BIO-GEOGRAPHY MODULE

Table of Content

Biogeography

Vocabulary

Biogeography:
The scientific study of how geography affects where different species of animals live (see also phytogeography)

Chlorophyll A:
A pigment used by plants to store energy from the sun through the process of photosynthesis.

Colonize:
To establish a breeding population in an area that had not previously been occupied.

Disperse:
To spread outward from a species' native home range. To "disperse to" a new area simply means to arrive there safely (see also colonize).

Distribution (two meanings):
1. The geographical patterning or location/s of something (e.g., the distribution of sea ice in the Sea of Okhotsk).
2. In statistics, the patterning or spread of a series of data points (e.g., the distribution of radiocarbon dates through time)

Fast ice:
Ice that is connected to shore.

Pack ice:
Free-floating chunks of ice that drift across the ocean pushed by wind and water circulation.

Phytogeography:
The scientific study of how geography affects where different species of plants live (see also biogeography).

Phytoplankton:
Free-floating plants that are usually made up of a single cell. Phytoplankton get their energy from the sun, and make up the base of the food chain.

Primary productivity:
A measure of how much of the sun's energy is captured by plants and made available in the food chain.

Zooplankton:
Free-floating microscopic and macroscopic animals.

Background Information

The Kuril Island Chain is part of a volcanic island arc that began forming 90 million years ago (during the Cretaceous Period) when an oceanic tectonic plate collided with the Siberian continent. The oldest island in the chain is Urup, which emerged from the sea 4.21 million years ago.

Island chains have a variety of characteristics that make them special in the biological world. They come in all manner of different shapes and sizes. Given that different kinds of animals have different home ranges, the size of an island can have a significant influence on the kinds of animals that are able to survive there.

By the same token, the distance between islands, or between any given island and the mainland will influence what species are likely to disperse to an island as well.

This is due to the fact that there are only three paths animals can take to get to an island:

- By land
- By sea
- By air

There are, of course, different options within each of these paths. For instance, "by land" can involve crossing dry land during periods of lower sea level. But it could also involve walking across sea ice.

Likewise, one image of how animals might arrive "by sea" involves swimming. This works well for marine mammals and fish. But for most terrestrial mammals this is only feasible for crossing narrow gaps between islands.

Consider, though, that small animals may raft across water crossings on logs, vegetation, or ice. And when it comes to water travel, humans have been very good at making boats for many thousands of years.

Finally, the "by air" pathway is limited to those animals that can fly such as insects, birds, and bats. In this module, we will deal exclusively with birds, although both insects and bats are found throughout the Kurils.

All of these limitations will influence which species can (a) disperse to and (b) successfully colonize islands within the Kuril Island Chain.

Even for many of the animals that can easily swim or fly to islands, such as birds or pinnipeds (seals, fur seals, and sea lions) can easily fly or swim to islands, they are often still tied to terrestrial habitat as part of their breeding cycle. Sea birds, for instance, often nest on cliffs or in burrows. Likewise, even though pinnipeds can stay at sea months or years at a time, they must return to land to mate and give birth to their pups.

This need to return to shore makes sea birds and pinnipeds particularly vulnerable to predation by terrestrial predators such as foxes, bears, and humans.

For a more detailed consideration of how the geography of the islands and the geological history may have affected the resulting animal distributions, examine Figure 1, which shows the relative distances between the islands and the depths of the passes between them. Even during the Last Glacial Maximum (LGM), when world-wide sea levels were 150 m lower than they are today, only a few islands were connected to their neighboring mainlands (Kunashir to Hokkaido, in the south, and Paramushir and Shumshu to Kamchatka, in the north).

