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SEA LION & BELUGA REPORT

by

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Project Progress Report
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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: John S. Vania

Project No.: W-17-2 / W-17-3 Project Title: Marine Mammals Investigations

Job No.: 8.1R Job Title: Sea Lion Pelage Study

Period Covered: January 1, 1969 to December 31, 1970

SUMMARY

Examination of pelage specimens from 111 sea lion pups indicates that the first molt begins about the last week in July and is completed by mid December.

BACKGROUND

The Steller sea lion (*Eumetopias jubata*) population in Alaskan waters probably exceeds 150,000 animals. Fur industry representatives have advised the Department of Fish and Game that the pelts of sea lion pups appear to have commercial value that would make their harvest and sale profitable. With this prospect that the sea lion could conceivably become a valuable harvestable resource, efforts are being made to determine how and when these animals could best be harvested. Because molt patterns would effectively regulate the optimal period during which pups should be harvested, their delineation is the logical first step in this program.

OBJECTIVE

To describe the structure, growth and replacement of pelage fibers of Steller sea lions (*Eumetopias jubata*) with relation to age, sex and seasons.

PROCEDURES

A small sample of pelage specimens from Steller sea lion pups has been collected, when the opportunity presented itself, since 1965. The original objective for collecting the specimens was to gain an understanding of the timing of the first molt and to pave the way for future, more detailed studies of the structure, growth and replacement of the fur fibers.

To date only 111 individual specimens have been collected, with the majority, 96, taken between June 5 and August 3. During these months commercial harvest operations were in progress and material could be obtained with little difficulty. Only two collections have been made after August 3. Six pelage specimens were taken on October 25, 1966 from Marmot Island and nine were collected on Amchitka Island on December 3, 1970. Sea lion rookeries are extremely difficult to get to in the winter months and the low priority of the job does not justify costly collection trips specifically for specimen material.

Specimens are collected by cutting a strip of skin about 10 cm square from the center of the back between the front shoulders. The skin sample is then fleshed, stretched and tacked on a small board and submersed in 10 percent formalin. After a week pieces of skin approximately 2 cm by 8 cm are cut from each square and stored individually in small vials containing formalin. Later each specimen is prepared for examination by cutting thin slices with a razor blade parallel to the lay of the roots. A typical slice is about 1 mm thick and 10 mm wide. At least five slices are cut from each specimen. Examination of the slides is made under a low power microscope using Isopropanol or cedarwood oil as a medium for mounting the slides.

FINDINGS

Sixty pelage specimens collected from pups between June 5 and July 6, 1965 on Sugarloaf Island were examined. None exhibited signs of molt. In this resting stage the hairs are mature and sharply tipped. The skin is white and the hair roots are colorless. Ten specimens collected on Marmot Island on July 23, 1966 also were in this resting stage.

Ten specimens collected on July 29, 1966 at Marmot Island and six collected on August 3 at the same location all exhibited the early stage of molt. At this stage some of the hair roots are becoming active and producing new fibers. Melanin is present in the root of the hair follicle. The skin appears white to the naked eye but under magnification some melanin can be seen in a few hair roots.

Six specimens collected on Marmot Island on October 25, 1966 exhibited a very active stage of molt. At this stage most or all of the hair follicles are producing new fibers and the skin appears black to the naked eye. Many of the new hairs have erupted at the surface and the animals show visible signs of hair shedding.

The last collection of nine pups made on December 3, 1970 at Amchitka Island indicated that they were approaching the final stage of molt. Except for a few hair roots the follicles were resting and the skin was white in color. The animals still showed signs of hair shedding but it was considerably less than those taken in October.

Although the pelage specimens have been collected over a long period of time and from widely scattered areas, a tentative conclusion may be drawn from the data. It appears that Steller sea lion pups in Alaska, which are generally born in June, begin to molt about August 1. The molt continues for approximately 19 weeks and is probably completed by December 10.

RECOMMENDATIONS

Pelage specimens collected to date have been obtained over a long time period and have come from widely scattered areas. The conclusions drawn from this type of data are tentative at best. Weekly collections of ten animals in one molting period from one location in late July and early August and in late November and early December should be made to verify the start and end of the molt.

The study should be continued for one additional year.

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: John S. Vania and Dr. James Fish, Department of the Navy

Project No.: W-17-2, W-17-3 Project Title: Marine Mammals Investigations

Job No.: 8.2R Job Title: Beluga Whale Studies

Period Covered: January 1, 1969 to December 31, 1970

SUMMARY

Underwater transmissions of killer whale vocalizations prevented white whales from moving up the Kvichak River, Bristol Bay, Alaska. During control periods when sound was not projected, the whales moved freely in and out the river feeding on young salmon migrating out to sea.

BACKGROUND

Underwater sound transmission experiments conducted in the Kvichak River in 1967 and 1968 indicated that killer whale sounds projected underwater could influence beluga whale movements. The reactions of belugas to the transmissions were inconsistent however, and it was felt that this inconsistency was probably due to weak playback signals. Due to budget limitations, the low priority of the job, and the experimental nature of the program the Department of Fish and Game was unwilling to expend the funds necessary in 1969 to purchase costly equipment capable of transmitting high-intensity underwater sounds. As a result no work was accomplished on this Job in 1969.

