Arctic Nearshore Processes
Proposed Initiative for OAII-LAII

Ken Dunton
University of Texas
Marine Science Institute
Port Aransas, TX

Lee Cooper
University of Tennessee
Ecology & Evolutionary Biology
Knoxville, TN

- The nearshore zone of the Arctic Ocean has been largely ignored, with a few exceptions (e.g. Swedish Tundra Expeditions). In the U.S., little research effort since the end of OCSEAP funded studies over two decades ago.

- The region represents an absolutely dynamic boundary between arctic coastal plain watersheds and the arctic shelf and basin.

The nearshore zone is the site of:

- Most human activity, especially subsistence hunting
- Increased coastal erosion

Bowhead, Pt. Barrow (from D. Schell)

Camden Bay, July 1991

The nearshore zone is the site of:

- Even greater human activity in the Russian Arctic
- Cities, industrial development

Unloading coal, Provideniya

Bilibino Nuclear Power Plant, Chukotka

- Intense petroleum development, both onshore and offshore

Prudhoe Bay

Tern Island, Stefannson Sound, early July

TAPS, south of Prudhoe Bay

- Organic and inorganic input of materials from river discharge
- Substantial variations in ice-retreat and spring ice breakup
- Physical extremes of temperature, winds, and ice cover

Fast Ice, Stefansson Sound, late February

Colville River, July

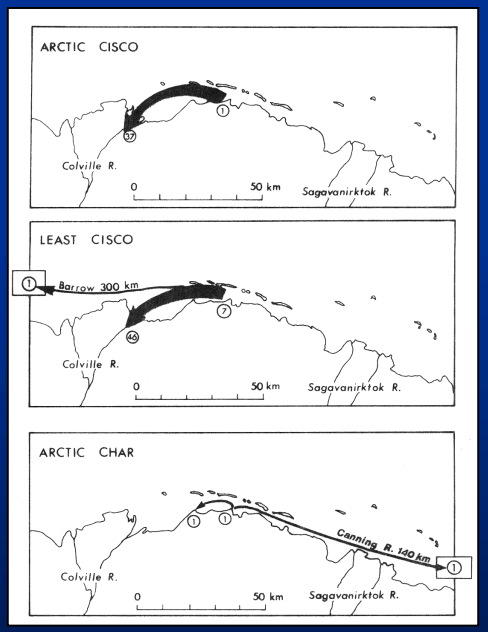
Ice break-up, near Cross Island,

- Migrations of anadromous fishes, migratory water fowl, and large animals.

S.R. Johnson, 2000

Black Brant, Prudhoe Bay

Caribou, Camden Bay



P.C. Craig, 1980

- Consequently, the nearshore zone is characterized by considerable biogeochemical and hydrological cycling, identified as two major thematic approaches in the OAII Science Plan.

The absence of recent studies on the arctic nearshore zone is largely a result of:

- Extremely variable and unpredictable physical and climatic conditions
- High costs of performing arctic field research
- The absence of logistical support and infrastructure to support arctic coastal studies

The absence of recent studies on the arctic nearshore zone is largely a result of:

- Access to ice-strengthened and shallow draft research vessels
- Emphasis on shelf and basin research

R.V. Karluk, USGS

In the Russian Arctic, additional burdens exist:

- Other permits needed, including Exclusive Economic Zone clearance
- Need to facilitate support for Russian scientist partners
- International coordination

