Interactions of the Arctic Fox and Sea Ice in a Changing Arctic Ecosystem

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Disclaimer: This paper was written as part of the Alaska Ocean Sciences Bowl high school competition. The conclusions in this report are solely those of the student authors throughout.
Abstract

Alopex lagopus is a mammal that lives above the Arctic Circle. It has a varied diet and will scavenge for food opportunistically. In the winter time it primarily scavenges polar bear kills on sea ice. One problem affecting Alopex lagopus is the Arctic sea ice has been decreasing extent, thickness, and length of season. At least one estimate predicts an ice free Arctic Ocean by 2037. That means that Alopex lagopus and other mammals will not be able use sea ice to get to the food. Even though much of its diet is sea ice based such as a polar bear kill, it can feed off of plants, berries, and other small mammals. Alopex lagopus is opportunistic enough, that populations will likely adapt to a newly defined habitat, based on accessible food sources in a changing Arctic ecosystem.
Alopex lagopus (Linnaeus, 1758) more commonly referred to as the Arctic fox, is an integral part of the arctic ecosystem and depend heavily on sea ice for winter habitat and other survival needs. Evidence suggests that the habitat will move Alopex lagopus landward as a result of sea ice melting. The movement of habitat will occur as it loses its marine based food sources such as feeding on fish, seal pups, and scavenging the remnants of other Arctic predators. Alopex lagopus is opportunistic enough, that populations will likely adapt to a newly defined habitat, based on accessible food sources in a changing Arctic ecosystem.

During the summer, Alopex lagopus lives in the tundra near forests where it burrows into the hillsides. During the winter, it moves out onto the ice and make its home in snow banks. It has a highly varied diet consisting of lemmings (Lemmus lemmus), Arctic hares (Lepus arcticus), carrion, fruits, berries, fish, and sea bird eggs such as the Common murre (Uria aalge). In order for them to survive it needs to eat a lot of food so it can stay warm, have energy, and hunt.

Alopex lagopus are omnivores, which means it can eat both plants and animals, but rely mostly on the remnants of animal kills. During the winters, Alopex lagopus cannot sustain itself on plants and berries because there will not be any plants or berries to eat. It is going to have to rely on animals that have been eaten, or it will have to look for lemmings (Lemmus lemmus), tundra voles (Microtus oeconomus), Arctic hare (Lepus arcticus) and other small creatures/mammals.

Direct use of sea-ice by foxes for feeding has been documented by a study that recorded Alopex lagopus both feeding on seal carrion left from polar bear (Ursus maritimus) kills and
taking ringed seal pups (*Phoca hispida*) from their birth lairs as well as scavenging on other marine mammal carcasses (Chesemore 1968; Smith 1976; Andriashek et al. 1985)

Roth (2002) found that “marine foods comprise up to half of the arctic foxes protein intake during years of low lemming abundance, suggesting that sea-ice plays a major role in maintaining population in the winter months in coastal areas when terrestrial resources are scarce.” If the ice continues to reduce at a rapid rate, *Alopex lagopus* is going to have to move its winter habitat towards land, causing them to move away from their primary winter food sources like seals, carrion, and other marine species. This is important to *Alopex lagopus* because meat is high in the protein it needs for energy and to maintaining its weight and muscle density during the winter months. If *Alopex lagopus* moves away from the Arctic Ocean, it will be forced to shift its winter diet to eat more vegetables and less meat. Lemmings will also become its major source of meat thereby greatly affecting the lemming population.

In general, male fox has a greater home range than the females and because it does not hibernate, female fox is able to have two litters, each consisting of about 15 pups per year. The mating and birthing season are between September and May and it lives for three to six years. *Alopex lagopus* is a very social animal that normally lives in a family consisting of one male, two females, and the kits. The second female is usually a leftover kit from the last season’s litter. She doesn’t hunt and instead helps to raise the kits.

*Alopex lagopus* have a very helpful adaptation that when the seasons change, so does its fur. In the winter its fur changes to a very pure white color so it is able to camouflage into the snow and ice when it is out looking for food. In the spring and summer seasons its fur changes to a mottled color. This way when the snow is gone, it will be able to camouflage into the grass, bushes, rocks, and etc.
"Arctic sea ice has declined by more than 86,000 square kilometers -- a space slightly larger than the state of South Carolina -- per year" (Post, 2014). "That's an area of critical habitat for many species and the rate of loss is increasing." Post added that “an acceleration of this rate likely will be due, in part, to the loss the white surface provided by ice that reflects sunlight - thereby causing a cooling effect.” During this process, referred to as albedo, the reflective white ice will be replaced by the dark ocean surface that will absorb the light and heat from the sun instead of reflecting it. The effect of albedo is accelerated warming and the subsequent melting of the Arctic sea ice.

