ENVIRONMENTAL CHARACTERIZATION AND BIOLOGICAL USE OF LAGOONS IN THE EASTERN BEAUFORT SEA

Edited by

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PREFACE

In recent years, petroleum related interests have expanded eastward from the Prudhoe Bay region of Arctic Alaska and have been anxious to undertake seismic and exploratory drilling programs in the Arctic National Wildlife Refuge and adjacent nearshore waters. Partly in response to the accelerated interests, the National Oceanic and Atmospheric Administration (NOAA], Office of Marine Pollution Assessment, Juneau, Alaska, sponsored a workshop in autumn 1981 to discuss the extent of current knowledge concerning biological and physical processes in the lagoons and adjacent nearshore waters along the east coast of the Alaskan Beaufort Sea. During the workshop a series of hypotheses and conceptual models were generated by the participating scientists. These hypotheses and models were compared and contrasted with those previously described from locations farther west (e.g. Simpson Lagoon-Prudhoe Bay area). A report of this workshop was prepared by Truett (1982).

In early spring 1982, NOAA issued a request for proposals to conduct a program of scientific research in the eastern Alaskan Beaufort Sea that included (1) a review of relevant information from this area and (2) appropriate comparisons with results of other research conducted at other lagoon and nearshore locations along the coast of the Alaskan Beaufort Sea in recent years. Thus, the proposed extensive study area included the bays, lagoons, and nearshore waters of the Alaskan Beaufort Sea from Pt. Barrow to Demarcation Bay. The intensive study area included the bays, lagoons and nearshore waters of the eastern Alaskan Beaufort coast from Barter Island to Demarcation Bay.

In early summer 1982, LGL Ecological Research Associates, Inc. (LGL), in conjunction with Science Applications, Inc. (SAI), Tetra Tech, Inc., and the institutes of Marine Science and Water Resources, University of Alaska, was awarded a contract to conduct the proposed research. The program involved interdisciplinary research in the following disciplines: physical oceanography, meteorology, chemistry (nutrients, primary production and trophic energetic) and marine biology (invertebrates, fisheries, and marine mammals and birds).

The overall objectives of the program were to characterize the physical environment and the extent of biological use of lagoons and nearshore waters in the eastern Beaufort Sea of Alaska.

Ancillary biological. data were to be collected in Simpson Lagoon and complementary meteorological data were to be collected as far west as Pt. Lay, along the Chukchi Sea coast and as far east as Herschel Island, Y.T. and Inuvik, NWT, Canada. These ancillary data were thought to be critical to allow valid comparisons of results over broad geographic areas from past years, given that the range of year-to-year variation in most **processes** in the ArcticLis typically large.

Two field programs were conducted. The first was from late July through mid-August 1982; the second was from mid- to late September 1982. The base of field operations was the U.S. Fish and Wildlife Service (USFWS) Field Station (abandoned DEW Station) at Nuvagapak Pt. (Beaufort Lagoon). Field research in this area was focused on three nearby lagoons--Pokok Bay, Angun Lagoon and Beaufort (Nuvagapak) Lagoon--and the block of adjacent nearshore marine water extending 20 n mi offshore, from Barter island to Demarcation Bay (Fig. 1).

Detailed illustrations of sampling sites are presented as appropriate *In* the various Chapters of this report. Details of biological and physical properties of the area of study appear in the following disciplinary summaries of research findings.

Marine Mammals and Birds Few marine birds or mammals were recorded during aerial surveys of nearshore marine waters in August, except that a significant number of bearded and ringed seals were recorded throughout the study area on 4 August. On all survey dates in August, ice was present in virtually the whole study area from Barter Island to the Alaska-Canada border. Few marine birds and mammals were recorded during the second sampling period (15-23 September) until 22 September, when 120″ bowhead whales were observed on- and off-transect in the eastern half of the study area. Most of these whales (91, 71$) were on-transect. Based on conservative density extrapolations, at least 281.5 bowheads were estimated to be present in the eastern half of the study area on 22 September.

