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STUDY TITLE: Feeding Ecology and Habitat Dependence of the Gray Whales in the Chirikof Basin, Bering Sea, Alaska.

REPORT TITLE: Feeding Ecology of Gray Whales (Eschrichtius robustus) in the Chirikof Basin, Summer 1982.

CONTRACT NUMBER(S): MMS: 14-12-0001-30019; Research Unit No. 626.

SPONSORING OCS REGION: Alaska.

APPLICABLE PLANNING AREA(S): Norton Basin.

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PROJECT MANAGER(S): Outer Continental Shelf Environmental Assessment Program (OCSEAP).

AFFILIATION: National Oceanic and Atmospheric Administration.

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KEY WORDS: Norton Basin; Alaska; endangered species; literature review; Chirikov Basin; feeding; biomass; distribution; aerial observations; shipboard observations; survey; sonar; gray whale; Eschrichtius; St. Lawrence Island; abundance; density; infauna; videotapes; amphipods; Alaska Region.

BACKGROUND: Some species (e.g., bearded seal, ringed seal) are year-round residents of the northern Beaufort Sea, whereas others (e.g., bowhead whale, belukha) use it as wintering grounds. Gray whales (Eschrichtius robustus) frequent this region in summer to forage, during which they must store enough energy to carry them through their stay on their wintering grounds off Baja California. In summering areas, benthic amphipods form the principal part of their diet. This study was implemented with funding from the U.S. Department of the Interior, Minerals Management Service to determine the carrying capacity of the summer habitat, which may ultimately regulate gray whale populations.

OBJECTIVES: (1) To determine the "carrying capacity" of the Chirikof Basin for gray whales as a means of evaluating the importance of this region to this whale species; and (2) To estimate the effect on gray whales of any serious adverse impacts on this habitat.

DESCRIPTION: Abundance and distribution data were gathered on gray whales utilizing the Chirikof Basin area. Food consumption by gray whales in summer was determined along with biomass, distribution, and productivity of prey species. The study encompassed four components, including: (1) estimation of the numbers and distribution of whales utilizing the Chirikof Basin, based on literature and shipboard and aerial surveys; (2) estimation of food consumption by gray whales using two independent methods; (3) estimation of biomass and distribution of gray whale prey species in the Chirikof Basin through the examination of samples collected by surface- and diver-operated gear, videotape camera, and 35-mm photography; and (4) estimation of the productivity of the infaunal prey of the gray whale using accepted methods and requiring year-round sampling at single site. Total food consumption by gray whales in the Chirikof Basin was estimated from data pertaining to the frequency of feeding dives, the amount of food removed per dive, and the estimate of the number of whales in the area. Food availability was determined by applying productivity to biomass ratios of prey species to the biomass of prey species in the area used by gray whales as foraging grounds. Aerial surveys, flown in mid-July and early September, were completed along 10 transects across the Chirikof Basin and over coastal areas. Shipboard work was conducted from 16 stations in the central Basin and 11 stations near St. Lawrence Island. At each station, a 500 kHz side-scan sonar was towed to detect the density of

feeding features. Five Van Veen grab samples were taken at each station. Abundance, biomass, and species composition of animals were recorded for each sample. Amphipod production was measured via sampling in August and September 1982 and January, March, and May 1983. Observations and videotapes of whale behavior were obtained (i.e., breathing rate, duration of surfacings and dives, distance travelled, and whether or not dives were accompanied by evidence of feeding).

SIGNIFICANT CONCLUSIONS: Aerial surveys showed that gray whales were concentrated in a broad band extending from Cape Prince of Wales (Seward Peninsula) and south to Northeast Cape (St. Lawrence Island), with few whales observed within the American Chirikof Basin to the east or west. Gray whales were also numerous along the east and west coasts of St. Lawrence Island. During the two surveys, 46% of the whales sighted were accompanied by mud plumes created as a result of feeding. Behavioral observations indicate that whales spent more time socializing and traveling and less time feeding in September than in July. In the Chirikof Basin and around St. Lawrence Island, gray whales feed in two different ways, both of which involve suction of the bottom while the whale is on its side. Assumed average amphipod consumption per whale is 321 kg/day, although this value could be as high as 678 kg/day. Gray whales were shown to selectively feed in areas with highest biomass. An average gray whale would require a daily intake of 800 kg/day in summer in order to store sufficient energy for a 62-day period of fasting off Baja California in winter. Evidence of feeding during $\geq$50% of the migration period would lower this demand to $\approx$604 kg/day.