Igor Melnikov at SHEBA ice camp, 24 January 1998

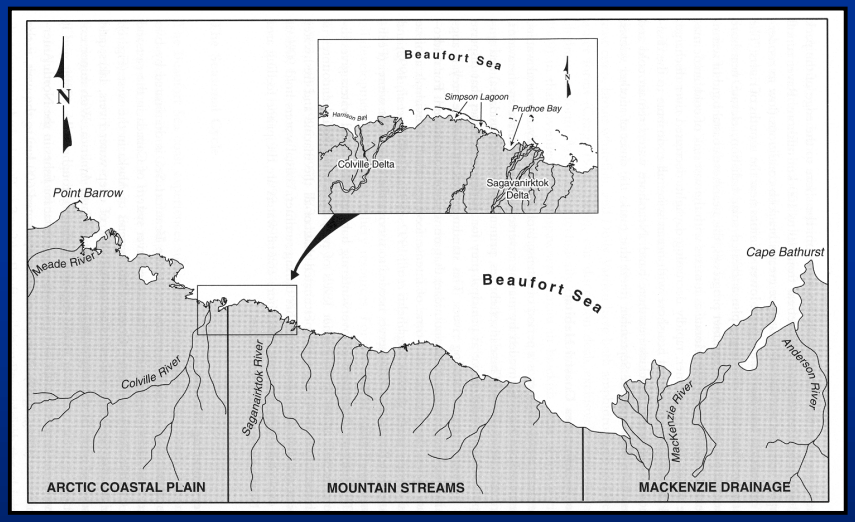
Aboard the RV OKEAN, 4th U.S. - Russian BERPAC Expedition, August 1993

Overarching goal of an Arctic Nearshore Processes Initiative:

- To improve our understanding of the biogeochemical and hydrological processes that occur on the nearshore zone of the arctic shelf and coastal plain with respect to changes in global climate.

Linkages with the land:

- How is the hydraulic contribution of arctic rivers important to the functioning of the nearshore environment?



B.J. Gallaway and R.G. Fechhelm, 2000

Canning River, Arctic National Wildlife Refuge

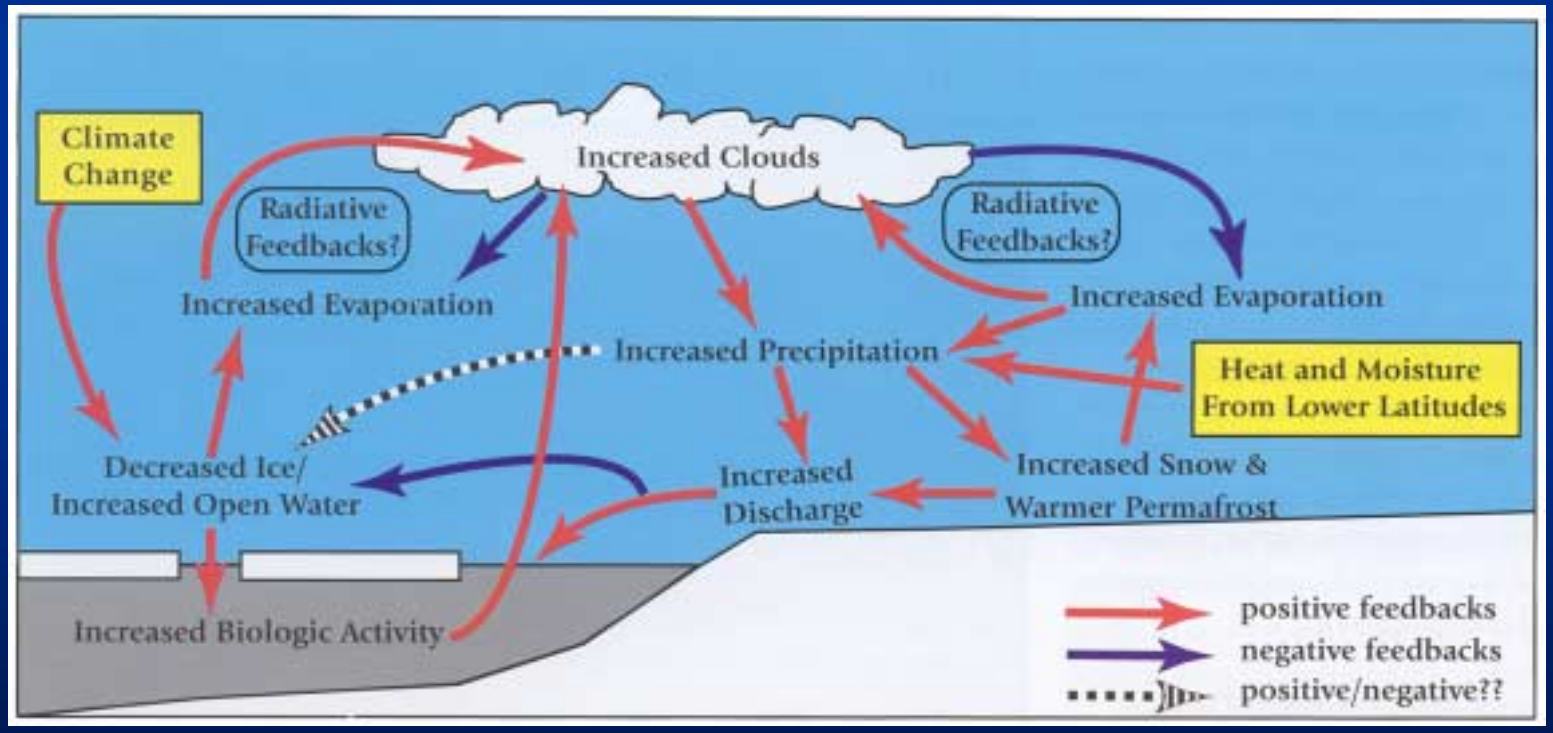
Linkages with the land:

