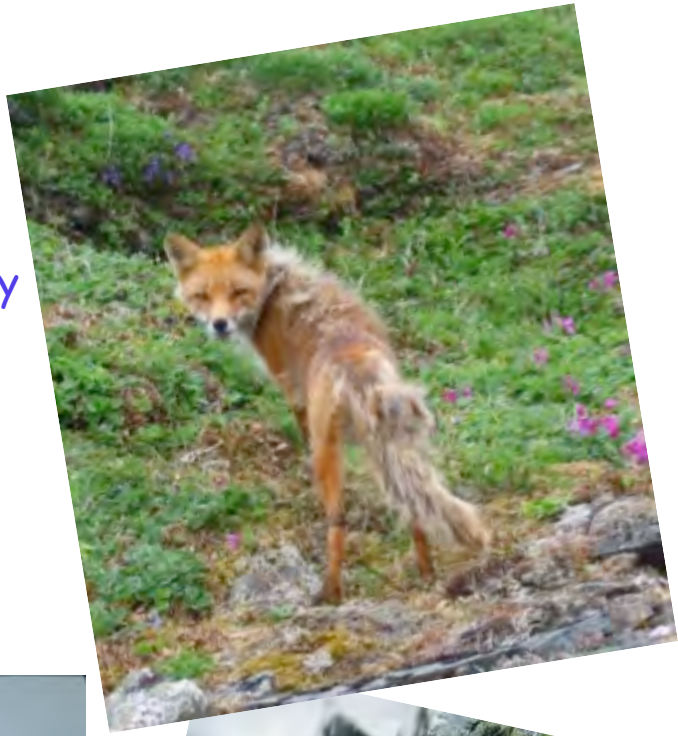
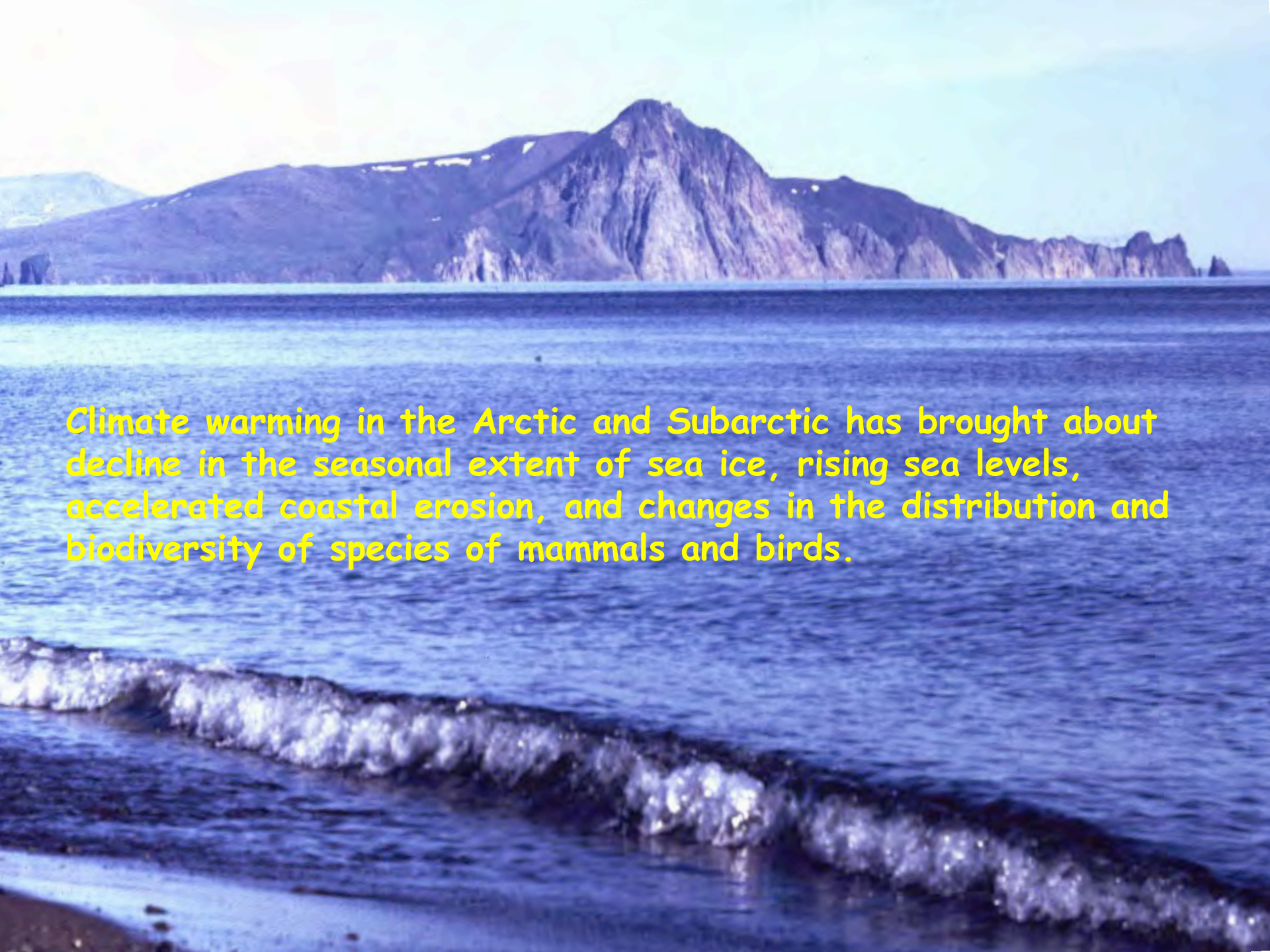
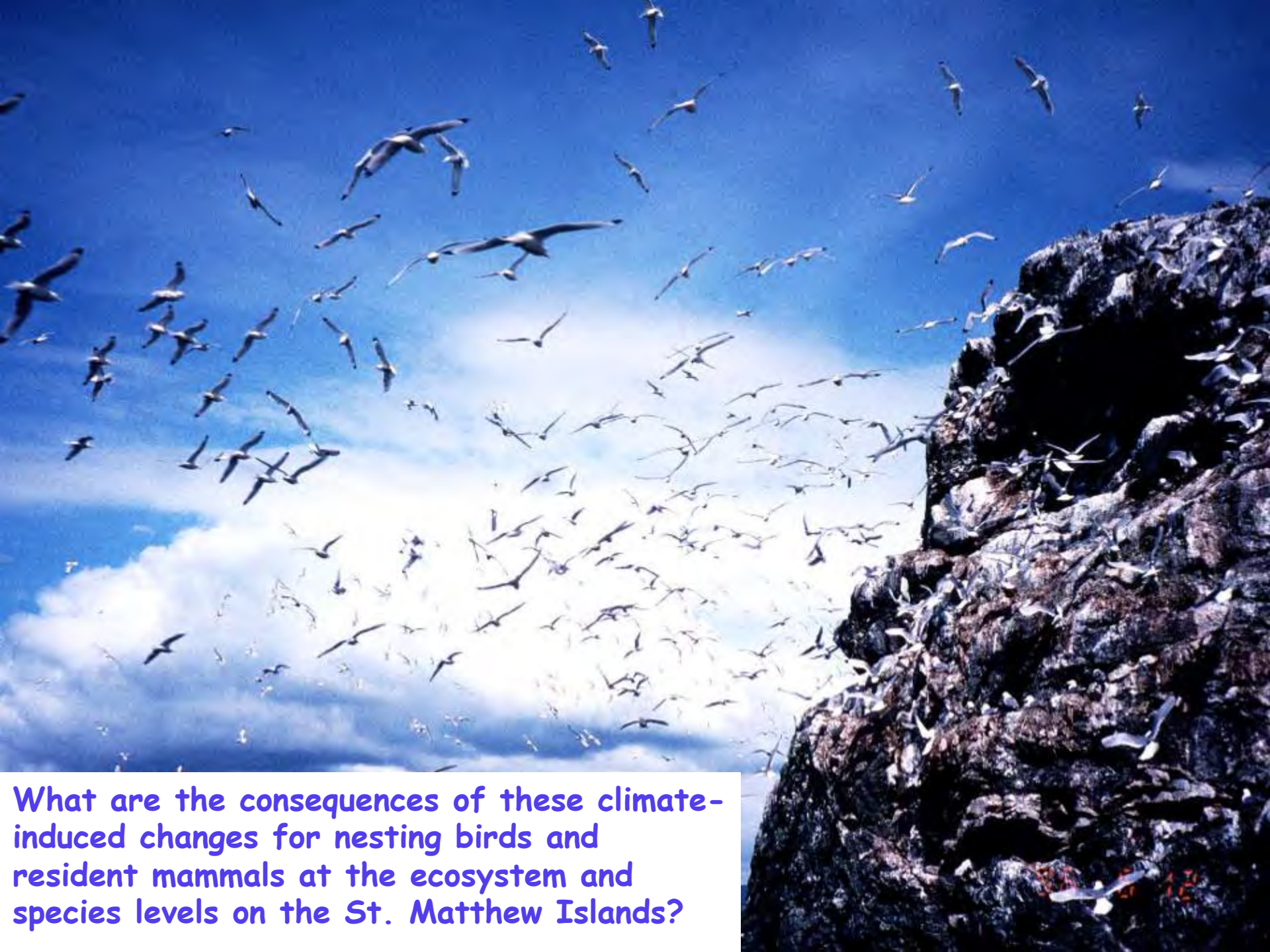
BIODIVERSITY CHANGES AT THE INTERFACE OF MARINE AND TERRESTRIAL ECOSYSTEMS: Nesting birds and two fox species