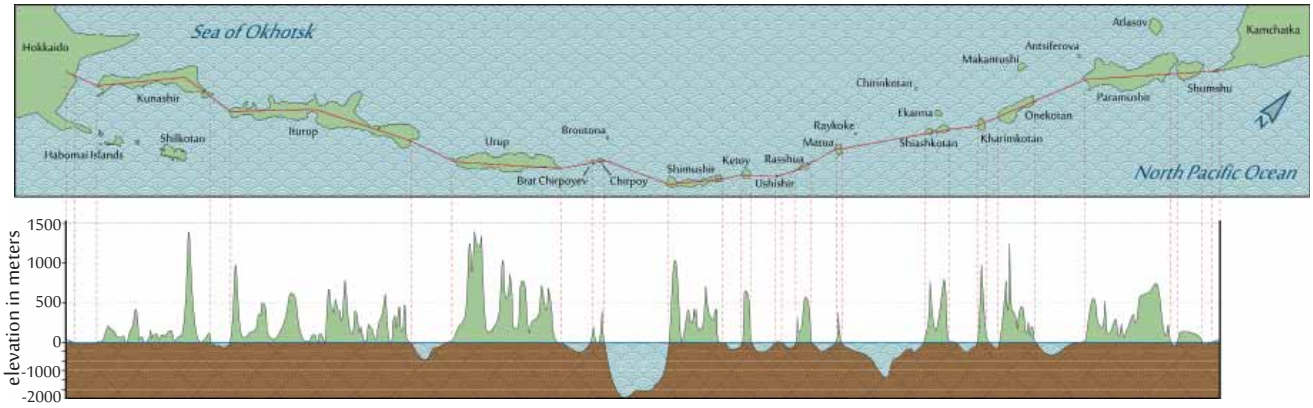

Figure 1: Kuril islands topo / bathy profile

There are two more important pieces to the biogeography "puzzle" at work in the Kuril Islands: sea ice distribution, and the distribution of marine nutrients. Sea ice primarily plays a role as a dispersal mechanism for terrestrial mammals, but sea ice is also important to several species of pinnipeds, including ringed seals and walrus. In most places in the northern hemisphere, northern areas tend to have more ice accumulation than southern areas. But this is not the case in the Kuril Islands. Counter-intuitively, sea ice concentrations in the Kurils tend to be highest in the southern portion of the island chain. This is because sea ice produced in the northern Sea of Okhotsk circulates counter-clockwise in ocean currents, and accumulates in late spring around Kunashir and Iturup, and occasionally Urup, as well. The presence of sea ice provides an important avenue of dispersal for terrestrial mammals coming to the Kurils from Hokkaido.

Another factor that plays a crucial role in determining the distributions of animals throughout the Kuril Islands is the distribution of marine nutrients. Marine nutrients are not uniformly distributed throughout the ocean—they get concentrated in certain areas by a variety of mechanisms. The greatest concentrations actually tend to be on or near the ocean floor, due to the accumulation of dead and decomposing phytoplankton and zooplankton from near the surface. However, phytoplankton, the very base of the food chain, require sunlight and nutrients in order to thrive. As a result, phytoplankton growth is highest in those areas where marine nutrients are brought to the surface from the ocean floor through a process called upwelling.

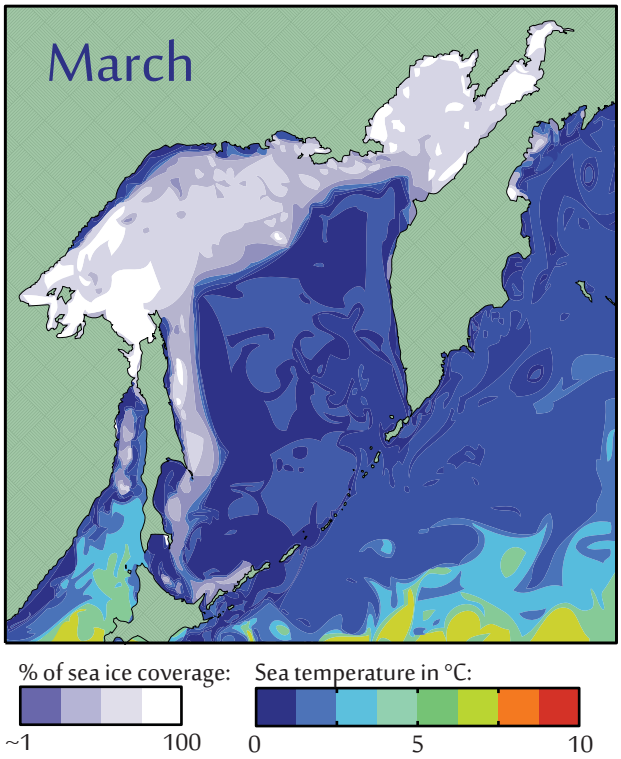

Figure 2: Average sea ice concentration in the Sea of Okhotsk and the Kuril Islands in March.

