Tundra, Biome 9

Lecture 13
Tundra is mostly a relatively thin ring around the arctic ocean. Again, no proper Southern Hemisphere relative of this biome.
Caribou antlers and tundra detail, Alaska
The first two climographs are from Tundra stations; the last is from Boreal Forest. Even though Ft. Yukon is quite cold on average, it has a respectable 87 days with temperatures above 10 C. Abisko and Chesterfield have no months with average temperatures above 10C. Tundra is also often cloudy in the summer, so light as well as heat income is limited during the growing season. Permafrost melts only to a slight depth, giving plants access to limited mineral nutrition.

Fig. 283. Climate diagrams from the forest tundra of Sweden (oceanic; left), the tundra of North America (centre) and the extreme continental boreal region of Alaska (right; cf. Fig. 5, Verchojansk and Fig 270)
Climographs from eastern and western Eurasian coasts. Note the relatively mild winters in northern Norway compared to eastern Siberia.

Climographs from the Arctic Ocean coast. Warmest mean monthly temperatures are below 5 C; barely above 0 C in far northern central Siberia. Note low rainfall totals. Sometimes people say that the Tundra is a desert because the rainfall totals are below 250 mm/yr. The climographs tell us that this statement is pointy-headed at best. These climates have more water than plants can use in every month, not to mention that permafrost soils impeded drainage.
Permafrost, permanently frozen ground is important in the Boreal Forest and Tundra. Only a relatively thin layer melts each summer, making soils thin and poorly drained.

Fig. 1-1 North Polar Projection, emphasizing the Boreal Regions. At this scale boundaries are approximate.
Ice does strange work in permafrost climates. When ice freezes ice crystals expand and ice tends to separate itself from dirt. Repeated freeze-thaw cycles create ice wedges (above). The ice crystals on the right show how ice can move mineral matter. Here they are mainly just lifting the grit, which will fall back as the ice melts. But when ice masses freeze outward even large stones can gradually be distances over distances of several meters.
“Patterned ground.” Freeze-thaw cycle has pushed up a rim of coarser, higher material around each freezing center, leaving a shallow summer melt pool in the center.
Fossil patterned ground, Wind River Mtns, Wyoming. Patterned ground appears in places that had permafrost in the last ice age. Freeze center laying on bedrock to the left gradually pushed rubble into a semicircular heap.
The signature plants of the Tundra are dwarf shrubs—willow, birch, rhododendron. Here dwarf birch in Finnish Lappland with fall colors.
Dwarf rhododendron. Wind River Mtns. True Tundra plants straggle down the high elevations of the Rockies, but not the Sierras. Why not?
At right, dwarf willows mixed with grass and moss.

Below, patchy mixture of dwarf shrubs and grass.
Some interesting plant adaptations. At left, Dryas. Many herbs that would be annuals elsewhere cannot grow, flower and fruit in one short, uncertain summer. They are adapted to become dormant and any stage of the growth cycle and thus take several years to mature and set seed.

Below, Cottongrass. Some plants like this drop their seeds on the top of the snow and disperse using the winter wind to blow them about. The cotton attached to each seed acts as a sail. The very low precipitation means that the snow will not be very deep, making this strategy feasible.
Signature animals of the Tundra. Caribou and Musk Ox. The Tundra is not very productive, but all of the above-ground plant tissue is exposed to grazers and browsers. Grasses and shrubs poorly protected by chemicals are common. Hence, much like arid grasslands, secondary productivity is relatively high compared to primary production.
Migratory waterfowl are also signature animals of the Tundra. Geese particularly breed on the Tundra. Geese are grazing animals and process large quantities of nutritious grasses and other plants. Many species that nest in Alaska and Western Canada spend their winters here in California. You can visit the various wildlife refuges in the region in late winter and observe rather spectacular masses of these birds. Their main protectors are hunters. Waterfowl shooting is an elite sport. Ducks and geese have long had friends in high places, if friends is the right word.