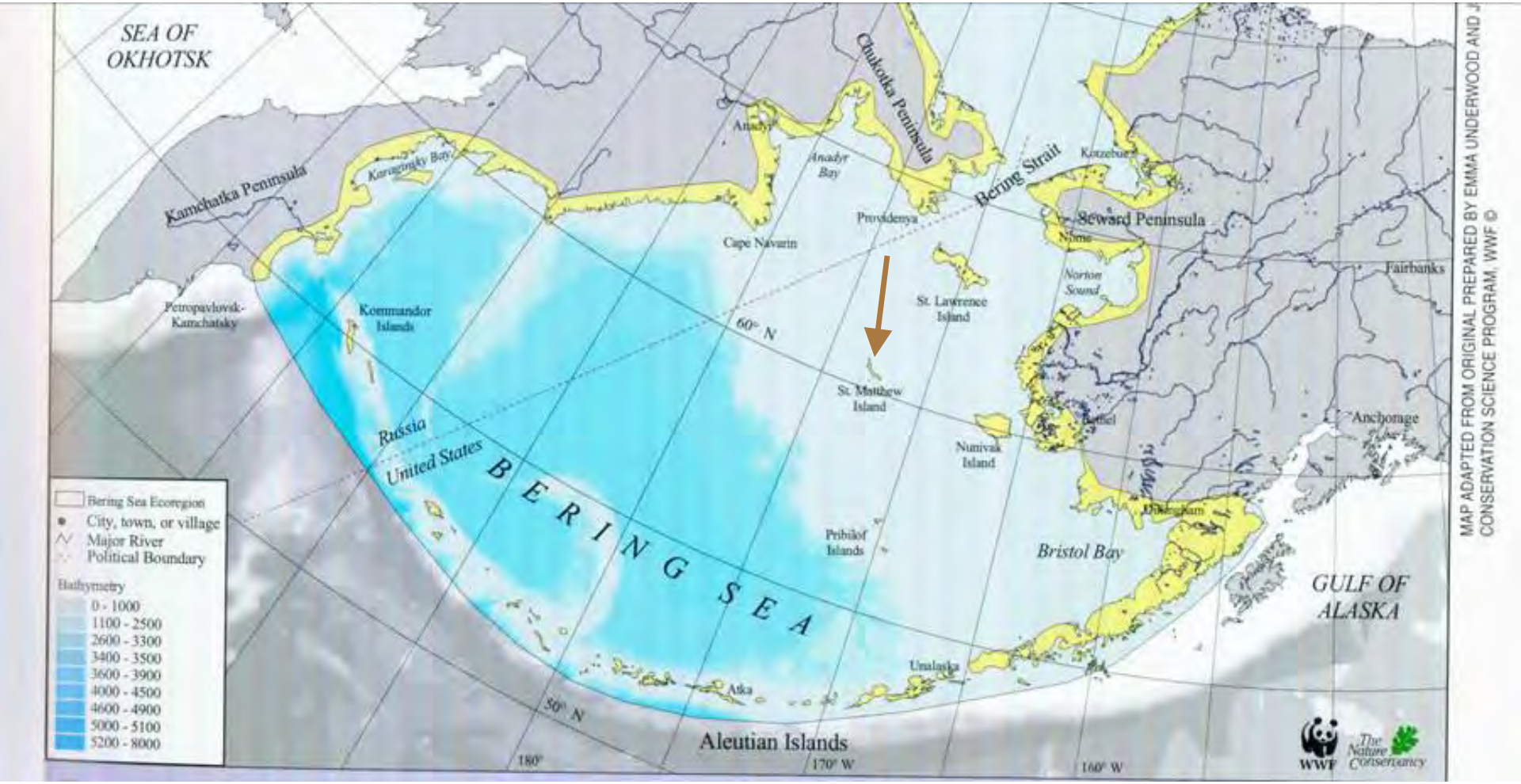
David R. Klein, University of Alaska Fairbanks, AK
Heather Renner, Alaska Maritime National Wildlife Refuge, Homer, AK
Richard Kleinleder, URS, Homer, AK


Climate warming in the Arctic and Subarctic has brought about decline in the seasonal extent of sea ice, rising sea levels, accelerated coastal erosion, and changes in the distribution and biodiversity of species of mammals and birds.



What are the consequences of these climate-induced changes for nesting birds and resident mammals at the ecosystem and species levels on the St. Matthew Islands?

The St. Matthew Islands, now part of Alaska, were discovered during an exploration cruise by Lieutenant Synd of the Russian Navy in the mid-1760's. Captain Cook "re-discovered" and named the islands in 1778.



•In 1909, St. Matthew and adjacent islands were given protective status as a bird reserve by President Theodore Roosevelt, designated as the Bering Sea Reservation

These islands attained "Wilderness" status within the Alaska Maritime National Wildlife Refuge in 1980

Several million sea birds, including >15 species, nest on the St. Matthew Islands, and walrus, sea lions, and seals haul out there

Pinnacle Is.