One of the areas that this happens consistently in the Kurils is in the passes between the islands. With each tidal exchange, huge volumes of water pass between the Pacific Ocean and the Sea of Okhotsk. This exchange of water between the passes results in very well-mixed, nutrient-rich water close to the surface (see Figure 3).

Areas that support high phytoplankton growth also support large populations of zooplankton (feeding on the phytoplankton), which also supports high populations of larger marine predators. (see Figure 4)

Finally, it is quite likely that these concentrated areas of high marine productivity influenced the distribution of human settlements in the Kuril Islands. Please refer to the "Settlement Module" for more information.

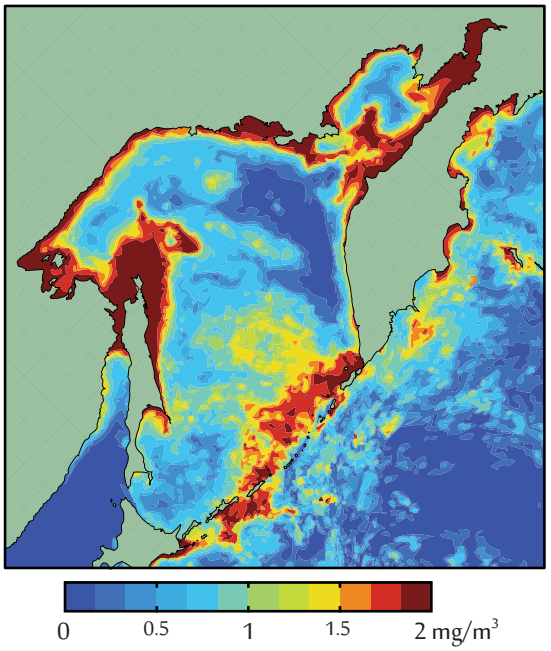

Figure 3: July average concentrations of chlorophyll over 10 years (1999-2008), which is an index of primary productivity (phytoplankton growth).

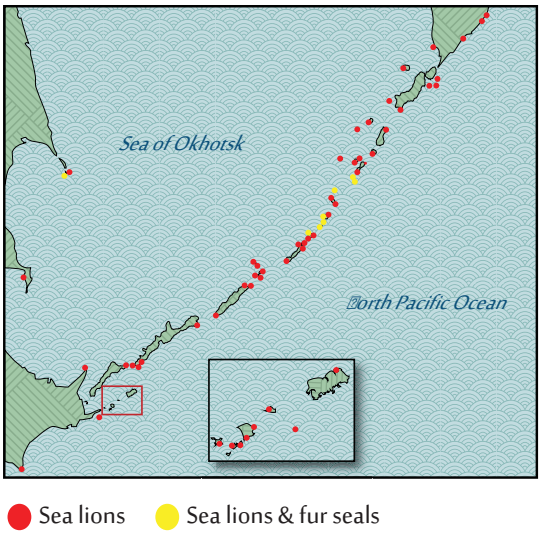

Figure 4: Map showing the distribution of sea lion and fur seal colonies. Note that on large islands, the colonies tend to be located towards the ends of the island (near the passes)

Name: _____

Excercise #1

Examine the lists of terrestrial mammal species that are native to Hokkaido, Japan, and Kamchatka, Russia. Based on what you know about these species, which would you predict would be able to colonize the Kuril Islands. Does it matter if they are colonizing from the south (from Hokkaido) or from the north (from Kamchatka)? Why?

List of Terrestrial Mammals Spicies in Hokkaido

Name and number of spieces	Able to disperse?	Able to colonize?
Brown Bear (1)		
Marten (1)		
Pica (1)		
Rabbit (1)		
Red Fox (1)		
River Otter (1)		
Shrew (6)		
Sika Deer (1)		
Squirrel (6)		
Vole (3)		
Weasel (2)		

List of Terrestrial Mammals Spicies in Kamchatka

Name and number of spieces	Able to disperse?	Able to colonize?
Brown Bear (1)		
Marten (1)		
Moose (1)		
Pica (1)		
Rabbit (1)		
Red fox (1)		
Reindeer (1)		
Shrew (5)		
Squirrel (2)		
Vole (6)		
Weasel (2)		
Wolf (1)		
Wolverine (1)		

Which of these species might be beneficial to humans?

