Coastal and Aquatic Habitats and Species present in the Beaufort and Chukchi Seas

1. Habitats: Species Associations and Habitat Use; Considerations for Primary/Secondary Production

Arctic Tundra

Arctic 'tundra' shorelines are complex and convoluted and comprised of tundra, vegetated flats, peat mats, brackish lagoons, and small streams. Inundated low-lying tundra occurs where very low-lying sections of the arctic shoreline have been recently flooded by the sea due to subsidence. These shorelines may have high ice content. The surface material is mostly peat with little in the way of inorganic sediments. Tundra is characterized by its unique soil structure and permafrost, which does not allow for animals to overwinter below the frozen soil (biologically inactive zone). Peat shorelines include exposed peat scarps, eroded peat, and slurries of rafted peats. These are typically erosional coastlines resulting from wave action, ice scour, and melting of the frozen peat. The intertidal zone is often very complex, with slumped peat blocks, fine-medium grained sands, and peat slurries intermixed. Peat slurries (which have the appearance of coffee grounds) are up to 50 cm thick and 10 meters wide. Peat slurries are found at the base of eroding peat scarps and in depositional areas; they are relatively permanent features but may move slightly and vary in thickness due to shore parallel transport. The intertidal zone of peat shoreline habitat is not particularly important as a biological habitat.

The Arctic coastal plain contains a mix of vegetation types, including arctic flora and tundra vegetation. Arctic tundra vegetation along the Beaufort Sea coast from the U.S./Canada border to just south of Point Lay and in the vicinity of Cape Prince of Wales and Shishmaref on the Seward Peninsula is dominated by wetland plants, primarily wet graminoid moss communities and wet sedge and moss communities in wet acidic and non-acidic coastal areas. Dominant plants include: sedges (genuses: *Carex, Eriophorum*); mosses (genuses: *Calliergon, Warnstorfia, Cinclidium, Hamatocaulis, Campylium, Plagiomnium, Bryum, Pseudocalliergon, Scorpidium, Meesia, Catascopium,* and *Distichium*); forbs (genuses: *Cardamine, Cerastium, Caltha, Bistorta, Saxifraga, Pedicularis,* and *Comarum*); grasses (genuses: *Arctophila, Alopecurus, Pleuropogon, Poa* and *Dupontia*), and prostrate dwarf-shrubs (genus: *Salix*).

Coastal vegetation south of Point Lay and along Kotzebue Sound is dominated by tussock graminoid tundra on non-sandy substrates, including tussock-sedge, dwarf-shrub, and moss communities; sedge, moss, and dwarf-shrub wetlands (common genuses described above); and low-shrub wetlands. Tussock-sedge, dwarf-shrub, and moss tundra communities occur on moist, cold, acidic soils. Dominant plants include: sedges (genuses described above); prostrate and erect dwarf-shrubs (genuses: *Ledum, Betula, Salix, Vaccinium, Arctous, Rubus,* and *Cornus*); mosses (genuses: *Sphagnum, Hylocomium, Oncophorus, Aulacomnium, Dicranum,* and *Polytrichum*); grasses (genus: *Arctagrostis*); forbs (genuses: *Pedicularis, Bistorta, Saxifraga,* and *Nardosmia*); and lichens (genuses: *Flavocetraria, Cladina, Cladonia, Ochrolechia, Alectoria,* and *Bryocaulon*). The sedge, moss, and low-shrub wetland communities are often bog/fen complexes with deep organic soils (genuses described above).

Key consumers of plant material in the Arctic tundra are hoofed mammals, birds, arthropods, and nematodes.

Lower River Reaches

River ecosystem components on the North Slope vary depending largely on stream class and origin of the stream/river. Spring-fed streams have high nutrient loads with mosses and algae as primary producers contributing to high diversity and abundance of invertebrates which support anadromous and freshwater fish. Glacial and clear water mountain streams tend to have a moderate nutrient load, low primary productivity, low diversity, density, and abundance of invertebrates, and low abundances of fish. Meandering tundra streams and beaded streams (consisting of < 2 meter deep, often circular pools of varying sizes connected by narrow channels at regular intervals) tend to have low nutrient inputs, moderately to highly productive epilithon (biofilms attached to rocky substrates), bryophytes (e.g., mosses), macrophytes, and algae, moderate to high diversity of insects and mollusks, and the potential for high abundances of fish.

