0	0.4	7.8	2.3	0	0	0	0%	0%	0%
Odin Cove	3	26	10	0	0	1	2.6	9.0	4.7	0	0	0	0%	0%	0%
Sea Ranch															
Sea Ranch Lodge	—	34	32	—	6	5	—	13.8	19.6	—	3.8	2.7	—	34%	22%
Green Cove	46	46	55	6	10	6	27.3	25.8	27.2	4.3	4.5	4.7	16%	22%	26%
Breaker's Reach	—	—	19	—	—	4	—	—	10.8	—	—	2.0	—	—	21%
Cormorant Close	43	44	44	7	19	9	22.7	27.6	26.0	5.3	10.0	8.5	24%	38%	46%
Tidepool Rookery	65	146	96	18	44	36	56.7	63.9	65.6	17.0	25.0	22.0	30%	31%	38%
Dune Drift	28	47	47	4	6	13	16.3	21.3	29.8	2.0	1.8	8.0	12%	9%	34%
Del Mar	13	11	12	0	0	1	12.0	4.9	6.4	0	0	0.7	0%	0%	25%

Twohy, unpublished data; Sarah Allen, personal communication).

New sites were added in 2000 at Point Bonita, Corte Madera, and along the San Mateo coast. The more completely our surveys cover the coast, the better we will be able to determine and track the harbor seal population of the central California coast.



A SEALS volunteer keeps an eye on harbor seals hauled out in Tomales Bay.

SUMMARY

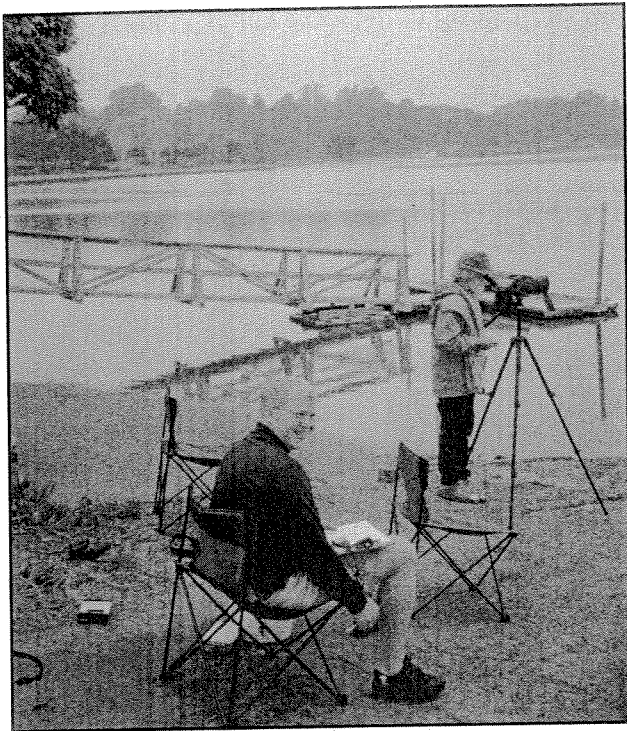
Clamming continues to be the most frequent activity on Clam and Seal Islands in Tomales Bay. However, during the past three years, with SEALS docents on the mudflats, clamming has been associated with a low flush rate (0.08 flushes per hour in 2000, 0.13 in 1999, and 0.08 in 1998). One percent of the clambers has been associated with flushing the seals. Prior to the SEALS program, 51% of the clambers and fishers were associated with flushes.

For the third year in a row, boating was the dominant human activity associated with harbor seal disturbance in Tomales Bay. In 2000, the mean daily number of motorboats increased from 29.6 to 59.4 and the associated flush rate increased from 0.21 in 1999 to 1.24 in 2000. Transportation patterns of clambers to the Islands has shifted from arriving to the Islands by barge to arriving by small motorboats. In 1999, the PRNS rangers patrolled Tomales Bay and counseled recreationists on how to avoid wildlife disturbances. The presence of the patrol ranger may have lowered the motorboat flush rate. However in 2000, the PRNS patrol boat was unable to operate for most of the clamming season, and its absence may have influenced the increased motorboat flush rate. The increase in motorboats presents a new management challenge for the Gulf of the Farallones National Marine Sanctuary. In response to the increase in disturbance from motorboats, the Farallones Marine Sanctuary Association will be forming a committee to develop a plan on how to address this problem. Potential solutions include increased boater education and enforcement.

Although a high percentage of the kayakers have been associated with flushes over the past three years, in Tomales Bay there has been a 40% decline in associated flushes. In 1999/00, 29% of the kayakers were associated with flushes compared to 38% in 1998/99 and 48% in 1997/98. In Bolinas Lagoon, the percentage of kayakers associated with flushes dropped from 27% in 1997/98 and 29% in 1998/99 to 12% in 1999/00. However, in Bolinas Lagoon the percentage of canoeist associated with flushes has increased from 29% in 1997/98 and 33% in 1998/99 to 44% in 1999/



Clammers dig deep on Seal Island, Tomales Bay.



SEALS volunteers count harbor seals (*P. vitulina*) around Kent Island at the new monitoring site on Bolinas Lagoon.

2000. Over the past two years, the Farallones Marine Sanctuary Association has been working with the kayaking community to educate members how to avoid disturbing wildlife. The Farallones Marine Sanctuary Association will continue its kayaking education work and will address the increase in disturbance from canoeists at the Bolinas Lagoon Technical Advisory Committee's wildlife subcommittee.

The SEALS program was initiated in Bolinas Lagoon to address the community's concern that shore-side visitors were disturbing resting harbor seals. Over the past three years, the SEALS program has observed very little disturbance from shore-side visitors. One percent of the hikers was associated with a flush in 1999/00 compared to 3% in 1998/99 and 2% in 1997/98. Roadside visitors were not associated with any flushes in 1999/00.

During the last three years in Bolinas Lagoon there has been a decline in the number of flushes observed per hour. The flush rate was 0.09 per hour in 1999/00 compared to 0.14 in 1998/99 and 0.16 in 1997/98. In July 2000, FMSA expanded the SEALS monitoring program to observe the seals on the mudflats near Kent Island in Bolinas Lagoon. This information will provide a clearer picture of human activities and harbor seal disturbances in the Lagoon. FMSA can then compare the present harbor seal disturbance rate to past studies and evaluate if the rate is increasing or decreasing.

In 2001, FMSA will be working with the Golden Gate National Recreation Area and the Marin Headlands Institute to help address harbor seal disturbance at Point Bonita in the Marin Headlands. FMSA will work with the Park and the Institute to develop a harbor seal monitoring program for students.

Overall the harbor seal population along the central California coast appears to be stable. The Farallones Marine Sanctuary Association will continue to encourage other researchers to join the Central California Cooperative Harbor Seal Census. With more sites included in the census, we can create a more complete picture of the central California harbor seal population and can determine habitat areas at greatest risk.

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ACKNOWLEDGMENTS

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