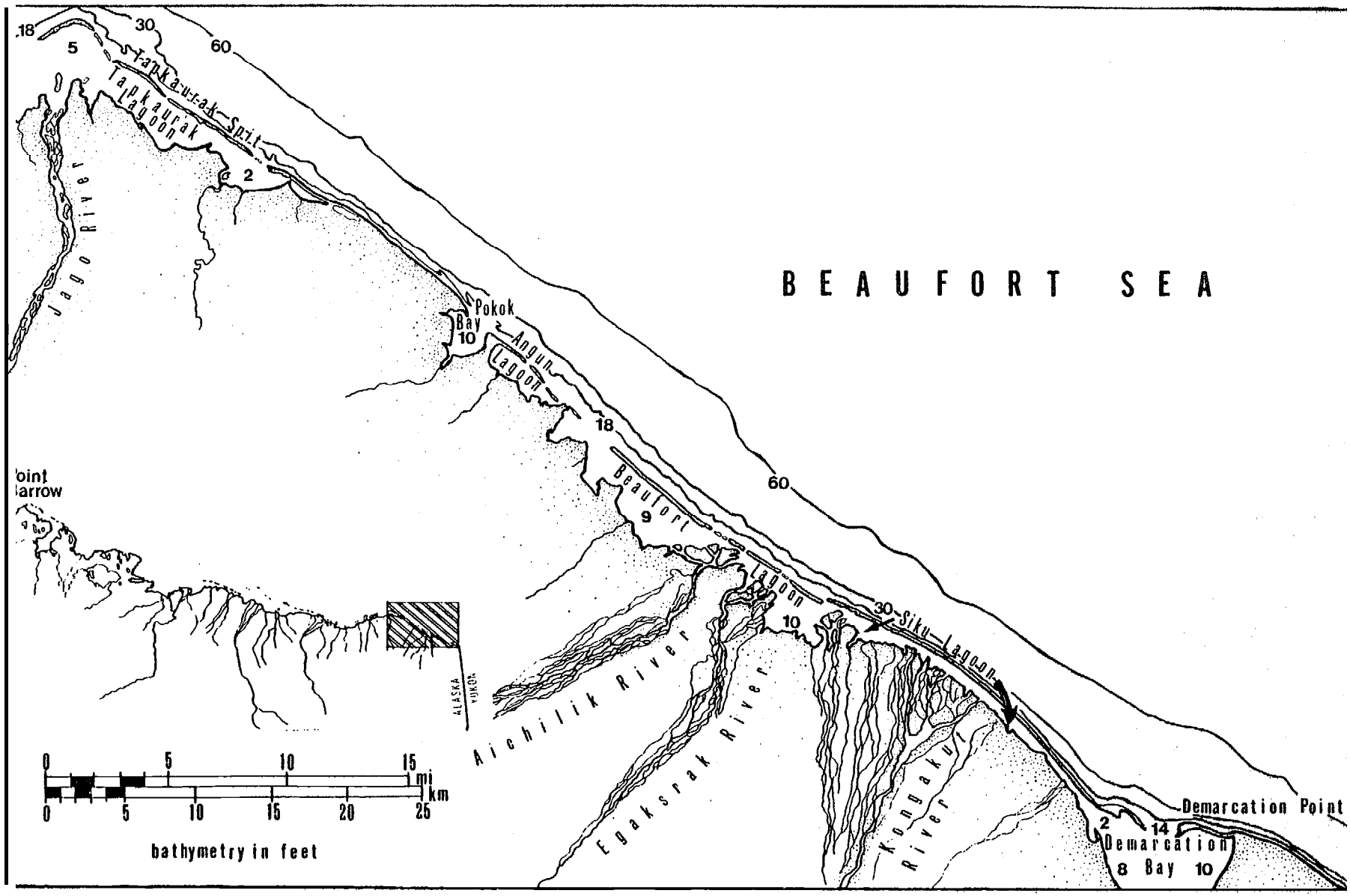

Figure 1. General region of study in the eastern Beaufort Sea, Alaska,

There was no evidence during this study that bowheads, or other marine mammals or birds, were concentrating (to feed) in any particular part of the study area. However, the aggregation of bowheads in the eastern half of the study area on 22 September was one of the largest records during the last half century. Bowheads were recorded in waters as shallow as 10 m and as close as 400 m from shore in the study area. This is much closer to shore and much shallower than has been recorded elsewhere in the Alaskan Beaufort Sea.

Oldsquaws were the most abundant birds recorded in lagoon habitats in the Beaufort (Nuvagapak) Lagoon study area. Densities of this species were highest along mid-lagoon and mainland shoreline transects in the study area, which was a different distribution of oldsquaws than had been found in other recent investigations in this area, and in investigations in other lagoons along the central Alaskan Beaufort Sea coast.

Red-necked (northern) phalaropes (primarily feeding juveniles) with smaller numbers of red phalaropes and sanderlings were the most abundant birds recorded along barrier island shoreline habitats in August. Only glaucous gulls were recorded in significant densities along mainland shoreline transects in this study; several pairs nested adjacent to this transect.

The diets of feeding oldsquaws and phalaropes collected in this study were similar to those of birds collected in Simpson Lagoon along the central Alaskan Beaufort coast in 1977 and 1978. Both mysid and amphipod crustaceans were important items in the diets of both oldsquaws and phalaropes. A larger proportion of small cottid fish (sculpins) was present in the diets of oldsquaws and phalaropes in the Beaufort Lagoon area than in other coastal lagoons investigated. Some fish were taken in shoreline habitat samples *where* phalaropes were feeding when they were collected, but no fish were present in drop net samples taken where feeding oldsquaws *were* collected. Mysids and amphipods (primarily Gammarus setosus) and some benthic organisms (polychaete worms) dominated habitat samples where feeding oldsquaws were collected.