- What are the rates and magnitudes of erosion into the coastal zone? How will these inputs change as transgression along the arctic coast accelerates in response to climatic warming?

Flaxman Island, 1991

Linkages with the land:

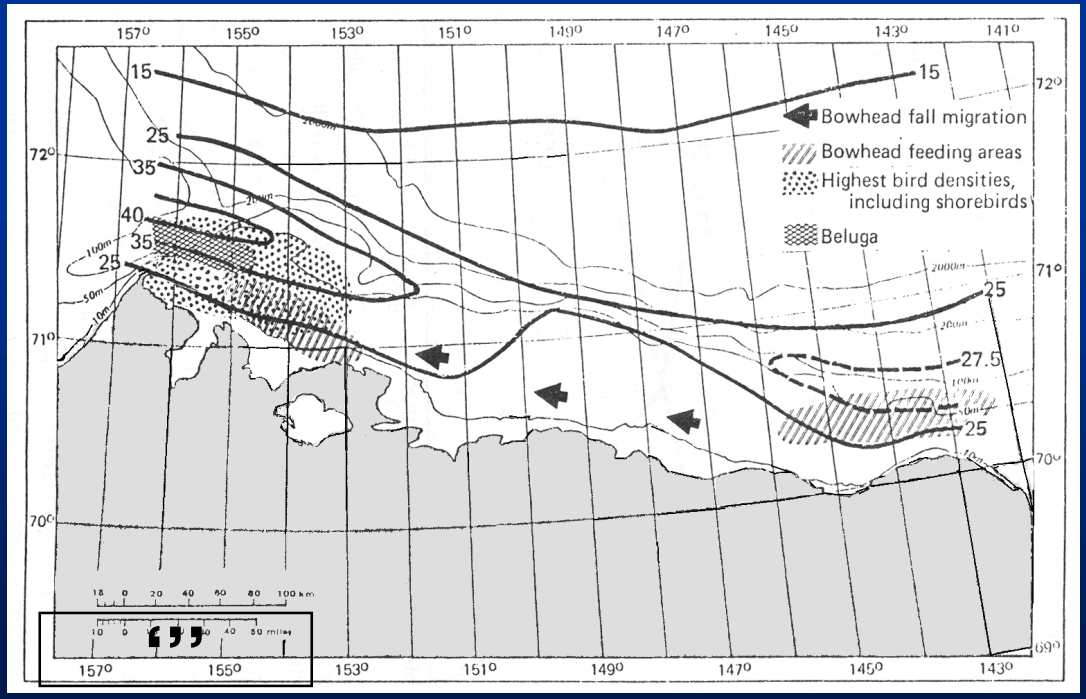
- What are the impacts of increased freshwater inflow on marine productivity in the nearshore zone?



