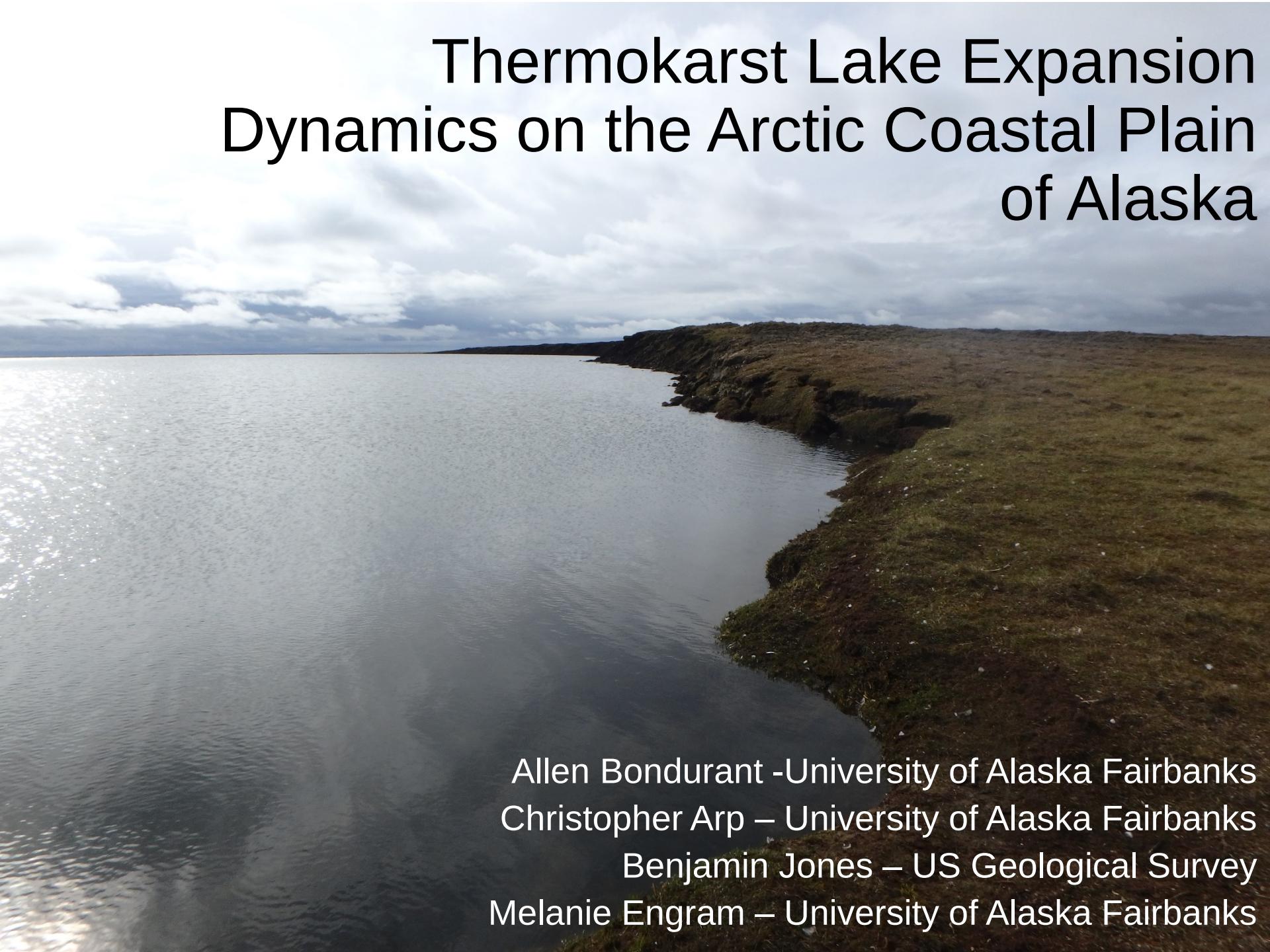
# Thermokarst Lake Expansion Dynamics on the Arctic Coastal Plain of Alaska



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ALISS: Arctic Lake Ice Systems Science

About Approach Team Project Highlights Real-Time Data Products Blog Synergistic Projects

Understanding winter lake dynamics and interactions with permafrost, hydrology, and climate to predict future Arctic system responses.