There are two vertebrate species endemic to these islands

McKay's bunting

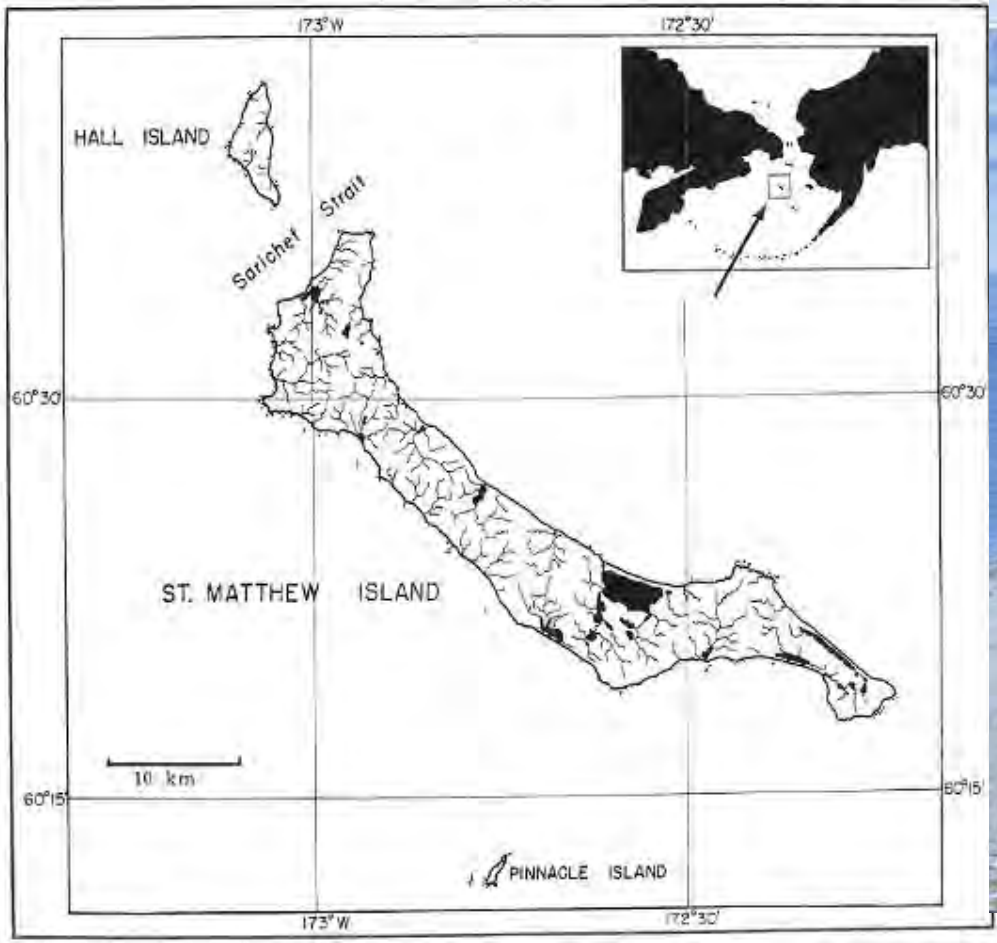
Plectrophenax hyperboreus

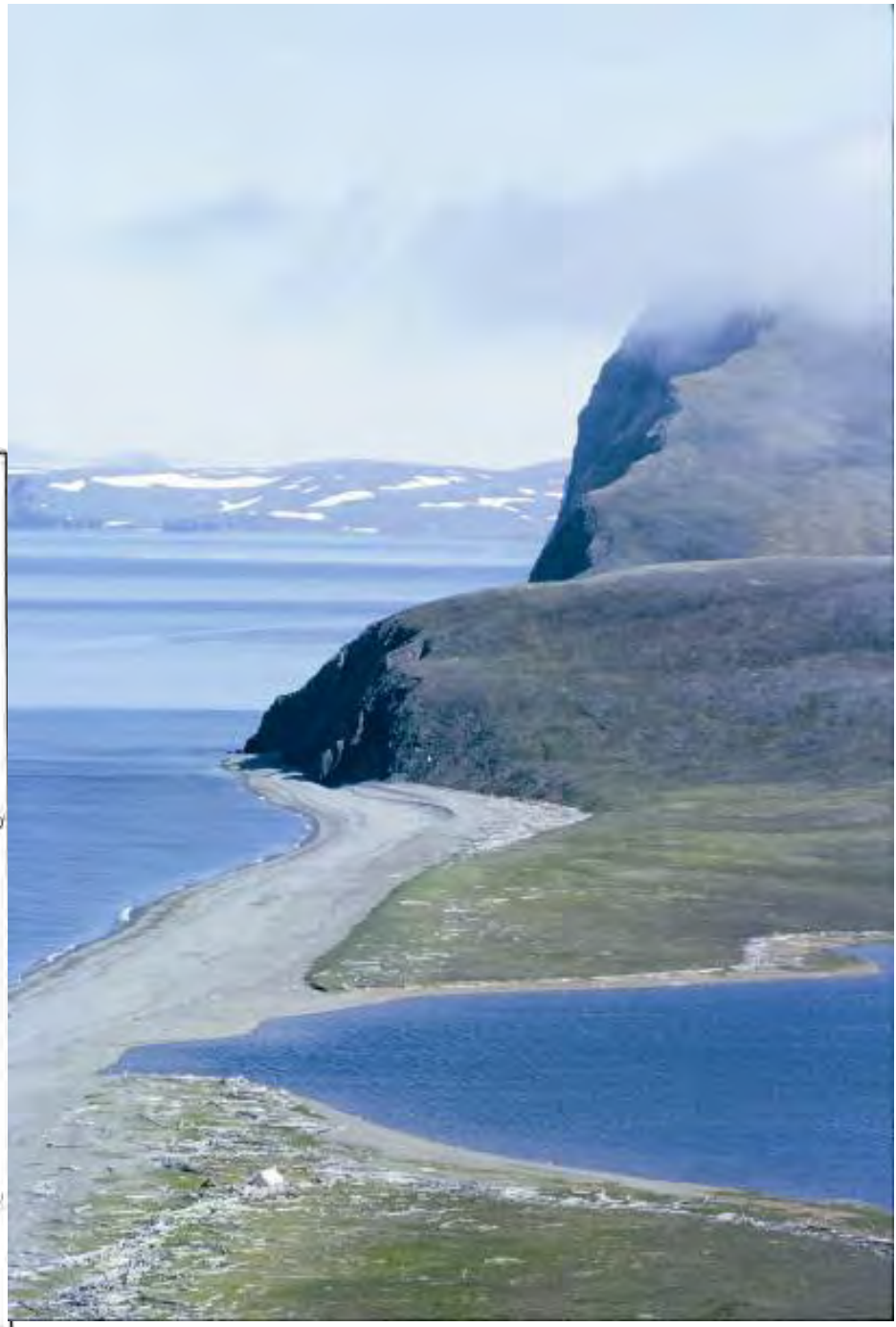
Singing vole

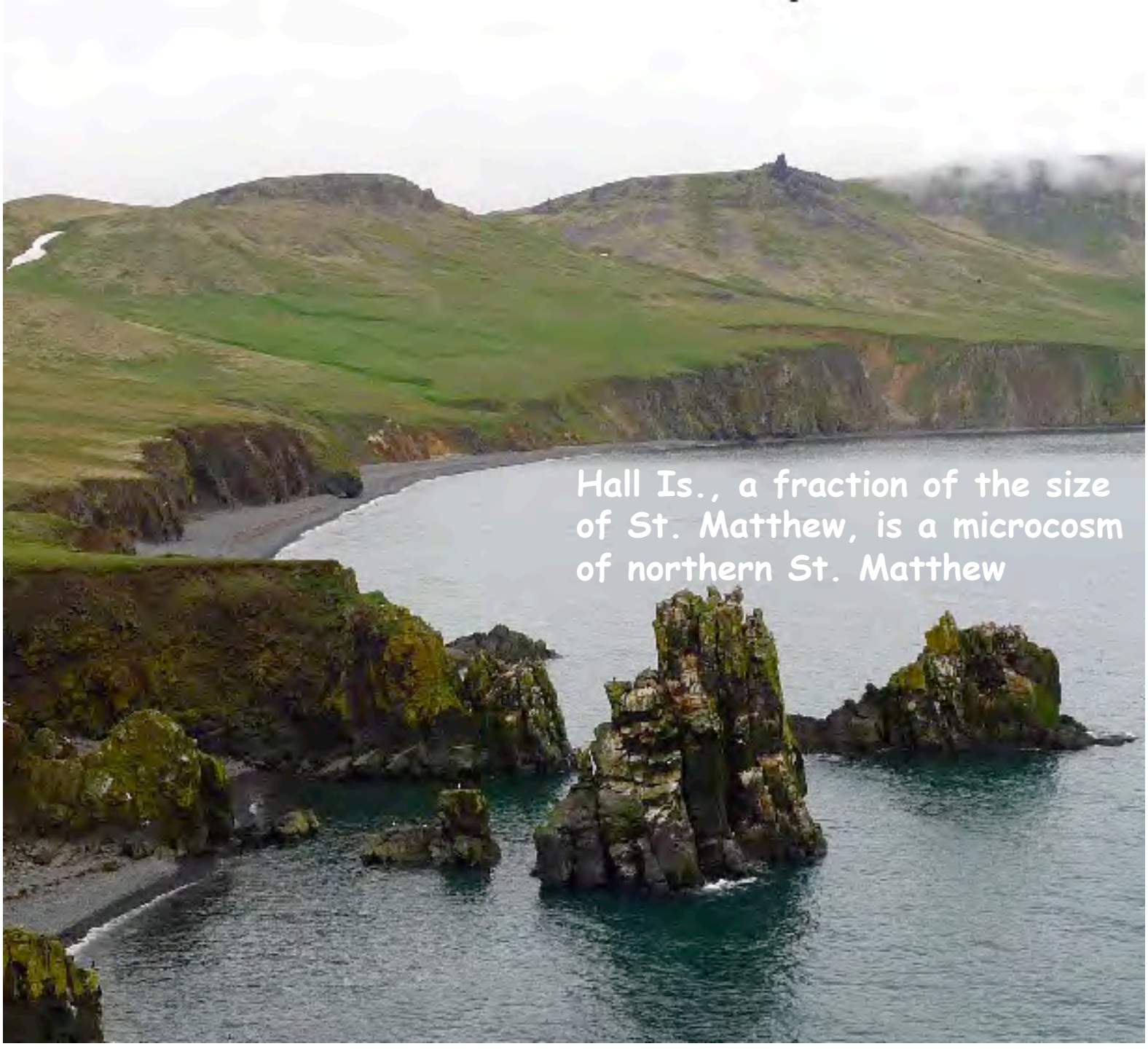
Microtus abreviatus


The St. Mathew Islands are the nesting location for the major portion of the Bering Sea rock sandpiper population

The St. Matthew Islands include 3 islands, the largest is about 52 km long, as the biologist walks, and averages ~6 km wide. Steep cliffs line much of its coasts.



