Executive Summary

Introduction

The U.S. Air Force (USAF) atmospheric interceptor technology (*ait*) program must conduct protected species monitoring during periods immediately before and after *ait* rocket launches from the Alaska Aerospace Development Corporation's Kodiak Launch Complex (AADC/KLC). Monitoring and mitigation efforts for two protected species, the endangered Steller sea lion (*Eumetopias jubatus*) and the threatened Steller's eider (*Polysticta stelleri*), are a condition of the FONSI for the program (AFSMC 1997) and were conducted by the University of Alaska's Environment and Natural Resources Institute (ENRI) in the days before and after the *ait*-2 launch.

The study reported herein was conducted from 12-15 September, 1999, before, during, and immediately after the *ait*-2 launch on 15 September. It ran in parallel with the ENRI effort and was designed to provide the USAF with detailed information about the acoustic characteristics of the ait-2 launch, in part for future prediction of animal impacts and in part for comparison with RNOISE model outputs (Wyle Laboratories). Opportunistic observations of animal behaviors were obtained during this effort as well.

Methods

Larson-Davis sound monitors (LD 820, 824) were deployed to collect noise data automatically at four sites within the Safety Exclusion Zone (SEZ) for the launch, including two sites on Narrow Cape, the portion of Kodiak Island extending closest to Ugak Spit. A fifth monitor on Ugak Spit failed. A real-time DAT recording was collected just outside the SEZ, close to the Launch Control Complex (LCC).

HSWRI and AFSMC cooperators were able to count and observe the behavior of marine mammals on 9/12 from Narrow Cape using a Meade ETX-90EC Telescope (Lang 2000). They also collected behavioral observations during helicopter approaches and landings on Ugak Island 9/14 (2000-2130 h) and 9/15 (1330-1350 h). Sea lions were observed at Ugak Spit after the launch from 1345 to 1500 h on 9/15 using the Meade telescope.

Results

Noise monitoring: The evening and night immediately preceding the launch were marked by moderate to high winds and rainsqualls. At the time of launch, skies were clear and wind close to the ground was from the west (230°) at low speed (9 kt). Ambient noise on 9/14 and 9/15 was similar during hours when there was little wind (<10 kt), with hourly L_{eq} measurements ranging from 43 to 55 dB(A). Only 0.6% of the samples exceeded 70 dB(A) at Site 1 while 4% of sample levels exceeded 70 dB(A) at Site 2, the two HSWRI monitoring sites closest to Ugak

Spit.

Launch ignition occurred at 12:59:59.34 h ADT (local time). At the LCC real-time monitoring site (Site 4), low-amplitude roar was detected on the real-time recording beginning at approximately 2 s after ignition; at 8-9 s, the noise level rose steeply, peaking at 127.5 dB(A). The real-time monitoring site was 3,130 m from the launch stool, leading to a predicted arrival time of 9 s. Thus, when the launch time was assumed to correspond to the peak in launch noise, propagation time was as expected. A-weighted maximum level of the noise was 107.9 dB (unweighted, slow L_{max}; 107.1 dB(A)). The time course of the launch noise was as expected, rising rapidly to an initial sharp peak and declining gradually over a period of 35-40 s.

There were two broad spectral peaks in the noise, one centered at around 30-120 Hz and one at 200-1100 Hz. Levels exceeded the local ambient out to approximately 22,000 Hz at Site 4, the closest to the launch stool. Using the sea lion's estimated threshold at 1000-8000 Hz and the highest 1/3-octave spectral level in that range, the signal-to-noise ratio (SNR) of the launch noise would have been more than 50 dB from the perspective of a sea lion close to Narrow Cape at the surface. However, by the time the vehicle reached its closest point of approach to Ugak Spit, the high-frequency component of the noise had attenuated, making the worst-case SNR at the site of the Steller sea lion haulout 36.5-47.2 dB.

Levels collected by ENRI LD 875 sound meters were compared with the HSWRI data. A-weighted levels measured from paired instruments on Narrow Cape were very consistent, particularly the A-weighted sound exposure levels (ASEL), which came within 1 dB of one another. A-weighted L_{max} and peak levels varied somewhat more (within 4 dB), but were still very consistent for field measurements. The levels measured at all sites were somewhat higher than predicted by the RNOISE launch model, particularly at the sea lion haulout on Ugak Spit. ASEL measured at that site by ENRI was 92.2 dB, 8.1 dB higher than predicted.

Observations of Steller sea lions: The sea lions on the spit at Ugak Island were approached twice on 9/14 in a Bell 206 helicopter to place equipment. According to the pilot, both landings were similar. The helicopter did not overfly the sea lions on the spit directly, instead making an oblique approach from the southwest, landing a few hundred meters from them. The animals congregated tightly and stood alert as the helicopter landed and observers approached. They did not enter the water immediately. A few eventually abandoned the beach as observers worked, but there was no general exodus, nor were individuals seen rafting - congregating in the water close to shore - as observers left the area.