Experimental “exclosures.” Low fence keep geese and goslings out of fenced in areas. Sow geese have grazed the area outside the exclosures to bare ground.
Blood sucking insects prey upon mammals in the Tundra (and Boreal Forest)

Blur at left: a mosquito
Remember that the present-day biomes are young, particularly the colder and drier ones. Here is Dale Guthrie’s concept of the Mammoth Steppe I mentioned in an earlier lecture. Tundra as we know it did not exist in the last glacial. The northern-most biome was sunnier, drier, grassier and more productive than Tundra, if Guthrie is right.

Fig. 9.12. Beringia and the Mammoth Steppe. These terms have been used to describe the biotic integrity of the far north during the late Pleistocene. The earlier concept of Beringia is especially useful in describing Siberian-Alaskan connections. Beringia extends from the Lena River in the east to the McKenzie River in the west. However, most major plant and animal taxa in Alaska and Siberia during the late Pleistocene also had affiliations with the entirety of northern Eurasia and Alaska-Yukon Territory.
Guthrie’s argument about the Mammoth Steppe partly turns on the Woolly Rhino and the Woolly Mammoth having huge molar teeth with a complex rasp-like surface designed to mill grasses very finely so as to extract maximum nutrition from them during the food-scarce winter. Regardless of Guthrie’s specific proposal, we have to imagine that the more poleward biomes were completely re-organized after the glaciers melted, mainly by community evolution by competitive exclusion, supplemented by a little Darwinian fine tuning. Nor were the tropics spared. Montane Tropical Evergreen species are known to have moved down slope. How exactly the lowland species escaped a big wave of extinctions during ice ages is still uncertain. Why didn’t the cooler adapted montane species push them into the sea? The lowland tropical forests are exceedingly diverse, so many, many species survived despite the downward migration of the cool adapted species.
Human Uses: Thule Culture. About 1000 years ago a sophisticated marine hunting and fishing system known as the Thule Culture spread rapidly from western Alaska across Arctic Canada to northern Greenland. These people were directly ancestral to the Inupiat and Inuit (Eskimo) peoples of today. Humans in the last glacial were quite sophisticated hunters. A long succession of increasingly sophisticated maritime hunters preceded the Thule. I think it is quite surprising that 10,000 years after the glacial ended, human cultural evolution was still ongoing even among hunter-gatherers. It evidently takes a long time to figure out how to hunt whales from skin boats.
Eskimo (Inupiat)

- Two habitats
  - Marine littoral (whales and seals)
  - Inland (Caribou)
- Same people foraged as families in one habitat and hunted collectively in the other
- Importance of trade
- Importance of umealiq "boat owners"
North Slope of Alaska
Basic subsistence technology

Marine specialization arose after 3,000BP

Terrestrial hunting in arctic much older
Eskimo whale hunters used “Umiaks” not kayaks for hunting whales. These bigger open boats carried a harpooner and several men ready to paddle like hell if a whale was spotted. Several boats usually hunted together. The umiak commanded a fairly sophisticated collective hunting operation. Arctic marine hunting was very unforgiving of errors. Men thrown from a boat into the sea by a whale could only survive minutes without rescue. On the other hand, an inadequate supply of meat and fat meant starvation in winter.

Eskimo skin boats were extremely sophisticated watercraft. Men made the frame from driftwood using stone tools. The leak-proof sealskin covers were sewn by women. Can you imagine inventing all the skills necessary to make a kayak or umiak? Perhaps the complexity of this technology explains why it took thousands of years to evolve.
Whaling large-scale collective enterprise
People gather round to get shares of meat and blubber

*Maktak* shares laid out
Trans-Alaska Pipeline under construction. Much like in deserts, the relative lack of other resources interesting to humans makes minerals relatively important in the Tundra.

Asians developed a system for semi-domesticating caribou and a sort of Reindeer pastoralism developed in the Tundra and Tundra-Boreal Forest ecotone.