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APPENDIX I

THE EFFECTS OF HUMAN DISTURBANCE ON A POPULATION OF HARBOR SEALS

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Tugidak Island (56°30'N. 154°40'W), one of the Trinity Islands, is located in the Gulf of Alaska 20 miles southwest of Kodiak Island. About 18 miles long and four to seven miles wide, its sand and pebble beaches are used by large concentrations of harbor seals (*Phoca vitulina richardi*) throughout the year.

From 1965 to 1971 Alaska Department of Fish and Game (ADF&G) personnel conducted investigations of the Tugidak harbor seal population, including the tagging of over 4,300 pups, in conjunction with monitoring the intensive seal hunting operations on the island. With the passage of the Marine Mammal Protection Act of 1972, hunting operations ceased, and ADF&G discontinued the study. The present project was undertaken in 1976 by ADF&G in order to assess the population during a relatively undisturbed period to provide data to compare with past and future studies. This paper reports the effect of human disturbance on seals from May through September, 1976.

The study consisted of daily field observations of a 3-mile stretch of beach at the southwest end of the island, where about two-thirds of the population regularly hauled out. Occasional observations were also made on the other haul out area regularly used by the seals, a 10-mile stretch of beach at the northeast end of the island, to aid extrapolations

During the pupping season (May 15 to July 4) about 4,000 seals regularly hauled out on the island. This number increased dramatically during August to a peak of about 13,000 in early September. Over 1,000 pups were born in the primary study area, and the total estimated production for the island was 2,000 pups, though the actual number may have been somewhat higher.

The following is a brief summary of our findings on disturbances. Sections 1 and 2 provide background information and Section 3 offers preliminary conclusions concerning the effects of disturbance on the population.

1. Behavior of Mother-Pup Pairs

Harbor seal pups are generally born on land, although there is one reported case of a captive harbor seal successfully giving birth in the water (Johnson 1969), and there is circumstantial evidence that this may occasionally occur in the wild (Venables and Venables 1955). Prior to birth, the pregnant female hauls out in or near a group of seals and after an average of one-half hour of visible labor, gives birth. The first two hours after birth are the most critical for the pup's ultimate survival. Initially, the pup is disoriented and lacks coordination. During this period the mother frequently initiates "nose-to-nose" contacts and the resulting exchange of sensory information provides the basis for future mutual recognition. Generally, within one hour of birth the pup moves with its mother into the water, where, after an initial 15-30 minutes of disorientation, it rapidly becomes a proficient swimmer. On

the average, the first nursing takes place two hours after birth (on land or in the water), further establishing the mother-pup bond.

Under normal circumstances the mother and pup remain together constantly for about three weeks. During the next week or two, periodic separations may be normal, and weaning occurs about the fifth week after which the pup leaves the area. A permanent separation of mother and pup during the first week of the pup's life usually leads to the death of the pup within two weeks. Permanent separations, occurring in the second or third week of life greatly reduce the pup's chance of survival, but early death is not inevitable. Upon separation from its mother a pup will approach and attempt to nurse off virtually any lactating female. Adult females are more discriminating than the pups, however, and will seldom allow any pup but their own to suckle, thus the chances of stolen meals or adoption are rare.

2. Mortality

As only a portion of a seal's life is spent ashore, harbor seal mortality is difficult to assess. The situation on Tugidak is further complicated because high tides frequently cover the entire beach, so carcasses seldom remain in the same place for over a day. With the exception of one tagged seal collected as part of the study, only three dead adults were seen during the study period. This adult mortality seems low for a population which numbered over 13,000.

The observed pup mortality was also undoubtedly a low figure. Fifty-three fresh pup carcasses were found at the southwest end of the island,

representing 5 percent of the known pup production. Pup mortality in the first three months of life has been reported at 13 to 21 percent (Boulva 1975, Johnson 1969). As further evidence that beach dead carcasses represented only part of the actual pup mortality, 66 starveling pup were counted during one census in late June, more than the total accountable pup mortality (starvelings are unattended pups of such emaciated condition that there is virtually no chance of their survival). Even though the actual pup mortality is an elusive figure, the number of dead and starveling pups seen in 1976 can be used as an indicator of pup mortality, and can be compared with future work on Tugidak.

Causes of pup mortality on Tugidak were similar to those reported in other studies (Boulva 1975). Although stillbirths, premature births, injuries and illness could account for some deaths, most pups died from starvation, directly resulting from a permanent separation of the mother and the pup. A large number of these separations occurred within the first hour and a half of the pups' lives, either because of outright abandonment by the female, or more frequently because of a major disturbance.

3. "Natural" Disturbances

Harbor seals are a vigilant animal, spending much of their time ashore alert and orienting around the environment. Haul out locations are generally characterized by easy access to water, and are located in areas which are difficult to approach unseen.

Any loud or sudden noise, or the appearance of an unfamiliar object can lead to the desertion of a haul-out area by a seal herd. "Natural" disturbances (not man-related) were of two intensities. If the disturbance was minor, sending just a portion of the group into the water, seals returned rapidly to the haul-out sites. However, a major disturbance, which sent all the seals into the water, was often followed by a long period with seals milling about offshore, and when the animals did return to shore the previous haul out area was usually avoided.

The tendency to leave haul-out areas at the slightest provocation frequently resulted in separation of mothers and pups. This was especially true of mothers with very young pups. Although some reunions took place, often these separations were permanent.

Minor disturbances to the seals of Tugidak Island generally involved localized bird activity, small clay slides, or aggressive interactions; all affecting only a section of one group. Major disturbances resulted either from an eagle landing near or in a group, or from a massive rock slide; both of which caused great panic among the seals with all the seals in the area becoming alert, then rushing into the water.