Fish. The lagoons of the eastern Alaskan Beaufort Sea are used by anadromous (arctic cisco and arctic char) and marine (arctic flounder and fourhorn sculpin) fish for feeding on epibenthic invertebrates during the open-water season, similar to lagoons in the central Alaskan Beaufort. The absence of least cisco, broad and humpback whitefishes in the eastern Beaufort compared to areas farther west is attributed more to the lack of spawning populations in nearby rivers than to the absence of required habitat in the nearshore waters. Large individuals of arctic cisco, arctic char and fourhorn sculpin occur in similar abundances in all lagoons sampled from Pt. Barrow, Alaska, to the Mackenzie River Delta, NWT. Smaller individuals of these species were less uniformly distributed among coastal habitat types.

Invertebrates. Laboratory analyses of invertebrates sampled from Angun Lagoon indicated that the same two species of mysids (*Mysis litoralis* and *M. relicta*) most common in the Simpson Lagoon area also predominated in the eastern Beaufort study area. *Gammarus setosus* and *Corophium* sp. were the two dominant amphipods in the eastern Beaufort study area, whereas *Onisimus glacialis* was the predominant amphipod in the Simpson Lagoon area.

Although total. biomass of epibenthic organisms was relatively lower in Angun Lagoon than had been found in Simpson Lagoon in 1978 (1034 vs. 1553 mg wet weight/m^2) food (in the form of these invertebrate organisms) probably was not a limiting factor for vertebrate consumers (fish and birds) during the open-water period along the eastern portion of the Alaskan Beaufort coast.

Nutrients, Primary Production and Trophic Energetics. Annual primary production in the Beaufort Lagoon area was approximately 25$ of thatin the Simpson Lagoon area {2.0 vs 6 g $C/m^{-2}.yr^{-1}$). Terrestrial inputsof energy were important to food webs in the Beaufort Lagoon area and were responsible for 50-80% of the carbon in samples of arctic cisco and an arctic flounder. This is in contrast to Simpson Lagoon where terrestrial carbon was unimportant to marine trophic energetic. This difference may

be due to the lower *in situ* primary production relative to terrestrial carbon inputs or may be due to recent immigration (by the arctic cisco) from overwintering areas where freshwater and terrestrial food sources dominate. The arctic flounder, as a predator of benthic invertebrates, is probably reflecting the energy sources supporting polychaetes and other infauna of the lagoon sediments. Pelagic primary production supports offshore food webs. The relatively high productivity along the Beaufort Sea coastline may be due to periodic upwelling and a recycling of terrestrially-derived nutrients. Nutrient regeneration and vitrification processes are evident beneath winter ice cover.

Mesoscale Meteorology. Winds recorded at the Barter Island DEW Station can be used to predict winds at Beaufort Lagoon, thus allowing extrapolation of these data to the study area for periods before and after the study period (August). The study period in 1982 was meteorologically atypical in that west winds occurred more than usual. This atypical situation prevails in this area during August in about 2 of every 10 years. The persistence of strong west winds during August acted to eliminate a shallow pycnocline in lagoons in the study area.

The blockage of airflow by nearby mountains and the effects of sea breezes in the study area act to complicate accurate" predictions of surface winds from syntoptic weather charts and could lead to errors as great as 1800 in stress application.

Physical Oceanography. Flushing efficiencies of pulsing and limited exchange lagoons found in the eastern Beaufort Sea are considerably lower than those of the open lagoons farther west (e.g. Simpson Lagoon) and may rely on extreme local wind events to effect rapid exchange of lagoon and nearshore waters.

The major driving mechanism for water exchange and transport on the inner shelf of the eastern Alaskan Beaufort Sea, including the nearshore and lagoon systems, is derived from atmospheric forcing. The windfield determines both the direction and the intensity of the longshore current, the retention or removal of warm nearshore waters from the coast, the

vertical mixing and horizontal exchange of lagoons, and (probably most importantly) the movement of ice and water on and off the nearshore region. In the western Beaufort this implies that year-round mean conditions will be very similar with prevailing winds primarily from the east. But in the eastern Beaufort, winds are bimodal with prevailing winds from the west through the fall and winter and from the east in the spring and summer. Storms tend to produce winds from the northwest in both regions and can result in strong longshore currents, especially in the fall when a large expanse of open water exists along the Beaufort coast.

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Those LGL people who helped produce the report deserve special credit. Jean Erwin worked diligently at typing and organizing several versions of various parts of the report. Its final appearance is largely to her credit. Bonnie Bower-Dennis and Betsy Sturm provided the graphics and Mardi Gazey helped in various ways.

There are a number of others who helped. We apologize for not naming them all.

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