Funds for purchasing equipment in 1970 again were not available so other avenues for completing the job had to be explored. Through personal correspondence, Dr. William Cummings, Department of the Navy, Naval Undersea Research and Development Center, San Diego, California agreed to send Dr. James Fish of his staff to Alaska to conduct experiments utilizing equipment capable of transmitting high-intensity signals. We are indebted to them for the services they performed.

PROCEDURES, FINDINGS, AND RECOMMENDATIONS

A report for this cooperative project was written and submitted for possible publication in a scientific journal. The text of this report, which when published will act as a final report for Job 8.2R, follows:

White whales, or belugas, Delphinapterus leucas commonly travel 20 to 30 km up Alaska's Kvichak River on the flood tide and back down on the ebb, foraging on available food organisms along the way. This twice-daily movement of from 25 to over 500 whales occurs during May and throughout most of June and is halted only after boat traffic from the seasonal salmon fishery becomes very heavy.

The Kvichak River supports the most extensive run of red salmon, Oncorhynchus nerka, in the world, ranging from 1 to 45 million fish per year. Lake Iliamna, the largest lake in Alaska, located about 80 km up the Kvichak, is the principal rearing area for the young fish before they migrate to sea as one or two year olds. The annual seaward migration of salmon fingerlings, called smolt, occurs during the end of May and the first two weeks in June with the peak of migration occurring about the first of June.

Field studies by the Alaska Department of Fish and Game in the 1950's (1) showed that beluga predation on red salmon smolt occurred during their spring migration and appeared to be most extensive in the confines of the river. As the smolt moved into Kvichak Bay, they apparently scattered and became less vulnerable to predation. Attempts were made to keep the belugas out of the river by chasing them with motorboats and by dropping small charges of explosives. These methods were not very successful and were difficult to use during inclement weather or at night.

From 1963 to 1968 the second author projected various sounds under water in an attempt to keep the whales out of the river. These experiments were only partially successful. They indicated, however, that the inconsistent reaction of the belugas to the sounds was probably due to weak playback signals. This paper reports the result of studies conducted during the 1970 season using equipment designed for transmitting high-intensity underwater sound.

Past attempts at influencing the movement of wild whales with sound generally have been unsuccessful, but in nearly all of these experiments the projected sounds did not exceed 140-150 dB re 1 $\mu N/m^2$ (= 40-50 dB re 1 $dyne/cm^2$) at 1m. An exception was a sound playback experiment on California gray whales Eschrichtius glaucus, by Cummings and Thompson (companion paper, this issue of Science) that utilized the same transmitting system used in this experiment.

The primary high-power transmitting system consisted of a Uher tape recorder, a small impedance-matching amplifier, a 250-watt Optimation power amplifier, and a sound projector developed and built by the Naval Undersea Research and Development Center. Frequency response of this system was ±3 dB from 300-4000 Hz, limited by the projector. A secondary, battery-operated playback system (completely portable) utilized a Uher tape recorder, a 40-watt Bogen amplifier powered by a motorcycle battery, and a J-9 sound projector; system response was ±3 dB from 200-6000 Hz. The primary system was operated from a pier at Station A and the secondary from a small boat at Station B.

A calibrated recording system, consisting of a Wilcoxon hydrophone, a Uher tape recorder, a sonar calibration box (2), and a modified GR Octave-Band Analyzer, was used to measure the sound pressure level of the playback signals at various points throughout the river, and to record the vocalizations from the belugas.

We selected killer whale, Orcinus orca, vocalizations for transmitting to the belugas because of their outstanding acoustic properties and because killer whales are known to kill and eat the relatively slow-swimming white whales (3). A long-play tape was made from "screams" and echo-location-type pulses with high signal-to-noise ratio (4).

In the first 10 playback trials, the sound, transmitted only from Station A, was not turned on until the approaching whales were sighted. But in subsequent trials, when we transmitted from both A and B, we started the playback as soon as the tide changed. A playback trial lasted from 15 min to 2 hrs -- as long as necessary to either move the whales back down the river (in those trials where they were permitted to move part way up before the sound was turned on), or keep them from moving up the river (when the sound was turned on before the whales started upriver).

We had an excellent view of the river from 25 m above the surface of the water at Station A; frequent low-altitude flights in small planes provided a check on the exact location of the whales. The white-colored whales were easy to see in the muddy brown river.

In all, there were 14 playback trials plus 7 control trials in which the whales were observed but sounds were not transmitted. The number of whales involved in each trial ranged from 50 to near 500 with about 100 being the average group size. Since several years of observations indicated the belugas move up the river on every incoming tide, we did not feel it was necessary to have an equal number of transmission and control trials. Consequently, we introduced a control after no more than 4 successive transmissions, primarily to determine if the belugas had stopped using the river as a result of the sound playbacks.