During the pupping period seals hauled out in small discrete groups along the 3-mile study area. Minor disturbances to the groups were frequent. Occasionally a birth sent surrounding lone seals to the water, more often gulls arriving at a birth site to clean up the detritus of parturition caused small flights. Females pass the placental membranes an average of 30 minutes after the birth of their pup, and most females

attempted to defend both the membranes and their pup from the persistent birds. These activities frequently sent many nearby seals into the water, including other mother-pup pairs, but the small number of seals involved created a minimum amount of confusion, and the seals generally hauled-out again within minutes. On occasion, the passage of the placental membranes would attract one or more eagles to the birth area, resulting in a massive exodus of all the surrounding seals to the water, often including the new mother. Any recently born pups were left ashore during this rush, lacking the locomotory ability as well as the practice to follow their mother to the water. Although cases of a female returning ashore to her newborn pup were observed, many separations of the mother and the pup were permanent. Older pups were frequently separated from their mothers during the move to and through the surf. Both females and pups approached other seals in the surf, but the chances of reunions were inversely proportional to the degree of the disturbance and the number of seals affected--the more seals in the water and the longer before hauling out began, the less the likelihood that a female would locate her pup.

4. Effects of Low Flying Aircraft

Planes of various types were frequent at Tugidak throughout the summer. Table 1 lists the dates and sizes of low flying aircraft, and includes only those high altitude planes which were observed to have an effect on the hauled out seals. Although planes flying at altitudes over 1,000 feet often caused seals to leave the haul out areas, they were seldom

Table 1. A list of aircraft over the beaches of Tugidak with date, time and altitude from mid-May through September, 1976.

Date	Time	Aircraft	Altitude
5-16	1400	large plane	250'
5-18	1200	helicopter	75'
5-20	1200	small plane	400'
5-24	1715	small plane	
5-25	1500	small plane	700'
5-31	1500	small plane	
6-02	1300	helicopter	75'
6-07	1115	small plane	50'
	1300	helicopter	50'
	1630	small plane	300'
6-10	0900	large plane	
	1430	helicopter	100'
6-18	1130	helicopter	
6-19	1400	helicopter	30'
	1515	helicopter	30'
6-20	1310	small plane	800'
6-21	0900	helicopter	30'
6-23	1600	small plane	
6-25	1700	helicopter	
	1730	small plane	
6-26	1830	helicopter	50'
6-27	0830	helicopter	50'
7-07	1500	small plane	400'
7-10	0930	helicopter	40'
	1145	helicopter	90'
7-14	0830	helicopter	
7-15	1200	small plane	1000'
7-17	1045	helicopter	30'
7-20	0900	helicopter	
7-31	1700	jet over island	
	1900	jet over island	
8-5	1500	helicopter	
8-12	1400	small plane	250'
8-16	1300	small plane	750'
8-19	1700	helicopter	100'
8-20	1400	jet over island	
8-22	1300	helicopter	20'
9-02	1400	small plane	700'
9-08	1710	small plane	800'
9-09	1510	large plane	1000'
9-10	1150	large plane	1000'
9-21	1430	small plane	700'

responsible for a total desertion of the beach. Aircraft flying at 400 to 1,000 feet had varied effects, depending on four factors; the weather, the frequency of recent disturbances, the type of aircraft, and the altitude. All other things being equal the effect of low flying aircraft on a group of seals is likely to be greater on a calm day than on a "noisy" day, with strong winds, rough seas or rain. Frequent disturbances in an area increase the wariness and disturbability of the seals, helicopters and large planes are more disturbing than small planes, and the lower the altitude the greater the reaction of the seals.

Aircraft flying at altitudes under 400 feet, particularly less than 100 feet, nearly always resulted in most or the seals in each herd entering the water. If all the seals in a group left the haul out beach, they rarely hauled out again at the same spot, instead, they cruised the shoreline looking for any seals which remained hauled-out, or waited for an "adventuresome" animal to choose a new location. If all the seals entered the water (e.g. when a helicopter flew over at 25 feet) at least two hours passed before the seals began to reuse the beach. The effects of low flying aircraft were therefore similar to the effects of major natural disturbances, except that natural disturbances were confined to one locality, while aircraft frequently circled the island causing the entire population to abandon all haul out areas.

Although low flying aircraft over seal haul-out areas are definitely disruptive to the normal daily activity patterns of the seals and thus may have a long term effect on the mortality rate of the population, the

only direct evidence of resulting increased mortality was obtained during the pupping season. During the height of the pupping season, 10 June to 20 June, we saw an average of 1.5 births per hour of observation in the study area (2/3 of island population). Since two observers were able to watch slightly less than 1/2 of the seals in this area, we estimated that there were a total of approximately 5 births per hour on Tugidak during this period. Because of their particular vulnerability, pups born within two hours before a major disturbance, or one-half hour after, were likely to become permanently separated from their mothers in the resulting confusion, especially if there had been a large number of seals onshore. Thus, any aircraft flying at less than 100 feet, circling the beaches of Tugidak during the peak pupping period can be considered responsible for the separation and ultimate death of about twelve newborn seal pups, plus an unknown number of older pups. Based on the number of births per hour throughout the pupping season and frequency of flights around Tugidak, we estimate that aircraft alone were directly responsible for the deaths of over 150 newborn pups, and up to twice that many slightly older pups. Therefore, the moderate number of low flying aircraft visiting Tugidak during 1976 may have accounted for the deaths of more than 10 percent of the pups born on Tugidak. In addition to aircraft, other human disturbances on Tugidak included all-terrain vehicles and hikers, each having effects similar to aircraft; thus the total human related pup mortality would be even higher.

Although the above calculations are speculative, it is clear that low flying aircraft have a deleterious effect on harbor seal populations. We therefore recommend that the number of aircraft flying over Tugidak

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