STUDY RESULTS: The shallow (10 to 15 m) shelf off Southeast Cape, St. Lawrence Island was covered with a cohesive "mat", which allowed bottom features made by feeding gray whales to be conspicuous and well defined. Photis fischmanni was the dominant amphipod in samples from the shallow shelf off Southeast Cape, with densities of approximately 100,000 individuals/m^2 and mean biomass of 125 g/m^2. Amphipods accounted for 98% of the total numbers of animals and 65% of biomass in airlift samples. Cumaceans, isopods, other crustaceans, and large numbers of pennate and centric diatoms were also found in the "mat". Standing stock biomass of all benthic infaunal samples was highest off Southeast Cape and along the west coast of St. Lawrence Island; lowest biomass was found in the Chirikof Basin. Overall, amphipods were the dominant taxa in terms of both density and biomass, followed by bivalves and polychaetes. Measurements of production were made on Ampelisca macrocephala and Photis fischmanni. Total production of A. macrocephala for the period July 1982 to May 1983 was 3.8 g/m^2 dry weight; mean standing crop was 2.9 ± 1.0 g/m^2. Production to biomass ratio was 1.3. Total productivity of P. fischmanni was 24.97 g/m^2; mean biomass was 8.158 g/m^2. Productivity to biomass ratio was 3.1. Within the study area, each of the species appeared to differ from the others in terms of habitat selection and utilization. Little niche overlap is apparent among the most common species. Two sets of aerial survey lines were flown 10-17 July totalling 3,709 km. A total of 79 gray whales (21.3/1,000 km) were seen. Their distribution suggests that gray whales were concentrated in a broad swath extending from Cape Prince of Wales south to Northeast Cape. Gray whales were also found in substantial numbers in nearshore waters east and west of St. Lawrence Island. The general distribution of whales observed during 9-10 September appears to have been similar that observed in July, with the exception that no whales were seen north or west of King Island during September. From the presence of mud plumes, it appears that gray whales were feeding throughout all of the areas in which they were recorded. High densities of whales were found off Southeast Cape and the south and west coasts of St. Lawrence Island, in the south central Chirikof Basin, and across the international boundary in the northwest part of the Chirikof Basin. These distributions closely parallel those found during aerial surveys. Whales off St. Lawrence Island were generally alone, with most behavior related to bottom feeding. Feeding whales were found to stay roughly in the same area for some time, despite the presence of current action. The presence of social grouping was significantly higher in September than July, and combined with shorter feeding dives. The surfacing-dive cycle of the gray whale was quantified in terms of a submerged period (duration) and a surfacing period (duration). During each surfacing, the frequency of blows (exhalations) and intervals between blows was measured. In July, 1,833 blows with a blow rate of 0.997 blows/min were noted. In September, 1,612 blows and a blow rate of 1.122 blows/min were noted. Blow intervals tended to be longer when whales were not feeding. Durations of surfacings showed the same trend as