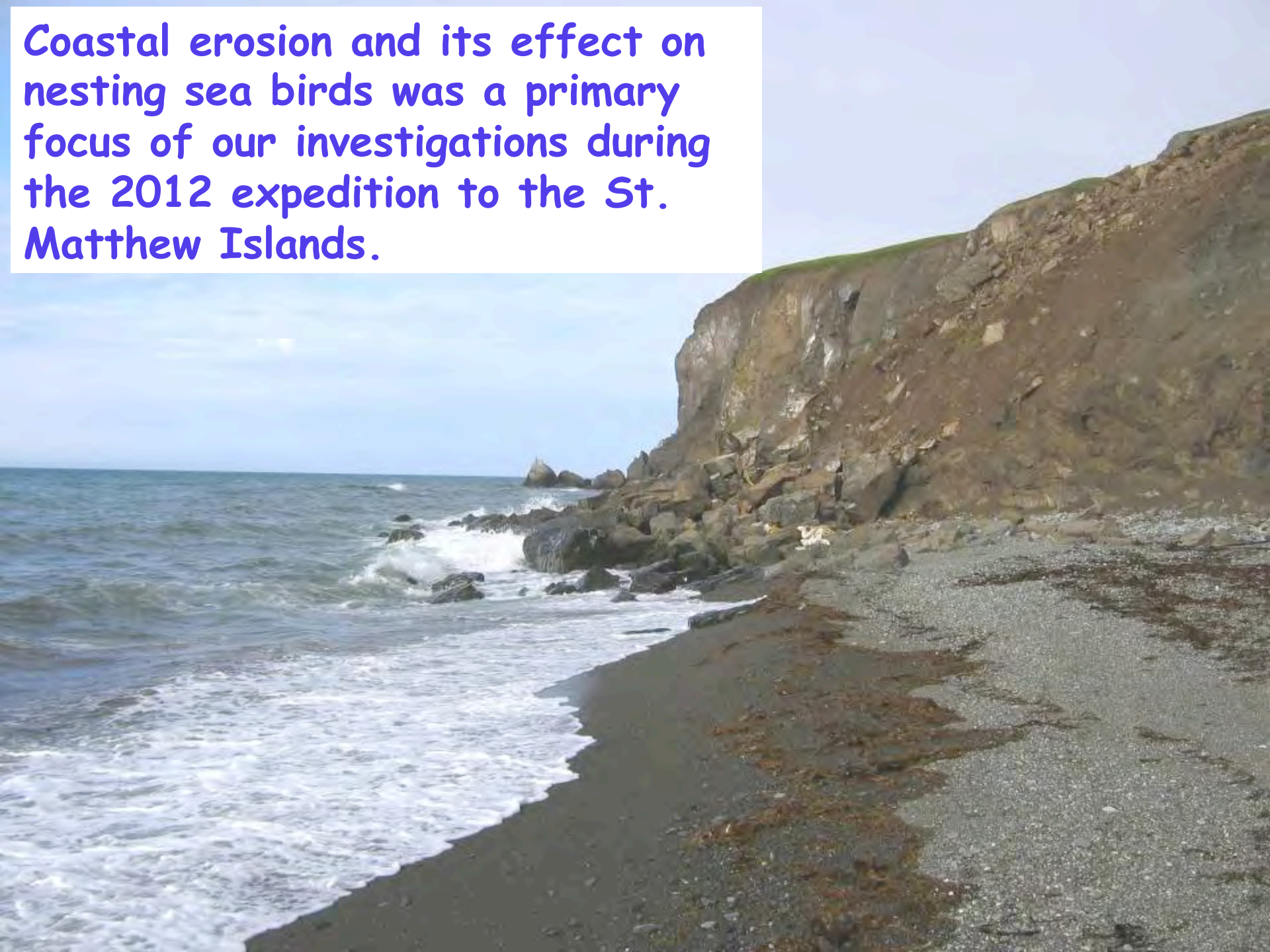



Hall Is., a fraction of the size
of St. Matthew, is a microcosm
of northern St. Matthew

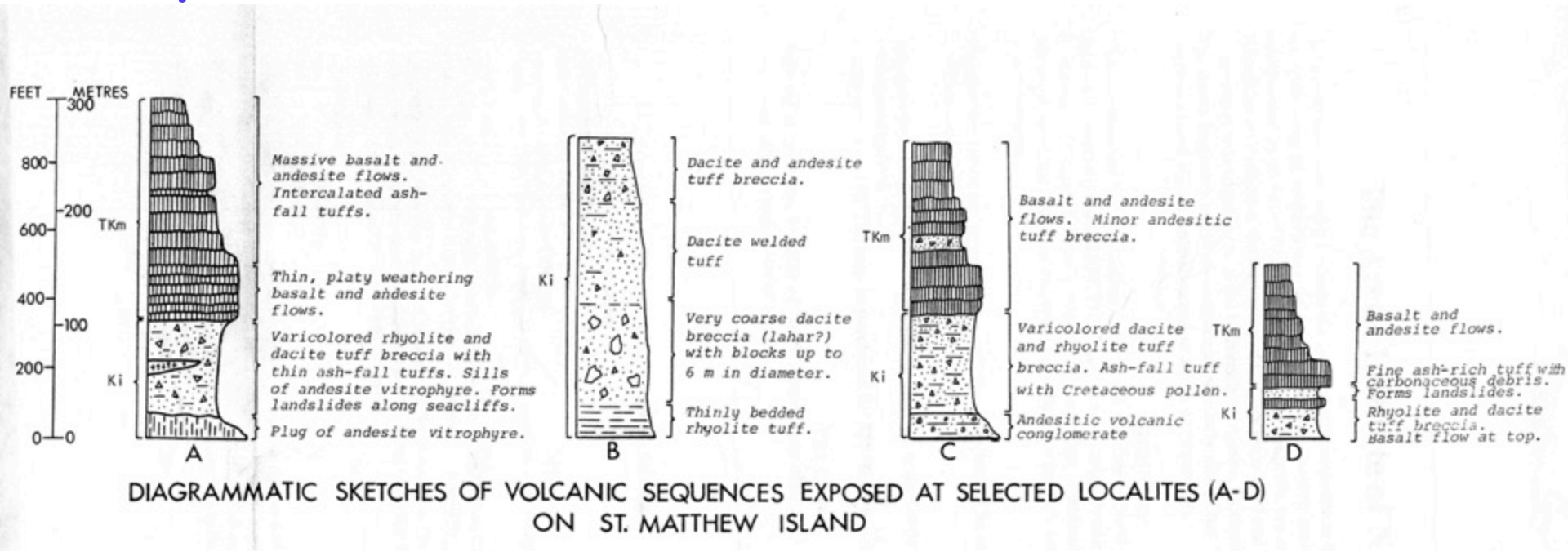
The St. Matthew Islands, without harbors or people living there are extremely remote.

The Alaska Maritime NWR vessel the *Tiglax* and its crew got us safely to and from the St. Matthew Islands.