Fluvial discharge occurring during spring ice breakup (late May-late June) at the mouths of North Slope rivers accounts for ~ 90% of annual runoff, and results in large amounts of terrestrial debris (including peat) being entrapped within the barrier island-lagoon system of the Beaufort Sea coast. This, along with high erosion rates generates a large carbon pool in these environments, which contributes to higher productivity in these systems, which are known as linked stream/river-estuarine lagoon systems.

Numerous rivers drain into the Chukchi Sea and Kotzebue Sound, the largest being the Kobuk and Noatak Rivers, which are examples of large, braided Arctic rivers that are common in this region. The lower reaches of many of these anastomosed river systems end in deltas composed primarily of silt, sand, and gravel. As is true of rivers on the Beaufort Sea coast, spring break-up (late May-June) following about 6 months of ice coverage for rivers along the Chukchi Sea, is a major event resulting in transport of large amounts of sediments from the eroded banks and surrounding permafrost. Measurable chlorophyll-a has been observed in Chukchi Sea and Kotzebue Sound lagoons year round, even in January when the sun never comes above the horizon, suggesting that spring bloom takes place prior to ice melt in these systems.

Coastal Lagoons and Tidal Flats

Coastal lagoons along the Beaufort Sea are biologically important features, particularly in summer, because of an estuarine band of warm and brackish water which increases productivity compared to the adjacent marine zone. Water temperatures and salinity range from 5 to 10ºC and 10-25‰ in summer, compared to the adjacent marine zone, where temperature and salinity range from -1 to 3ºC and 27-32‰. In general, the Beaufort Sea has relatively low productivity and benthic faunal biomass compared to the Bering and Chukchi seas. There is also a decreasing gradient in benthic biomass in nearshore marine and estuarine waters from west to east along the Alaskan Beaufort Sea Coast. In addition to river inputs (mentioned above), coastal erosion of peat contributes large amounts of organic carbon to barrier-island lagoon systems, especially on the eastern Alaska Beaufort Sea coast, although the fate of this terrigenous organic matter is not well understood. Marine phytoplankton is another key primary producer in coastal lagoon habitats.

Northwestern Alaska lagoons vary in their exchange with the waters of Kotzebue Sound and the Chukchi Sea as some are open year round (e.g., Sisualik Lagoon), some are intermittently open (e.g., Akulaaq, Imik, and Kotlik lagoons), and some are closed to the Sound (Krusenstern Lagoon). Even for lagoons that are closed or intermittently open, strong westerly storms (often in the summer) commonly push seawater into all of the lagoons. The salinity-temperature relationship in each lagoon varies throughout the year, and particularly in the winter, may keep the lagoons from freezing to the bottom, allowing for salt tolerant species to overwinter. Lagoons that are either always closed or always open tend to provide a more stable environment and have higher species richness than those that are intermittently open, most likely due to smaller ranges in salinity and dissolved oxygen that occurs throughout the year in the more stable lagoons vs. the more unstable/dynamic lagoons.

Lagoons have abundant populations of phytoplankton, zooplankton, epibenthic mysids, amphipods, pelagic and epibenthic crustaceans, and copepods, most commonly observed during the summer open-water period. Infauna (e.g., foraminifera, polychaetes, nematodes, amphipods, isopods, bivalves, chironomids, oligochaetes, and priapulids) tend to be less abundant than epifauna due to the presence of land-fast ice in the winter. The epifauna listed above are the predominant prey species for large populations of upper trophic-level consumers, such as anadromous and marine fishes (e.g., whitefish) and birds. Fish also feed on benthic organisms that are capable of overwintering. As shallow lagoon waters freeze in winter, fish vacate the area and overwinter in nearshore ice or return to the drainages.

The coastal lagoons of northwestern Alaska on the Chukchi Sea/Kotzebue Sound provide essential habitat for fish (both as nurseries and over-wintering habitats), birds, and subsistence resources. Kasegaluk Lagoon, in particular, is critical for beluga whale molting and spotted seal haul-outs. Low, narrow sand and gravel islands, shallow water (<4 m), and relatively warm temperatures are important features of this and other lagoons. Beluga whales may feed on mollusks, crustaceans, and bottom fish in shallow lagoons. Lagoons with freshwater influence from rivers and tidal flats on both sea coasts are important habitats for numerous species of migratory birds.