Vörösmarty et al., 2001 NSF-ARCSS Hydrology Workshop Report

Productivity and Biogeochemical Cycling:

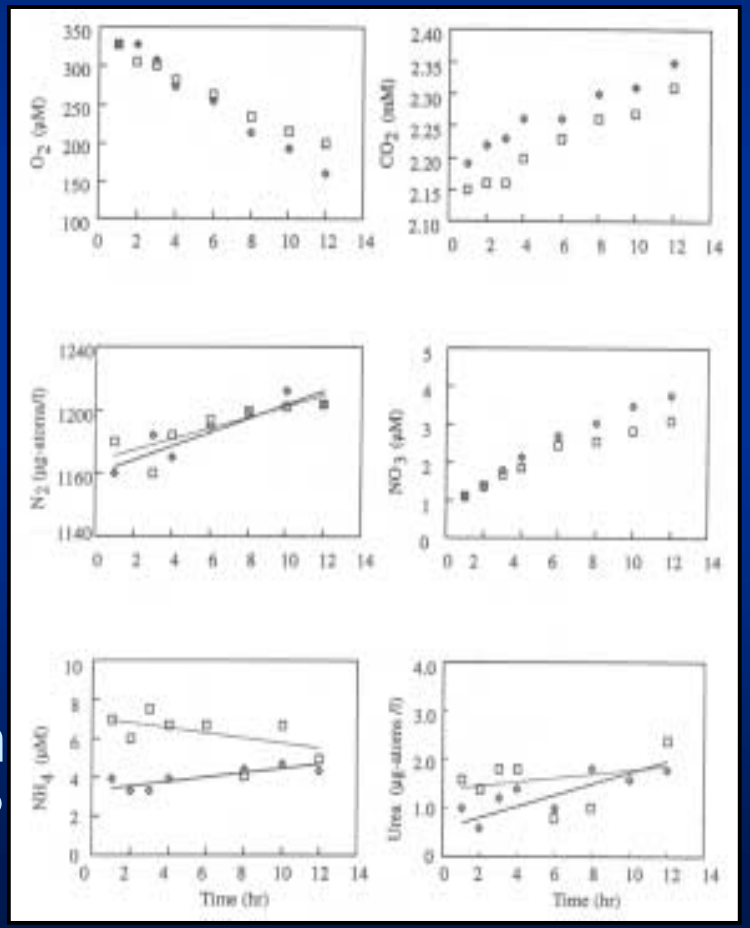
- Define the temporal and spatial scales of primary productivity along the nearshore arctic coast; how are these variations related to “hot spots” of secondary productivity, local hydrology, and nearshore/shelf circulation?



D..M. Schell et al, 1982

Productivity and Biogeochemical Cycling:

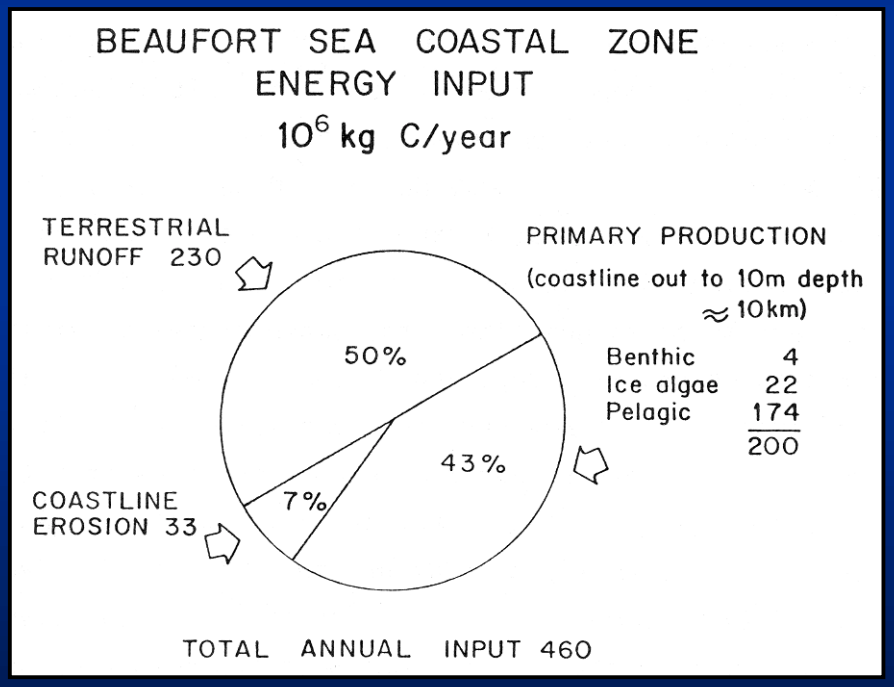
- Do nearshore sediments constitute an important source of marine denitrification and loss of contained nitrogen for arctic waters?
  - Do rate processes change during the 9-month ice-covered period?
  - Does the decomposition of organic matter from coastal watersheds contribute a significant source of new nitrogen for nearshore primary producers?



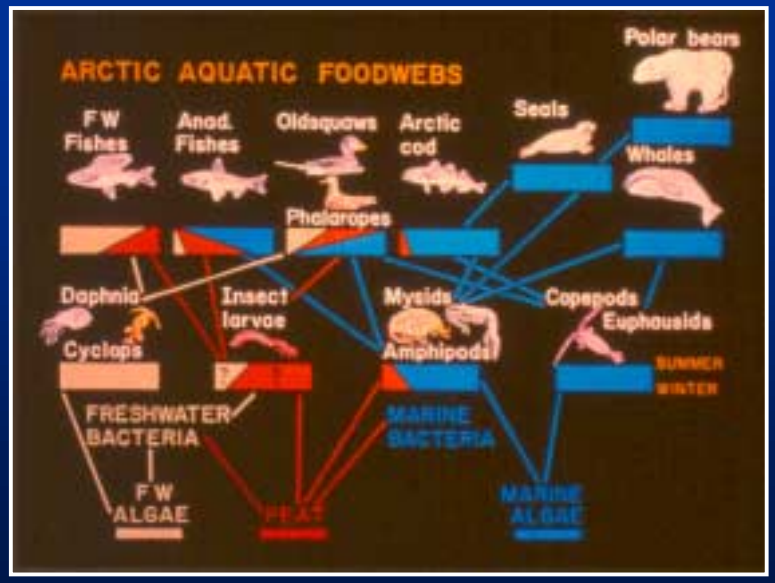
Devol et al., 1997

Productivity and Biogeochemical Cycling:

- Is peat really a dead end carbon source on the nearshore shelf? What about other sources of terrigenous carbon and inorganic nutrients that enter the nearshore zone through erosion and river inputs?