Arriving in 2012 on St. Matthew, 55 years since my first visit

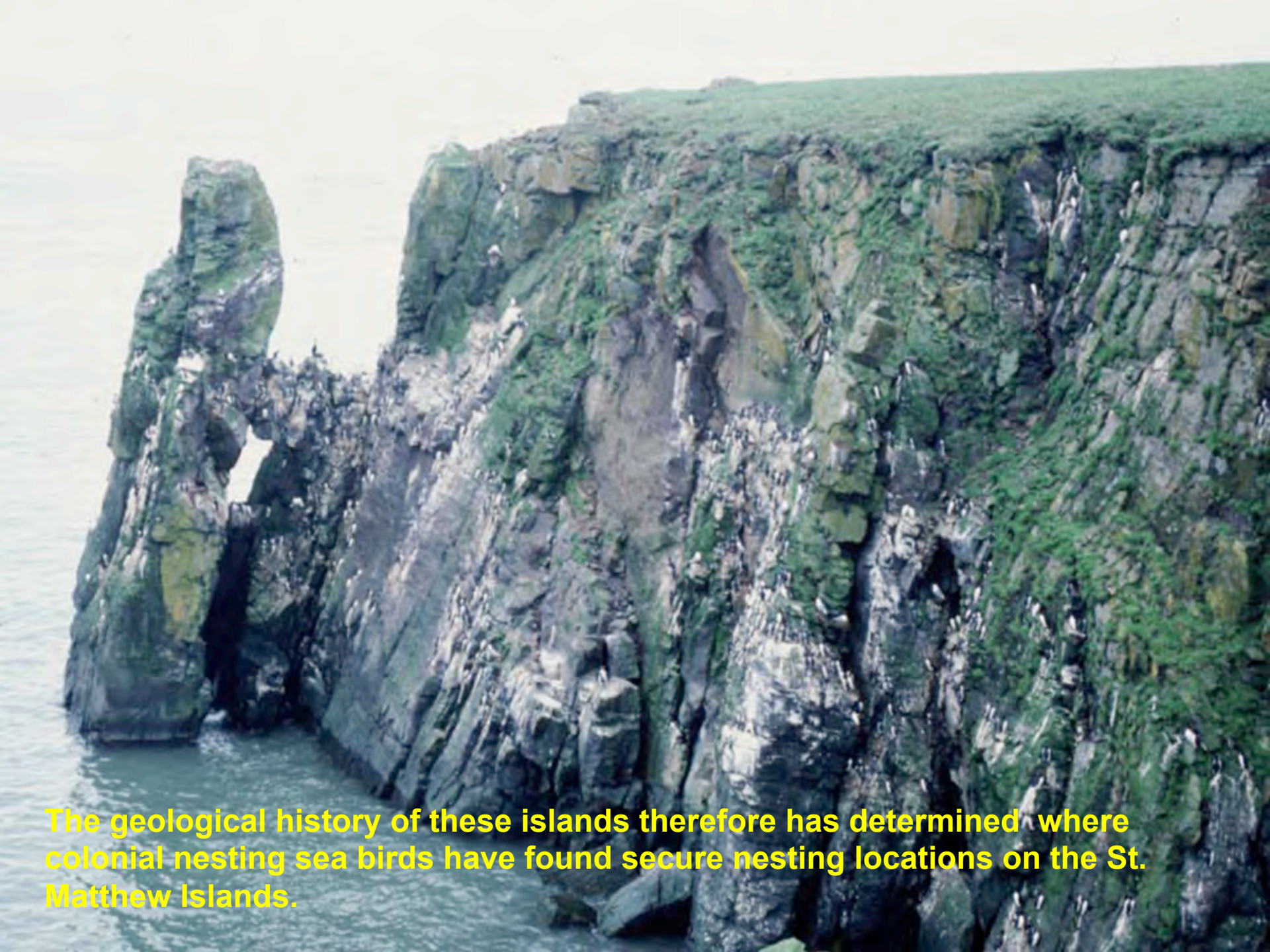

Coastal erosion and its effect on nesting sea birds was a primary focus of our investigations during the 2012 expedition to the St. Matthew Islands.

In 2012 we collected samples of rocks at bird nesting colonies for later determination of density at colonies that we were able to access during our week long stay on the island.



DIAGRAMMATIC SKETCHES OF VOLCANIC SEQUENCES EXPOSED AT SELECTED LOCALITES (A-D) ON ST. MATTHEW ISLAND

Potter et al. (1975) showed that volcanic activity from the late Cretaceous and early Tertiary periods ~ 60-77 million years BP account for the present morphology and coastal land forms of the St. Matthew Islands.