Boulder Fields/Kelp Beds

Boulder fields/kelp beds are areas of special concern in the Beaufort Sea because they are the only known benthic areas with a hard substrate in the region. The hard substrate allows the growth of kelp, soft corals, and anemones. As a result, numerous fish and invertebrates as well as attached plants and animals (e.g., macroalgae, barnacles, crustose coralline red algae, bryozoans, tunicates, snails, chitons, and sponges are associated with this habitat, prompting the State of Alaska to classify the Stefansson Sound Beaufort Sea Boulder Patches as a “Most Environmentally Sensitive Area.” Kelp contributes to the energy base (primary productivity) in the benthic-pelagic food web of the Beaufort Sea.

In addition, there are kelp beds along southern Kotzebue Sound that are important habitat for Pacific herring. There are also eelgrass beds in Shishmaref Inlet, which is part of a large, critical series of lagoons on the Seward Peninsula that provide key habitat for a large suite of birds, fish, and seals; in particular, brant (approximately 15,000 birds) during fall migration.

Sea Ice

Ice algae is one of three sources of primary production in the western Beaufort Sea (the other two being phytoplankton and benthic macroalgae). The ice algal community lives in and on the underside of sea ice and is comprised primarily of diatoms, as well as microflagellates and dinoflagellates. Cells are present in the ice throughout the winter, but the primary period of live algal presence is from April through June. Diatom cells may be released from the ice as it starts to disintegrate in late spring. In a study conducted in Stefansson Sound, primary productivity in ice was found to be ten times higher than in the water column. Productivity increases as submarine light levels increase. Following the breakup of shorefast ice, benthic macroalgae becomes the most important source of primary production in the nearshore ecosystem. Sub-ice algal communities have also been studied in the Chukchi Sea, suggesting a positive relationship between ice algal and benthic systems. The contribution of ice algae to primary production is higher in the Chukchi Sea than in the Alaskan Beaufort Sea.

The organic matter produced within the sea ice is the base for an ice-associated food web including protozoans, metazoans, larvae of benthic polychaetes and gastropods, nematodes, copepods, and amphipods. Under-ice amphipods, copepods, and zooplankton are an important food source for arctic diving birds and arctic cod; cod is a major component of the diets of seabirds and marine mammals.

Ice terminology used in this document

Sea ice: Any form of ice found at sea which has originated from the freezing of sea water.

Pack ice: Ice that is not attached to the shoreline and drifts in response to winds, currents, and other forces; may also be termed ‘drift ice’.

Shorefast or fast ice: Ice that is anchored to the shore or ocean bottom, typically over shallow ocean shelves at continental margins; fast ice is defined by the fact that it does not move with the winds or currents.

Ice floes: Separate patches of floating ice or flat sheets of unbroken pack ice greater than 20 meters across.

Leads: Narrow, linear cracks in the ice that form when ice floes diverge or shear as they move parallel to each other. The width of leads varies from a couple of meters to over a kilometer.

Flaw lead: a navigable passage between pack ice and fast ice.

2. Important Species Assemblages (and geographic or habitat preferences)

a. Marine Mammals

i. Pinnipeds:

- Bearded seal (pack ice edge in Chukchi Sea)
- Ringed seal (shorefast ice, large flat ice floes, permanent pack ice edge)
- Spotted seal (Kasegaluk Lagoon)
- Ribbon seal (moderately thick, stable, new, clean, white ice floes with even surfaces and open sea)

- Walrus (Chukchi sea ice)

ii. Polar bear (sea ice, southern pack ice edge, active pack ice/shorefast ice flaw zone, onshore (denning mostly), offshore islands)

iii. Cetaceans:

- Beluga whale (nearshore Chukchi, offshore Beaufort, Kasegaluk Lagoon)
- Bowhead whale (Chukchi Sea leads, nearshore Beaufort Sea)
- Gray whale (between Icy Cape and Barrow and Lisburne Peninsula when ice is not present)

b. Birds

i. Waterfowl (Some species are nesting on barrier islands and/or the tundra. Most are using nearshore marine or estuarine waters (lagoons) for migratory staging, foraging, etc. Waterfowl are particularly vulnerable during the July-August molt as some birds are flightless. Migratory timing varies by species, but ranges from June-October with some birds present into December):