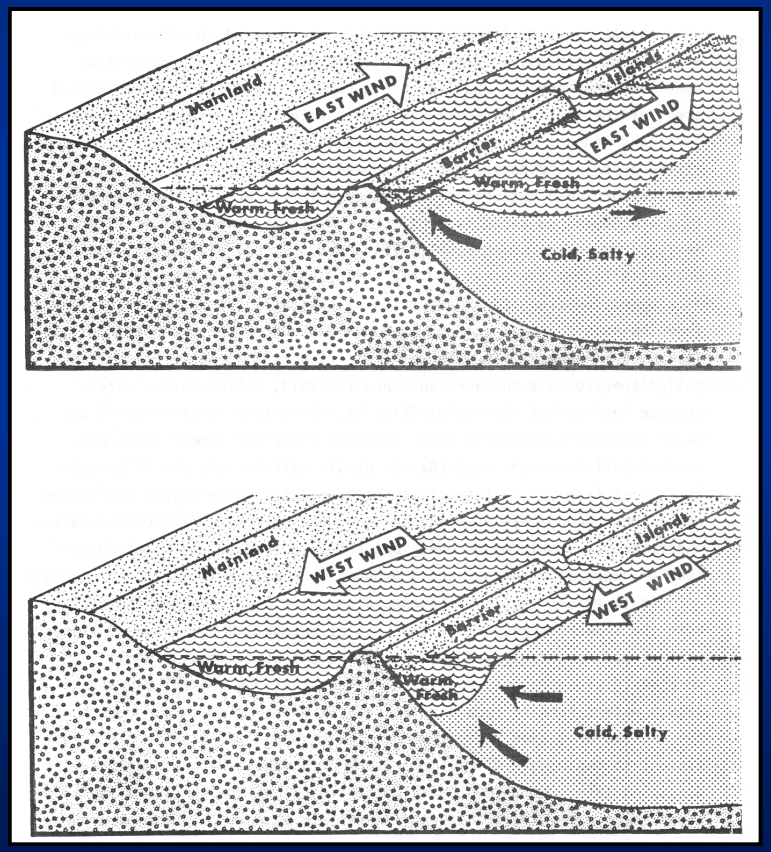
D..M. Schell et al, 1982



From D. Schell. unpub.

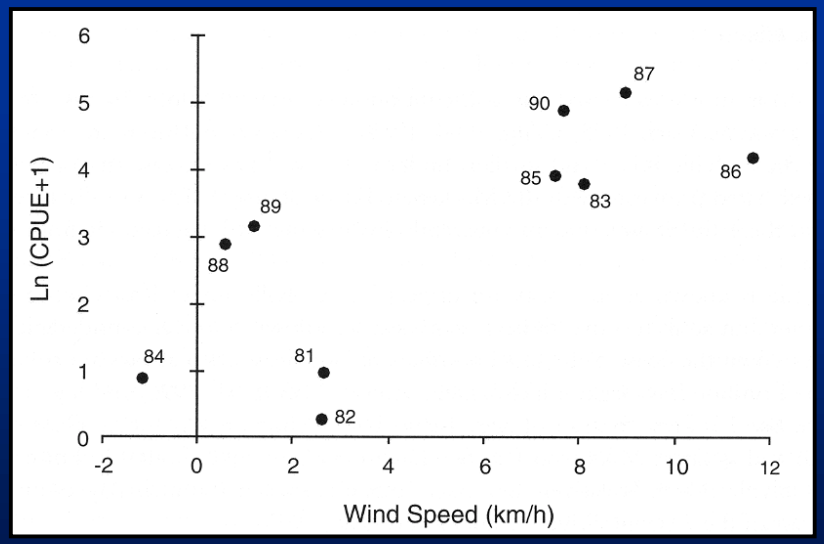
Linkages with the atmosphere:

- Nearshore circulation patterns in the Arctic are poorly understood; how do frequent changes in wind direction and speed influence circulation and the advection of nutrients into the nearshore zone?



J.C. Truett, 1980

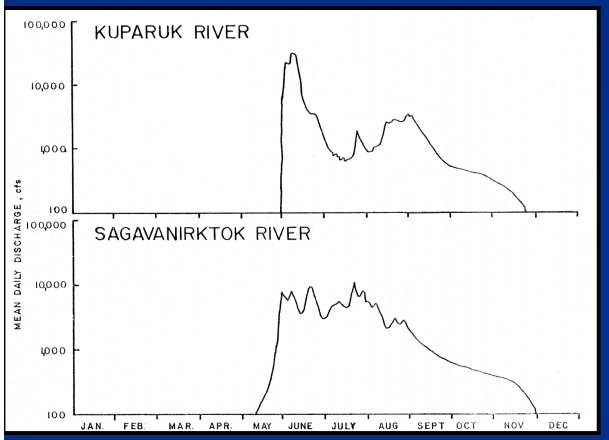
- How do variations in winds influence the dispersion of fast ice, rates of primary production, and the distribution of nekton?