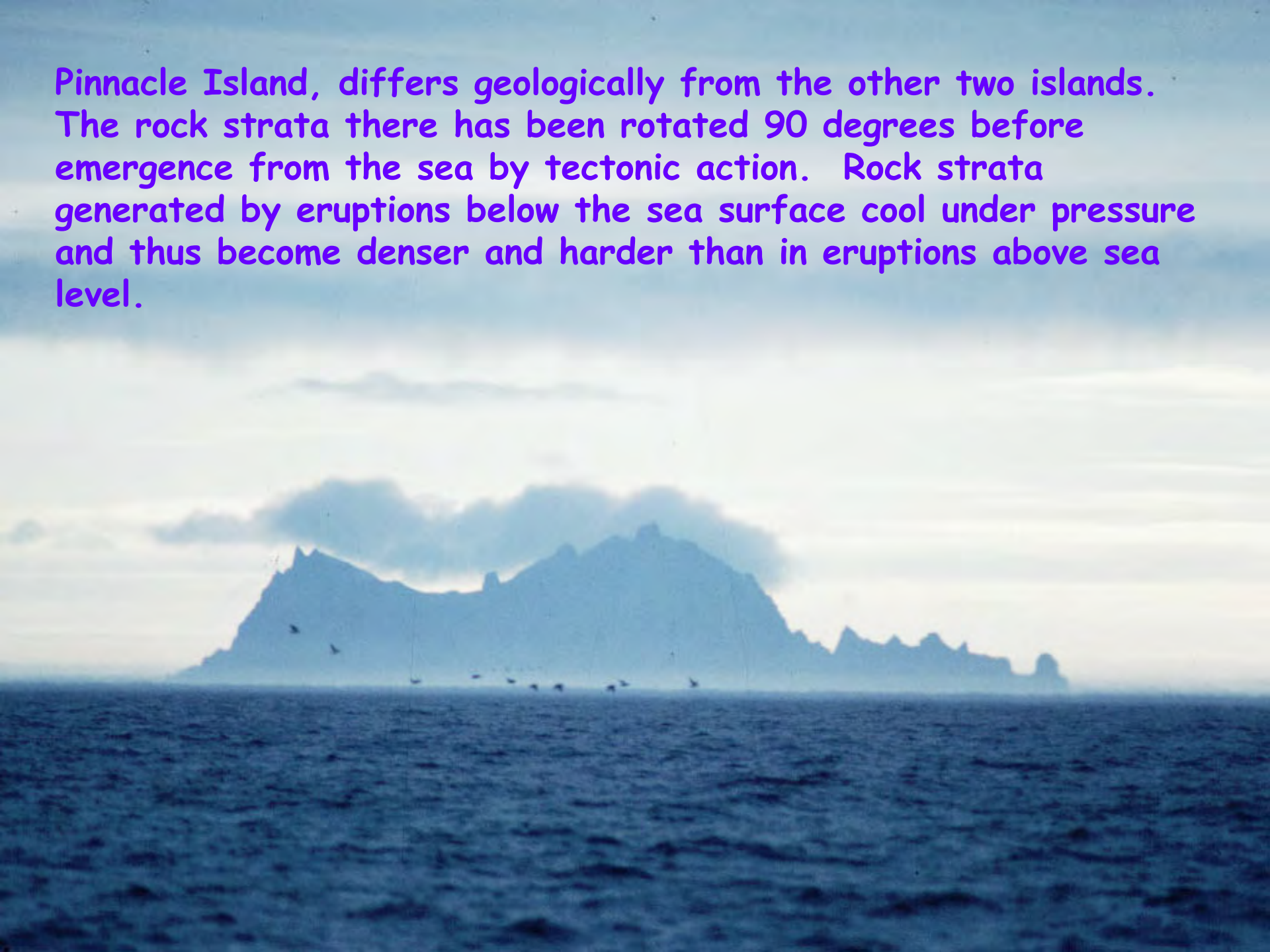


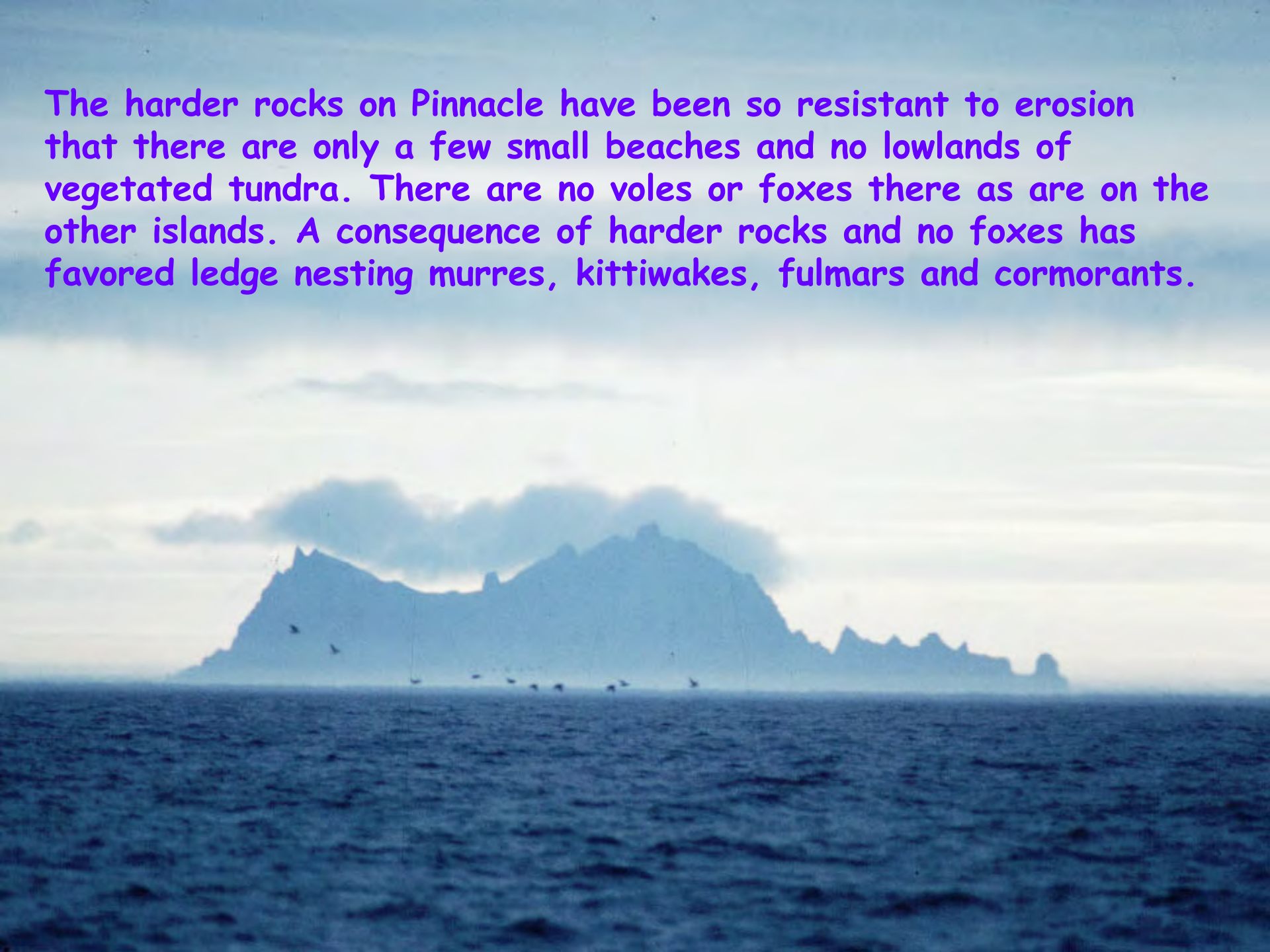
The geological history of these islands therefore has determined where colonial nesting sea birds have found secure nesting locations on the St. Matthew Islands.

Secure nesting sites for sea birds are absent in the soft ash-derived rocks on the left as well as in the fractured basalt on the right that are exposed here on the northeast coast of St. Matthew Island. Both are highly erodible

Satellite imagery from July 2009 show turbidity plumes in the sea adjacent to northwestern St. Matthew and southwestern Hall islands, confirming ongoing erosion of unconsolidated tuff that underlies the boulder fields at all auklet colonies.

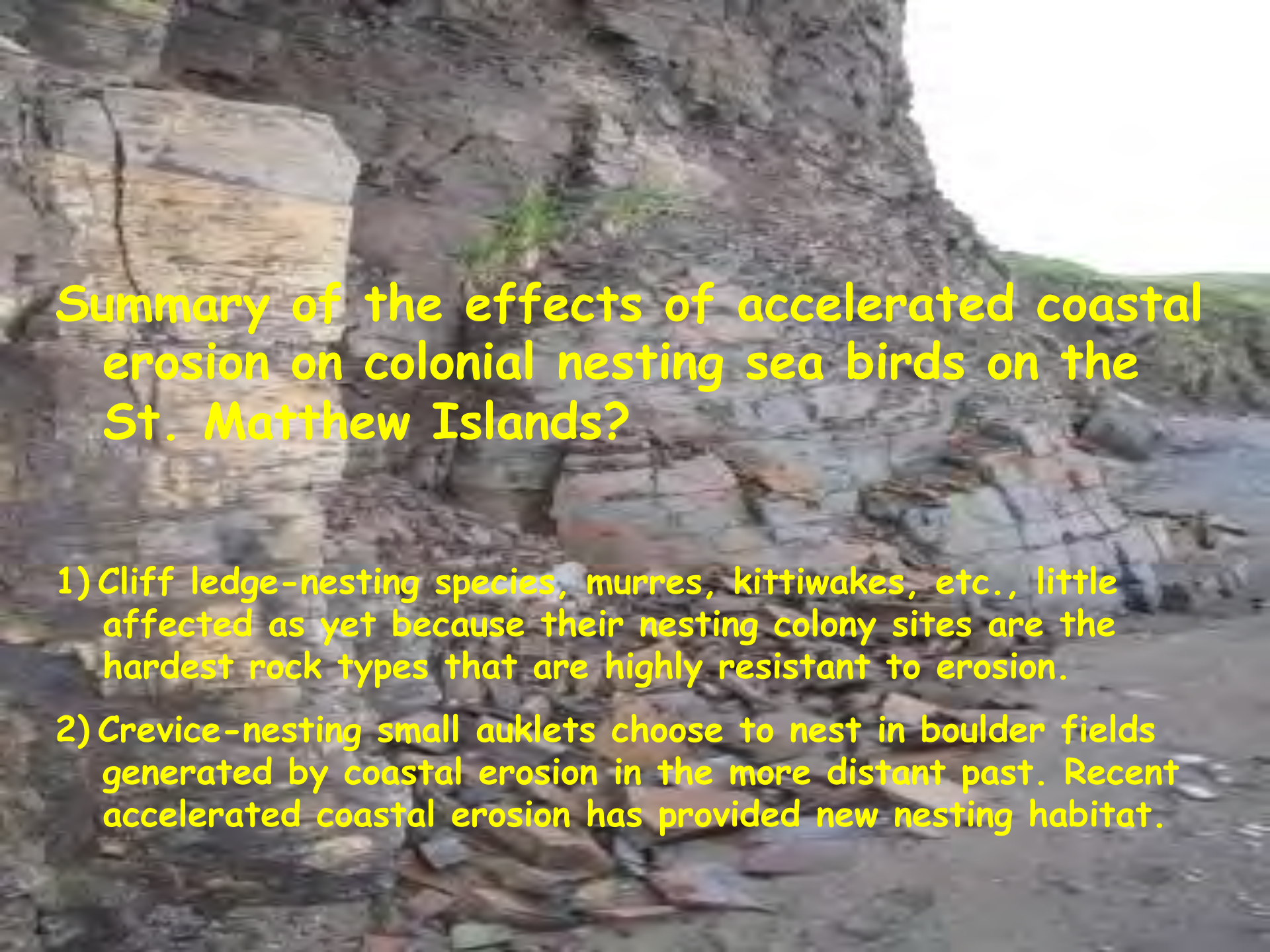
Pinnacle Island, differs geologically from the other two islands. The rock strata there has been rotated 90 degrees before emergence from the sea by tectonic action. Rock strata generated by eruptions below the sea surface cool under pressure and thus become denser and harder than in eruptions above sea level.