ENRI staff and a NMFS observer (ENRI/NMFS observers) surveyed the haulout on Ugak Spit before, during and after the ait-2 launch. On 9/15, these observers overflew the spit at 0800 h, estimating 76 animals from the air. Aircraft and vessels were cleared from the area thereafter, with the possible exception of overpasses of Ugak Channel by support helicopters patrolling the SEZ. No observers were present on Ugak Island during the launch, so it is difficult to know what the sea lions saw from the spit. At LCC, 3 km from the launch site, the launch was not simply a noisy event - there were also striking visual and tactile stimuli. The burning rocket engines

produced a bright light that climbed rapidly into the sky and a white exhaust plume. A shock wave from the launch was quite palpable at LCC, 3 km away.

At 1327 h observers returned to Ugak Island to retrieve equipment. From the air, no sea lions were visible on the spit. Once observers were on the ground, some sea lions were found in the area, rafting among kelp floats 10-15 m offshore. These sea lions were congregated in 3 groups, tightly rafted, swimming alongshore with heads frequently oriented towards the intruders on the spit. They remained in the water staring at the shore until at least 1500 h. However, by the time of the ENRI/NMFS survey the following morning (0845 h on 9/16), 70-80 animals were back on the spit.

Gray Whales (*Eschrichtius robustus*): As observers scanned the island with telescope and binoculars on 9/12, numerous whales were sighted. They did not appear to be migrating through Ugak Pass or around the outer side of the island, but rather were surfacing in the same general location time after time. Surfacing animals were examined carefully with the telescope whenever they arched or fluked; all of these were found to be gray whales. A few were concentrated at the southwest end of Ugak Island, but most were in the broad entrance to Ugak Bay seaward of Gull Point. The greatest number counted at the surface at any time was 38; the actual number of whales in the area was probably larger.

Conclusions: The rafting behavior observed on Ugak Spit - congregating tightly in the water while watching a potential danger on shore - is a common otariid (sea lion) defensive behavior in the face of a surprising or threatening event. When a large proportion of the sea lions in a group enter the water defensively (‘stampede’), rafting is the usual result. When animals enter the water singly or in small groups, as is typical of foraging trips, rafting typically does not involve a large proportion of the hauled animals. Therefore, an empty beach with many of the animals rafting immediately offshore is strong evidence that sea lions have been surprised or frightened into the water *en masse*.

Unfortunately, the evidence available on the responses of sea lions on 9/15 is equivocal. Although the beach was empty, only 25% of the animals sighted on the beach early that morning were rafting offshore at 1330 h on a warm afternoon. The behavior of the sea lions conceivably could be interpreted as a thermoregulatory response.

In addition, due to an equipment failure, no video was available of sea lion responses at the time of the launch, nor were any direct observations made. ENRI (2000) reports that many of the sea lions entered the water shortly before the monitoring system failed at 0930 h; however, their account lacks the kind of detail needed to evaluate the response, nor was the video made available. Therefore, it is difficult to interpret their observations. It is possible that this behavior was thermoregulatory in nature, or that one or more unknown events occurring on the morning of the launch could have contributed to the rafting observed, for example uncontrolled overflights by the helicopter guarding the SEZ. However, the complete absence of animals on the beach and the tight rafts close inshore at 1330 h argue for some type of disturbance in the relatively recent past (say, within the past hour).

Since the sea lions were already in the water with the beach empty when the helicopter approached at 1330 h, it is also quite likely that the launch was a contributing factor, if not actually a triggering event for long-term evacuation of the spit (they stayed in the water until at least 1500h). In other studies, pinnipeds have reacted similarly when exposed to unusual stimuli (noise, overflights, *etc*.)

Without monitoring noise at Ugak Island over a long period, it is difficult to know what levels would have been unusual from the sea lions' perspective; however, considering only the monitoring period (9/14-9/15) and typical noise levels in remote areas, the SNR of the launch was unusual. Moreover, the launch presented sea lions with novel visual and possibly tactile stimuli. In the face of these novel, high-intensity stimuli, evacuation of the beach and rafting would not be at all surprising.

If sea lions were actually stimulated to enter the water or to remain in it as a result of the *ait*-2 launch, from a legal point of view they would have been harassed. This does not mean that sea lions on Ugak Island necessarily would have been harmed, however. Disturbances of this kind, occurring infrequently and unaccompanied by protracted harassment on the beach, are not known to cause abandonment of favored hauling areas - usually, the animals return to their previous hauling patterns within a day, as was observed by NMFS survey crews on the morning of 9/16 (ENRI 2000). Occasional launch-related harassment would not be likely to have any biologically-significant effect on sea lions outside crucial phases of the breeding season.