Catch-per-unit effort of arctic cisco in the Colville River as a function of average east/west wind component (B.J. Gallaway and R.G. Fechhelm, 2000).

Climate change and environmental variability:

- Some of the factors known to have significant impacts on nearshore processes, which are not well understood, include:



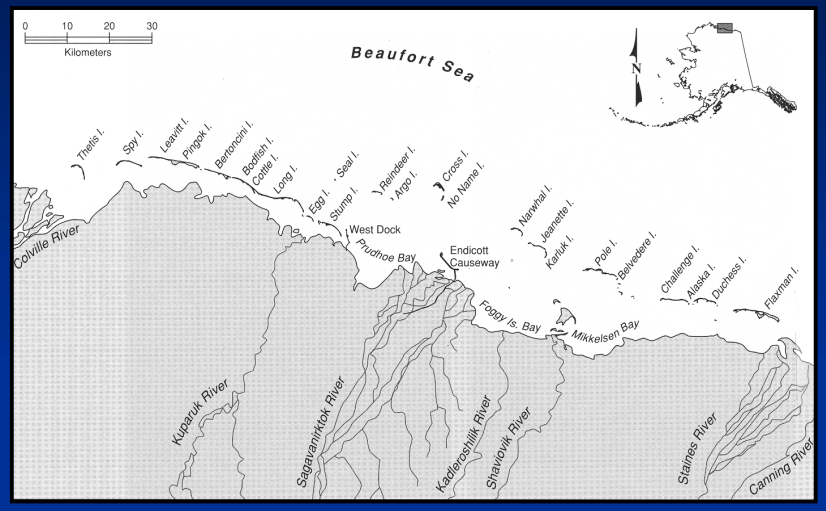
J.C. Truett, 1980

- Timing of the breakup of the nearshore fast ice and the duration and magnitude of fresh water discharge.
  - Sediment transport by fast ice

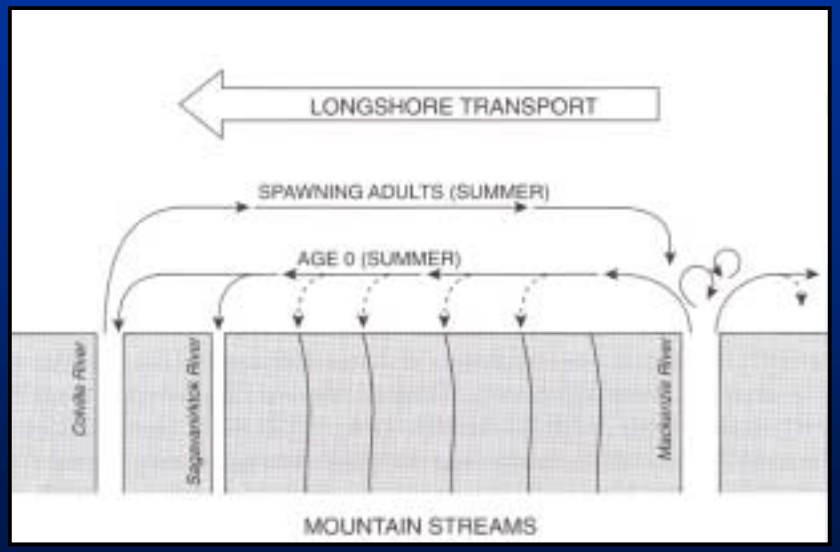
Strudel scour formation during flooding of the fast ice, north of Sag River Delta, Stefannson