The harder rocks on Pinnacle have been so resistant to erosion that there are only a few small beaches and no lowlands of vegetated tundra. There are no voles or foxes there as are on the other islands. A consequence of harder rocks and no foxes has favored ledge nesting murres, kittiwakes, fulmars and cormorants.

Crevice nesting auklets establish nesting colonies in boulder fields generated by erosion of the softer strata of pyroclastic tuffs underlying thin basalt & andesite lavas from ancient volcanism.



Summary of the effects of accelerated coastal erosion on colonial nesting sea birds on the St. Matthew Islands?

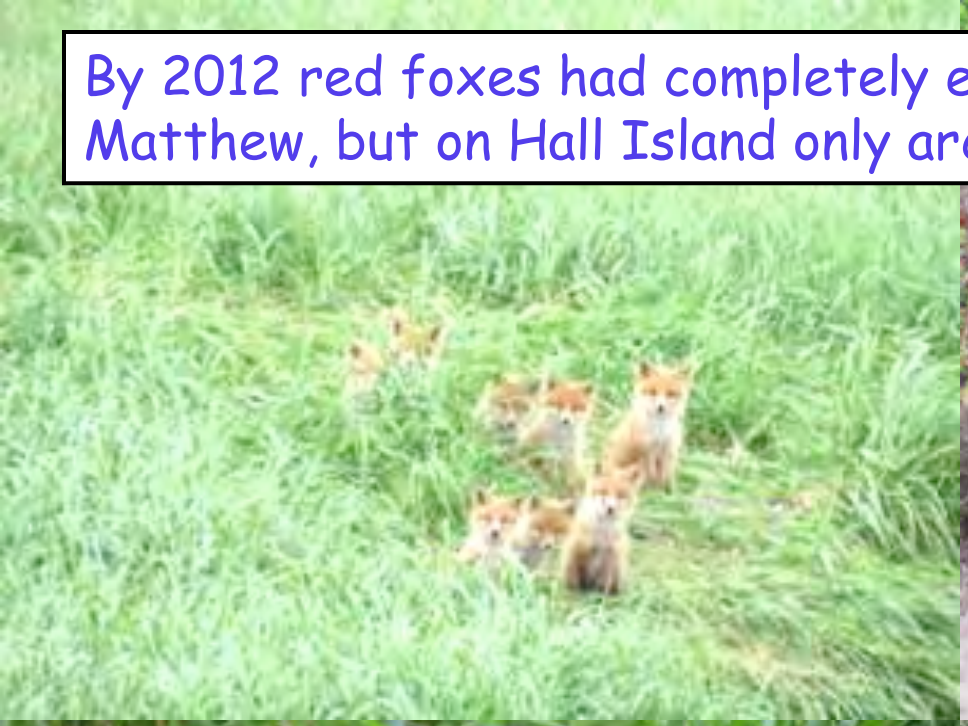
1) Cliff ledge-nesting species, murres, kittiwakes, etc., little affected as yet because their nesting colony sites are the hardest rock types that are highly resistant to erosion.
2) Crevice-nesting small auklets choose to nest in boulder fields generated by coastal erosion in the more distant past. Recent accelerated coastal erosion has provided new nesting habitat.

Arctic foxes were abundant on St. Matthew and Hall islands when I first arrived there in 1957

The first red fox was observed there in 1966

In 1999 reds were first observed to be breeding on the large island

By 2012 red foxes had completely eliminated the arctic foxes on St. Matthew, but on Hall Island only arctic foxes were still present



The small bodied and short legged arctic fox is an agile climber.

Compared to the red fox it is more effective in preying on cliff-nesting birds, such as murres and fulmars

On the St. Matthew Islands, both red and arctic foxes show a high preference for the crevice-nesting least and crested auklets when they are available to them


The top of this massive basalt pillar on Hall Is., inaccessible to foxes, is a favored nesting site for northern fulmars
Foxes can reach this pillar

What have been the consequences of replacement of the arctic by red foxes for the colonial nesting birds on Saint Matthew Is.?

Relatively little affect on ledge-nesting, colonial sea birds. They remain relatively secure from predation by both fox species.

The main focus of predation by both fox species has been on predation at the auklet colonies, but it appears to have had minimal impact on colony population levels.

What effect is the change in fox species on St. Matthew Is. having on ground nesting birds, the endemic McKay's bunting and the singing vole?

Can the red fox, a typical boreal forest species, survive the Subarctic winters when sea ice surrounds the island for five months ?

•On St. Matthew Is. what are the consequences of the shift from arctic to red foxes for the nesting birds and the singing vole ?

1. Red foxes, defend a larger area around their maternal dens, thus limiting population density at a lower level than when only arctic foxes where there.
2. Red foxes appear to be having less effect on bird population numbers on St. Matthew Is. than when only arctic foxes were there.
3. Although ecosystem change has occurred biodiversity change has been minimal.

Leaving St. Matthew 2012

Assistance provided by the twelve other 2012 St. Matthew expedition members was essential to the coastal erosion and fox investigations. We also appreciate permission for use of three of Ian Jones' s 2005 photos.

It was my 6th expedition to the ~~St~~ Matthew Islands over the last 56 years

Expedition Participants

The voyage to the St. Matthew Islands was a collaborative effort that included 13 researchers from six different organizations. The team spent 9 days documenting the biodiversity of birds, mammals, insects, fish, plants, and cultural resources of the islands.

Tony DeGange
U.S. Geological Survey
Fish, Freshwater Invertebrates, Birds

Dennis Griffin
State of Oregon
Archeology

Monte Garroute,
University of Alaska
Botany

Heather Renner,
Alaska Maritime NWR
Supervisory Biologist

Rich Kleinleder
URS inc.
Climate, Hydrology

Derek Sikes
University of AK Museum
Arthropods

Casey Bickford
University of AK Museum
Arthropods

Marianne Aplin
Alaska Maritime NWR
Seabird Monitoring

Ned Rozell
University of AK Geophysical Institute—Science Writer

Steve Delehanty
Alaska Maritime NWR
Refuge Manager

Marc Romano,
Alaska Maritime NWR
Bering Sea Unit Biologist

Aaron Foe
Aleutian-Bering Sea Islands LCC
Seabird Monitoring

Dave Klein, Professor Emeritus at the University of Alaska Fairbanks, likely knows more about St. Matthew Island than anyone else alive today. He has visited the island six times over the last 55 years and this year he returned to study geology, climate, and paleo-environment and their influence on the wildlife community.

This expedition would not have been possible without the hard work and dedicated support of the crew of the M/V Tigiax. They kept us safe, comfortable, and well-fed throughout the entire journey.

Financial & logistic support

Alaska Maritime National Wildlife Refuge

U.S. Fish and Wildlife Service

Alaska Cooperative Fish and Wildlife Research Unit

University of Alaska Fairbanks

U.S. Coast Guard

U.S. Navy

U.S. Bureau of Indian Affairs

World View 2 Satellite Imagery, ABSI-LCC

THE END

Ledge nesters

Common Murre
Thick-billed Murre
Black-legged Kittiwake
Pigeon Guillemot
Pelagic Cormorant
Northern Fulmar