Which of these species might be detrimental to humans?

Name: _____

Excercise #2

Continued

Now examine the map showing the number of land mammal species that occurs naturally on islands and the adjacent mainland. Island size and distance to the mainland are the two main factors that influence the number of land mammal species any given island can support. For each of the islands identified in Figure 1, indicate which of those two factors you think is MOST important, and indicate why.

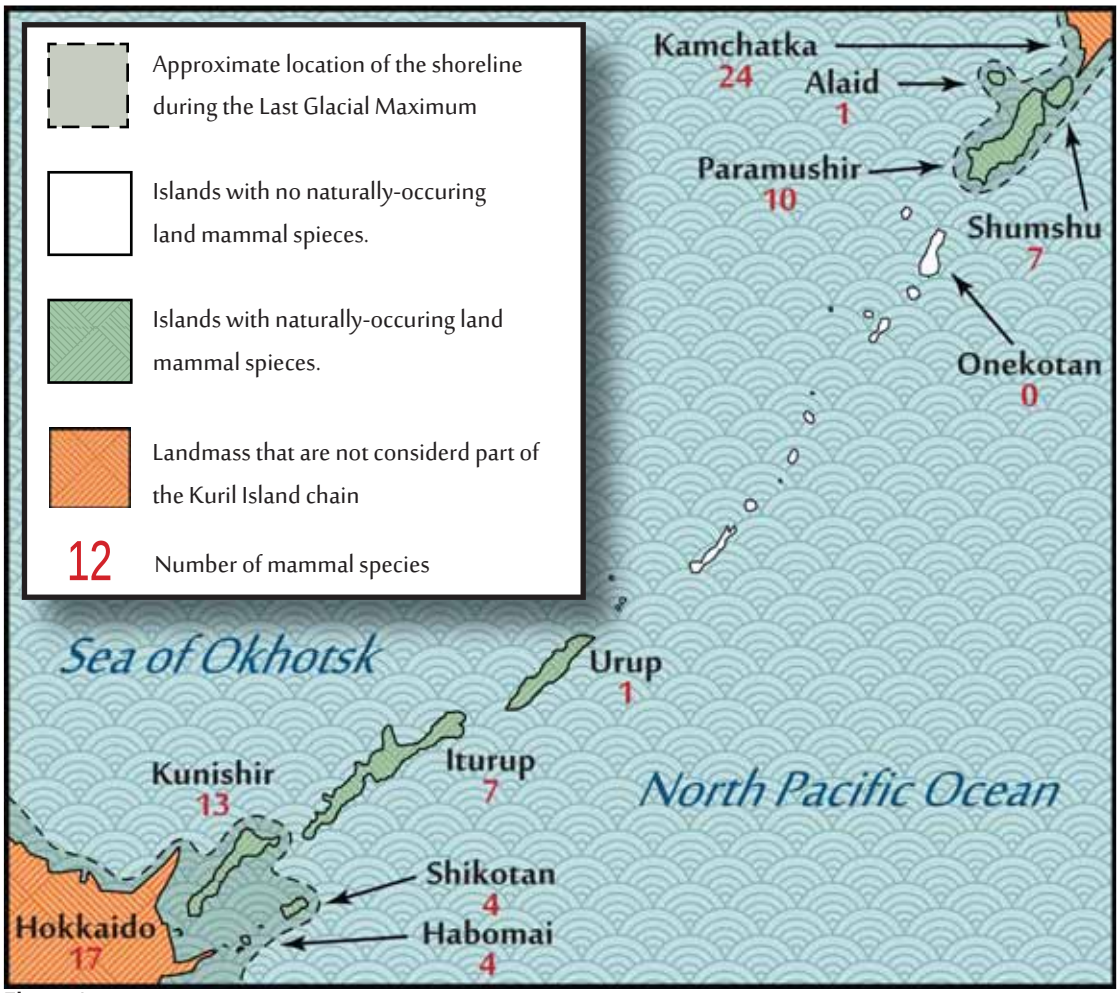

Figure 1: Number of land mammal species that occurs naturally on islands and the adjacent mainland.

Alaid: _____ Iturup: _____

Shumshu: _____ Kunashir: _____

Paramushir: _____ Shikotan: _____

Urup: _____ Habomai: _____