- Surf, White-winged and Black Scoters (migratory staging in nearshore waters and lagoons)
- Common and Spectacled Eiders (nesting on barrier islands and tundra; migratory staging in nearshore waters and lagoons and in Chukchi Sea leads)
    - Spectacled eider (a portion of the Chukchi Sea is Designated Critical Habitat for this federally threatened species)
- Brant (nearshore/lagoon migratory staging, large numbers in Kasegaluk Lagoon)
- Cackling Geese (nesting on coastal plain/tundra, migratory staging in nearshore marshes)
- White-fronted Geese (nesting on coastal plain/tundra and barrier islands, migratory staging in nearshore marshes)
- Long-tailed duck (nesting on tundra; migratory staging in nearshore waters and lagoons and in Chukchi Sea leads)
- Northern pintail (nesting on tundra; migratory staging nearshore and in coastal lagoons)
- Red-breasted merganser (migratory staging nearshore and in coastal lagoons)
- Greater Scaup (migratory staging nearshore and in coastal lagoons)

ii. Alcids and Pelagic birds:

- Northern Fulmar (offshore migrant)
- Short-tailed Shearwater (offshore migrant)
- Black Guillemots (nesting on Beaufort Sea barrier islands/Cape Lisburne)
- Thick-billed Murres (nesting at Cape Lisburne, nearshore Chukchi and Beaufort Sea)
- Horned Puffins (nesting at Cape Lisburne)

iii. Diving birds:

- Pacific, Red-throated and Yellow-billed Loons (forage nearshore to offshore, bays and sounds, Chukchi Sea leads; nesting: coastal plain/tundra)
- Pelagic Cormorants (nesting at Cape Lisburne)

iv. Raptors:

- Peregrine falcons (forage in nearshore habitats)
- Merlins (forage in nearshore habitats)

v. Shorebirds (Massive numbers [thousands to hundreds of thousands of each species] use tundra, barrier islands, lagoons, and river mouths (all primary/critical habitats) for migratory stopover, foraging, and nesting June-September; eastern Beaufort Sea is a particularly high use area.) The following species use coastal and nearshore habitats for staging July-September:

- Black-bellied Plover
- American Golden Plover
- Semipalmated Plover (also nests on barrier islands)
- Bar-tailed Godwit
- Ruddy Turnstone
- Sanderling
- Semipalmated Sandpiper
- Western Sandpiper
- Least Sandpiper
- White-rumped Sandpiper
- Baird's Sandpiper
- Pectoral Sandpiper
- Dunlin
- Long-billed Dowitcher
- Red-necked Phalarope
- Red Phalarope

vi. Gulls/Terns:

- Arctic tern (common barrier island/river mouth nester)
- Black-legged Kittiwake (nesting at Cape Lisburne)
- Glaucous gull (common barrier island/river mouth nester)
- Sabine's Gull (forage nearshore and coastal plain nester)
- Parasitic, Long-tailed and Pomarine Jaegers (forage nearshore and coastal plain nester)

vii. Owls:

- Snowy Owl (nesting on tundra/coastal plain, occasionally use nearshore)
- Short-eared Owl (nesting on tundra/coastal plain, occasionally use nearshore)

viii. Passserines:

- Snow Bunting (commonly nest on the barrier islands)

c. Fish and invertebrates:

i. Fish in coastal waters, bays:

- Cisco (e.g., Arctic, Bering)
- Cod (Arctic and Saffron)
- Flounder
- Whitefish
- Salmon (pink, chum, chinook, sockeye: adults and juveniles during open water period)
- Dolly Varden
- Sculpin (e.g., Arctic, fourhorn)
- Stickleback
- Pacific Herring
- Rainbow Smelt
- Capelin
- Pacific Sand Lance

ii. River, river mouth, river delta, stream, coastal lagoon:

- Arctic Grayling (spawning)
- Dolly Varden (spawning)
- Whitefish
- Salmon (adult spawning and juvenile rearing)
- Stickleback
- Burbot
- Sculpin
- Smelt
- Cisco
- Cod
- Trout
- Pike
- Blackfish
- Sole
- Pacific herring
- Starry flounder
- Sheefish

iii. Invertebrates:

- Crabs (open water/nearshore)
- Bivalves/gastropods (coastal lagoons and deeper water away from ice scoured areas)
- Shrimp
- Benthic invertebrates (infauna and epifauna)
- Zooplankton

d. Aquatic Vegetation (*Dominant vegetation species are not well known, for either lagoons or shoreline fringe, or open water ice algae)*

- Benthic marine algae
    - *Laminaria solidingula* (Arctic Suction-cup Kelp)
    - *Zostera marina* (eelgrass)
    - Algal mats