The sound pressure level of the playback sounds transmitted from Station A was measured at 6 locations in the river within 4 km of the source (Table 1). All levels reported in this paper are in dB re 1 $\mu N/m^2$. Sandbars prevented good transmission across the river, particularly during the early stages of the flood tide when some of the bars were covered by less than 0.5 m of water. For example, the sounds projected from Station A were below the background noise level at Location 6. The best transmitting channel was downriver toward Telephone Point (Location 2), where a level of 132 dB was measured for the playback signals. Beyond this area, the signal level dropped off quickly due to shallow water which extended out a considerable distance from the Point. Since most of the energy of the playback sounds occurred in a frequency band from 500-5000 Hz, we measured the ambient levels in this band in addition to making broadband measurements.

In the first 7 transmission trials, we allowed the whales to move up the river to within approximately 2 km of the sound source before turning on the playback. The first 6 times, the animals turned immediately when the sound began and swam directly out of the river against the strong incoming tide. Their rate of blowing increased and they were lifted out of the water by the current, making it very easy for us to observe their course. On the 7th trial, some of the animals crossed to the opposite side of the river when the sound started and swam downstream along the sandbar (Location 4). The others remained just off Telephone Point for an hour, then moved out of the river.

It was difficult to see the approaching belugas on the 8th trial because of low light levels, and they had already moved up to Location 6 before we started transmitting. About half of the 100 whales continued up the river; the other turned and swam back out along the sandbar. On the next trial, the animals were first seen moving upriver along the sandbar. They continued up to the end of the bar, even after the sound was turned on, but then rounded it and moved back down the river on the other side of the bar (Location 5).

The belugas similarly rounded the upriver end of the sandbar on the 10th trial; but, instead of turning around, they swam to the shore (Location 7) and moved on up the river very close to the bank. Poor transmission to this location from Station A and the reaction of the whales during the 10th trial made it necessary to use a second transducer simultaneously at Station B. A copy of the Station A playback tape was used at Station B, but it was not possible to synchronize the playback sounds from the 2 projectors. In the subsequent 4 trials, we turned on the playback as soon as the tide changed, thus eliminating the possibility of the whales going by us unnoticed before the start of transmission.

Table 1. Sound pressure level (dB re 1 $\mu N/m^2$) of playback signals and ambient noise at the indicated locations.

Location re Fig. 2	Signal Broad-band (dB)	Ambient Noise Broad-band (dB)	Ambient Noise 500-5000 Hz Band (dB)
1 m from Source A	170	120	No Data
1	115	103	96
2	132	90	84
3	107	91	85
4	103	95	90
6	Below Ambient	98	95

The 4 transmissions using both projectors completely kept the whales from swimming up the river; they never approached closer than 1.5 km to the sound source.

In each of the 7 control trials, when no sound was played, the whales moved directly up the river with the incoming tide, past the transmitting stations. They behaved the same as they did before any of our experiments, with some of the animals passing near the pier at Station A. We frequently saw more whales during the controls than during the playback trials. Low-altitude reconnaisance flights confirmed our suspicion that numerous whales were remaining down the river out of view during the killer whale transmissions. Apparently, only part of the herd attempted to go up the river during the killer whale transmissions (5).

Belugas vocalize extensively (6). We recorded their sounds many times at various places throughout the river, often under ideal conditions: flat calm water with no boat traffic. Once, we drifted in a small boat for over 2 hours during a no-playback control with a group of about 500 whales and recorded a spectacular variety of vocalizations from this relatively undisturbed group. However, the belugas emitted very few sounds when the killer whale signals were being transmitted.

The belugas did not appear to habituate to the killer whale signals during the 2-week period of this experiment. Even if the whales were to habituate after 2 weeks of playback, this would not significantly affect the usefulness of the technique. Playback could be timed to coincide with the 2-week peak of the smolt run.

Our experiments showed that belugas can be kept out of the Kvichak River with sound. This method was very effective and practical. Installing and maintaining such a playback system for 2 to 3 weeks each year would seem to be an economically feasible way of reducing belugas predation on red salmon smolts.

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4. Killer whale vocalizations from several sources were used to make the playback tape -- primarily from animals in Puget Sound, Washington. A typical "scream" is shown in the spectrogram in the companion paper (this issue Science) by Cummings and Thompson.

5. After completing this experiment with killer whale playbacks, we projected a 2500-Hz continuous tone and 2500-Hz randomly pulsed tones.

The belugas continued up the river during the continuous-tone playback, but turned back on the 2 occasions when pulsed tones were transmitted. Since these playbacks were tried after the white whales had been subjected to the killer whale sounds for 2 weeks, we cannot speculate on how naive whales would have reacted.

6. W. E. Schevill and B. Lawrence, *Science*, 109, 2824 (1949); *Woods Hole Oceanographic Institution*, Ref. No. 50-1, phonograph record (1950); M. P. Fish and W. H. Mowbray, *J. Marine Res.* (Sears Found. Marine Res.), 20, 2 (1962).

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