*Alopex lagopus* habitat includes Canada, Denmark (Greenland), Finland, Iceland, Norway, Russia, Sweden, and the United States (Alaska) (Hall and Kelson 1959; Vibe 1967; Nasimovic and Isakov 1985; Mitchell-Jones et al. 1999). “This species also extends its range northwards over sea ice, and has been recorded in the vicinity of the North Pole, while its southern range limits extend to subarctic regions, including islands in the Bering Sea and Gulf of Alaska, as well as the southern tip of the Hudson Bay, Canada.” (IUCN Red List, 2009) “The Arctic fox occupies arctic and alpine tundra with the ‘white’ form occurring principally in open, treeless plains,” (IUCN Red List, 2009).

Because of the melting sea ice its habitat and diet will shift more inland. Average Monthly arctic Sea Ice Extent (Figure 1), illustrates the decline of Arctic sea ice from 1978-2013) (National Snow and Ice Data Center, 2013)
There is an extreme change going on in the Arctic. Sea ice is melting, and it is affecting so many Arctic organisms such as humans, sea animals, and even many land animals. “September 2008 followed 2007 as the second sequential year with an extreme summer Arctic sea ice extent minimum. Although such a sea ice loss was not indicated until much later in the century in the Intergovernmental Panel on Climate Change” (Wang, 2009).

Many models show an accelerating decline in the summer minimum sea ice extent during the 21st century. It is estimated that a nearly sea ice free Arctic may emerge in the near future. One study predicted an expected value for a nearly sea ice free Arctic in September by the year 2037. (Wang, 2009) The rate at which the sea ice has been decreasing is also quite alarming. “The Arctic climate is changing rapidly. From 1979 to 2006, September sea-ice extent decreased by almost 25% or about 100,000 km² per year.” Because of this drastic change sea ice it will also affect its eating habits, and its habitat. (Julien Boé, 2009)
This trend illustrates why *Alopex lagopus* habitat will likely be pushed back further inland. Thus changing its habitat, food, food sources, and possibly its overall lifestyle.

To some degree losing *Alopex lagopus* would not cause a direct impact on humans. However, there are many reasons why it is important. For example, it is a scavenger, which keeps “the environment clean by eating dead animals and keeping the rodent population down” (Tye, 2003). *Alopex lagopus* also help keep the arctic clear of dead rotting flesh. As well, sea ice acts as a barrier to many animals, which prevents intermixing. Animals that may have not intermixed, may carry unknown pathogens, which when introduced to other animals, may cause some drastic change in disease dynamics “For example, a population that is currently host to a certain pathogen to another, previously unexposed population” (Voss, 2013).

Being a very adaptable animal, the loss of sea ice would only inconvenience *Alopex lagopus* and not become a life threatening change. The fox would have to transition its diet to be almost solely comprised up of lemmings, various plants, along with other possible land animals, and spend the winter months on land. The *Alopex lagopus* would most likely not be able to eat marine animals any longer.

In order to reverse this trend, we must first stop the receding sea ice. Some people believe that it is caused by climate change. If that is the case then we would have to stop putting out so many carbon dioxide and greenhouse gas emissions, otherwise the sea ice will only decrease more drastically and faster. There are other people that believe this is just a “phase” the earth is going through, for example the ice age. If this is the case then there isn’t much we can do but simply hope that the ice doesn’t decrease to the point of incredibly harming other animal species and what it relies on.
Nathan J. Pamperin studied Alopex lagopus and the extent to which it has to rely on the sea ice. For one of his experiments he trapped Arctic fox and put satellite tags on them. He tracked them to see where it went. Two of the foxes were consistently located at substantial distances from the coastline, with mean distance from the coast of 128 km. Maximum distances from the coast were 214 km.

“Diets of these foxes were likely 100% marine while on the sea-ice, given its consistent use of the sea-ice at distances from land that would preclude periodic trips to feed on terrestrial resources Seal carcasses left from polar bear kills likely compose the majority of a fox’s diet while on the ice, with some foxes being able to take seal pups on its own during spring (Smith, 1976).

While seal carcasses would be the most consistent source of food on the ice, any accessible marine mammal or bird carcass would likely be utilized by the foxes, and larger carcasses (whales and walrus) may be able to sustain numerous foxes for extended periods of time” (Pamperin 2008). “Over the past 50 years Alaska has warmed twice as fast as the rest of the United States’ Average” (EPA, 2014) since we are close to the arctic circle, this may affect the arctic circle.
References