Stefannson Sound

Climate change and environmental variability:



S.R. Johnson, 2000



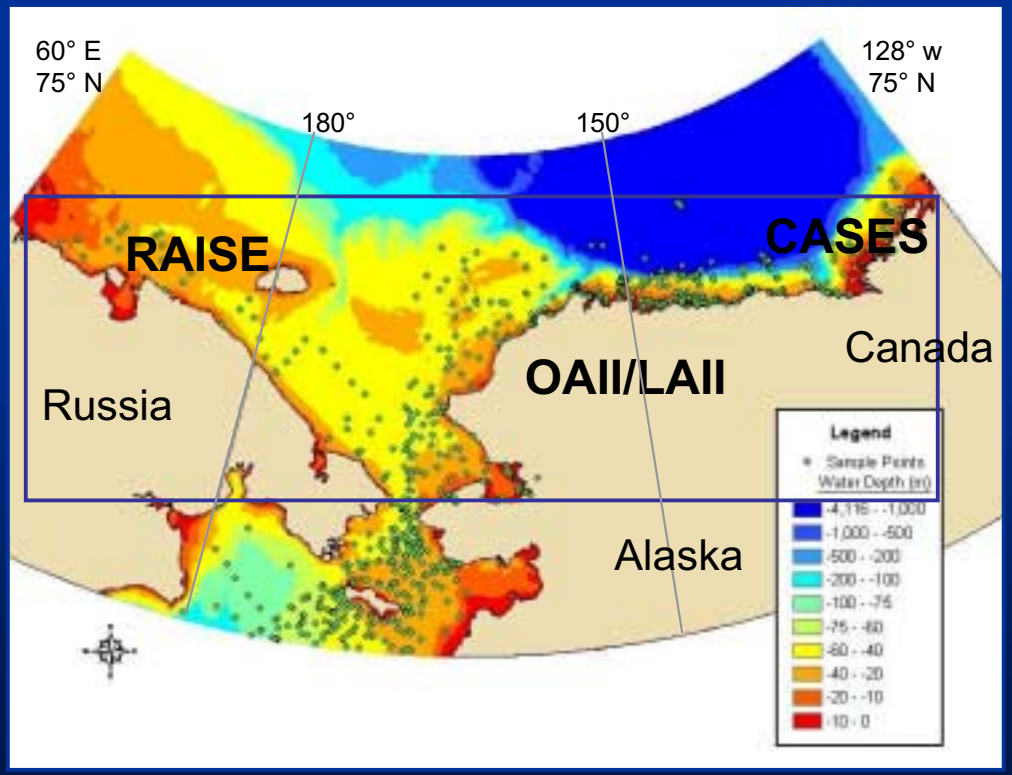
B.J. Gallaway and R.G. Fechhelm, 2000

- Configuration and changes in emergent land forms (barrier islands) which alter the effects of wind on biota, water, ice movement, and exchange processes.

Cross Island, early July

Proposed study area and linkages with other programs:

- RAISE: Eastern Siberian Shelf
- CASES: Mackenzie Delta
- HARC: Subsistence and native knowledge
- LAII: Rivers and watersheds
- ACD: International Program on Arctic Coastal Dynamics
- LOIRA: Russian Arctic land-sea boundary



Specific Linkages with RAISE

- RAISE Science Steering Committee is developing a science plan to provide a ship-based research opportunity to be supported by both NSF and the Russian Foundation for Basic Research.
- Coordination with International Arctic Science Committee (IASC) efforts, such as the International Science Initiative in the Russian Arctic (ISIRA) and its projects, e.g. Land-Ocean Interactions in the Russian Arctic (LOIRA).
- Potential for coordination with third countries (e.g. Swedish Beringia expedition with Oden planned in 2005).

Proposed study area and linkages with other programs:

- AAAWS: American Academy of Arctic Water Skiers

K. Dunton near Narwhal Island