with duration of dives. Blow intervals were found to be correlated with depth, with number of blows per surfacing and the correlated duration of surfacing increasing with increasing depth. Duration of dives did not show a consistent increase with increasing depth. Marked seasonal effects on dive duration were noted, with much less known feeding dives in September. Feeding dives were also shorter in duration in September. In July, overall horizontal distance traveled during surfacing was 57 ± 55.0 m, and minimum horizontal distance traveled during dives was 95 ± 82.9 m. In September, surface distance was considered shorter, at 30 ± 23.48 m, whereas dive distance was comparable to the July value, 92 ± 88.1 m. Gray whales are believed to feed on their sides, sucking up the surface layers of sediment and leaving a series of oblong, mouth-sized depressions. Two types of features resulting from gray whale feeding were common in the Chirikof Basin: furrows and pits. Furrows are believed to result from feeding while in motion, leaving gaps when expelling sediment. Mean length of the numerous furrows was 4.9 ± 3.7 m and width was 47.6 ± 34 cm. Depth of all features was 1 to 2 cm. Pits are defined as shallow depressions, resulting from single feeding events, or individual suction "bites" of the substrate. The pits may be regularly spaced in a semicircle, random in a small area, or so close together that the individual pits are not recognizable. Side-scan records indicate that the nearshore areas off Southeast Cape showing heavy pitting encompassed about 12 km^2. Feeding feature size tended to increase in September. Three feeding feature areas were identified: the northeastern and west central regions of the Chirikof Basin (used very little or not at all by gray whales); the north central region of the basin (sparsely used); and the central portion of the basin and all examined areas around St. Lawrence Island (extensively used). Distributions of feeding features on the sea floor closely parallel the distribution of whales as observed during shipboard and aerial surveys. Bivalves, echinoderms, and polychaetes were the dominant benthic organisms in areas that showed few or no feeding features. The sea bottom within shallow waters off Southeast Cape were covered by a "mat", consisting of a gelatinous mixture of primarily amphipod tubes and sediment. Amphipods accounted for 65% of the total biomass and 98% of the total density of benthic animals in this area. Polychaetes and bivalves accounted for 13% and 10% of benthic biomass, respectively. Data indicate that gray whales actively select for amphipods both during selection of feeding sites and by processing only the top 2 cm of the substrate, which apparently has little effect on burrowing polychaetes and bivalves. Estimates for numbers of gray whales near St. Lawrence Island and in regions to the north for 1982 total 19,338 individuals. Whales arrive at St. Lawrence Island in May and June and depart in October and November. Total number of feeding dives for whales migrating through the Chirikof Basin would be 16.4 x 10^6, clearing an area of 1,046 km^2, representing about 4.4% of their feeding habitat in the Chirikof Basin. Assuming that the whales consume only amphipods and do so with a 95% retention efficiency, then the average whale in the Chirikof Basin will consume a mean of 361 kg/day over the 150-day study period. Basal metabolic rate for an average adult male gray whale was estimated at 70.5 kcal/day. Assuming no net gain or loss in energy stores during migration, a summering whale would have to collect 629 kg/day to meet its daily requirements while on the feeding grounds, plus 170 kg/day to store energy for the 62 days it spends off Baja. If the whales consume half their daily energetic requirements through feeding during the 152 days of migration, then a further 210 kg/day must be collected during summer to account for the other half of the energy needed for migration (a total of 1,009 kg/day). If no feeding occurs during migrations, then whales feeding on the summer grounds must consume 1,218 kg/day. Overall, gray whale food requirements do not appear to be as close to the carrying capacity of their environment as are the food requirements of some other consumers, such as the Pacific walrus and certain North Sea demersal fish. Gray whales in the Chirikof Basin consume approximately 4% of the productivity of benthic amphipods. The primary concern regarding potential oil and gas development in this region would be disruption or denial to the whales of pockets or patches of prime feeding habitat.

STUDY PRODUCT(S): Thomson, D. H. (ed.). 1984. Feeding Ecology of Gray Whales (Eschrichtius robustus) in the Chirikof Basin, Summer 1982. A final report by LGL Ecological Research Associates, Inc. for the U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, Anchorage, AK and the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, OCS Environmental Assessment Program, Anchorage, AK. Contract No. 14-12-0001-30019; Research Unit No. 626. 252 pp.

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The report(s) cited above has/have been included within the report series entitled "Outer Continental Shelf Environmental Assessment Program, Final Reports of Principal Investigators," Volume 43 (June 1986), pp. 209-460 (NTIS No. PB87-192118/AS; MMS Report 86-0057).

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