Crevice nesters

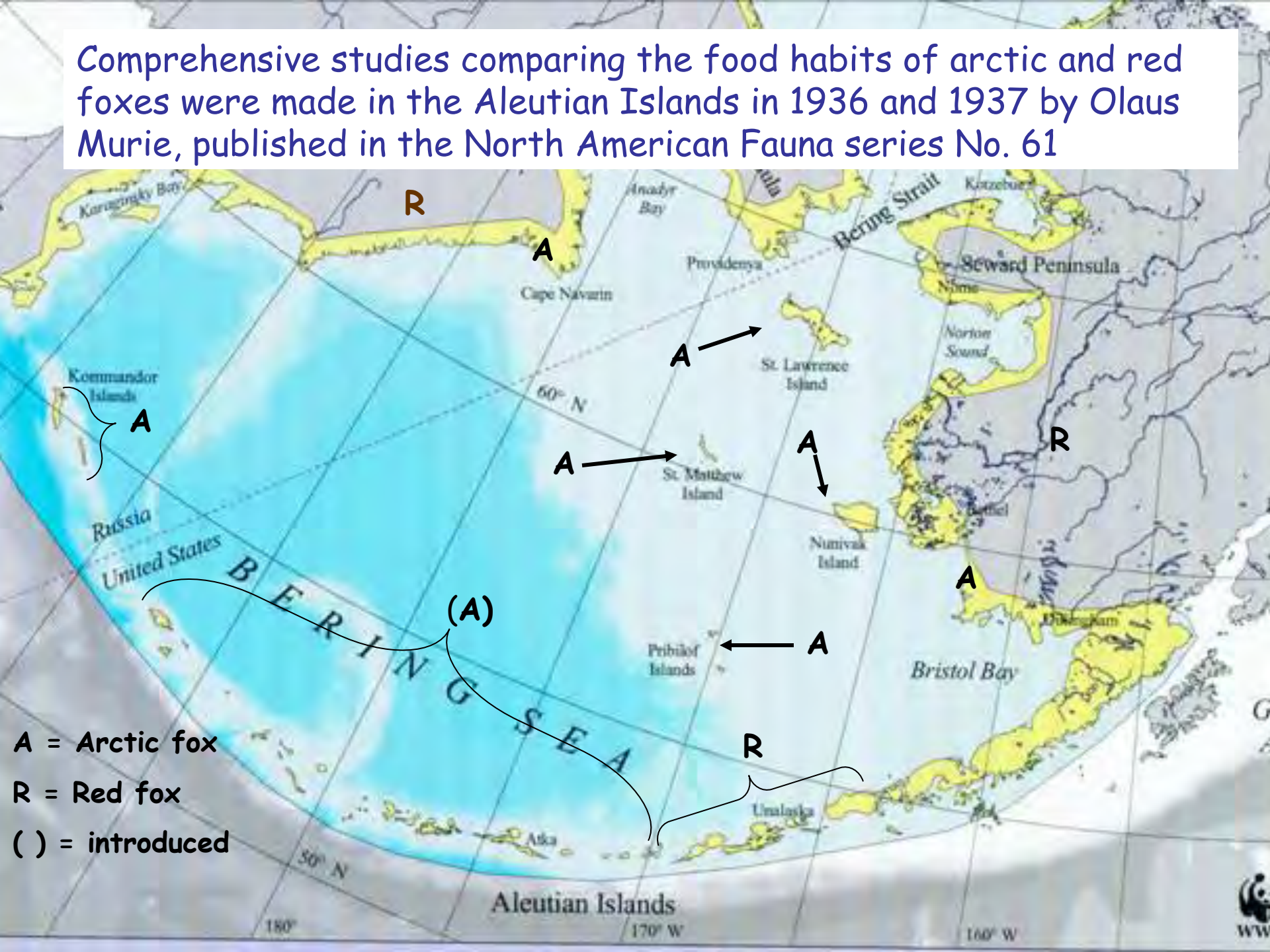
Least Auklet
Parakeet Auklet
Crested Auklet
Horned Puffin
Tufted Puffin
McKay's Bunting
Gray-crowned Rosy-Finch

Ground nesters

Rock Sandpiper
Common Eider
Long-tailed Duck
Lapland Longspur
Red-necked Phalarope

The tundra vegetation that established on the fine ash exposed in the large slump gives a false impression of secure footing

Comprehensive studies comparing the food habits of arctic and red foxes were made in the Aleutian Islands in 1936 and 1937 by Olaus Murie, published in the North American Fauna series No. 61



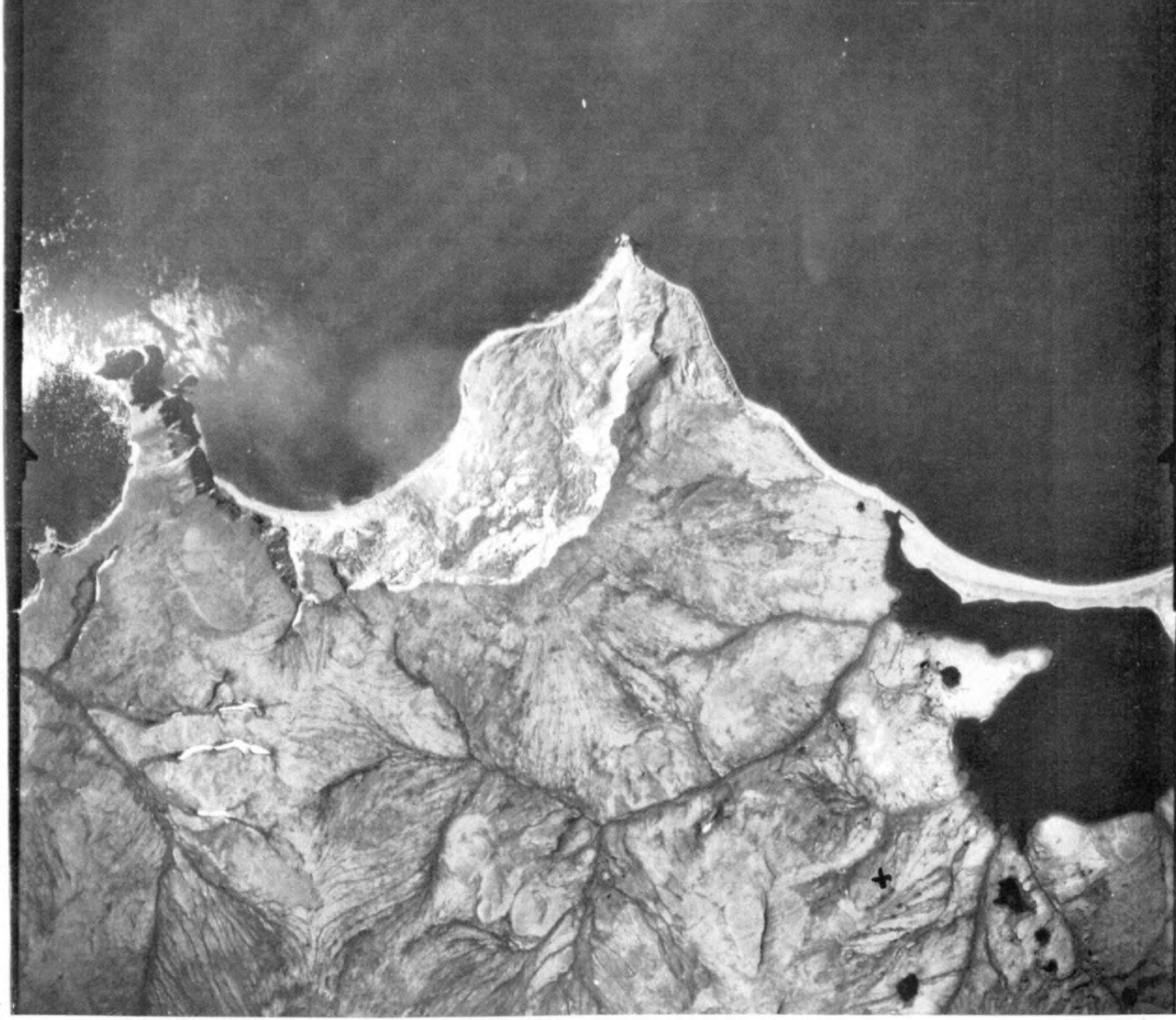
Relative impact on nesting birds of replacement of arctic foxes by red foxes:

1. Larger territorially-defended areas around red fox maternal dens accounts for lower population density of red foxes on St. Matthew Is. than when only arctic foxes where there.

2. Under recent conditions of climate-driven environmental change red foxes appear to be having less effect on bird population numbers on St. Matthew Is. than when only arctic foxes were there. Thus, although ecosystem change has occurred biodiversity change has been minimal.

3 Assessing consequences at the ecosystem level of changes in predator-prey relationships of specific species is nevertheless confounded by dynamic changes in the environment that are being driven by the changing climate.

Early winter storms and uncharted rocks make for dangerous shipping



1948 Navy
aerial photo

+ =
approximate
coring site

approx. 3 miles

Massive pyroclastic tuff deposit on southeast coast of St. Matthew Is.

Coastal erosion, accelerated by climate change, sea level rise, and reduction in winter sea ice, can damage nesting sites at sea bird colonies.

Wave action brings in food for foxes and shore birds

Our base camp on St. Matthew in 2005 & 2012 was near its northeast end