http://arcticlakeice.org/

UNIVERSITY OF ALASKA FAIRBANKS

USGS science for a changing world

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# Outline

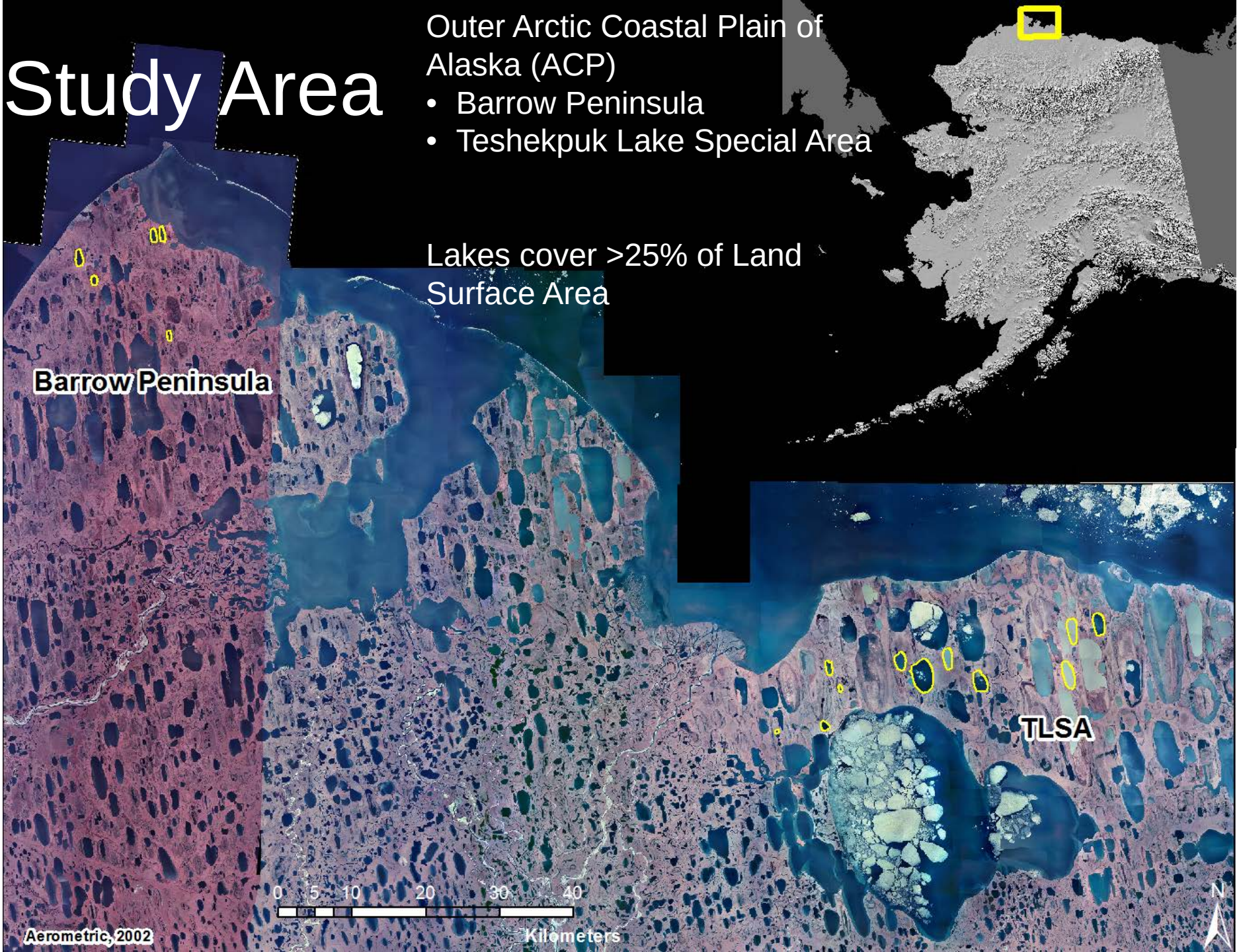
- Study Area and Background
- What are bedfast and floating ice lakes?
- Why would ice regime affect erosion rates?
- What are the rates of erosion on bedfast vs. floating ice lakes?
- Where do shorelines erode?

# Study Area

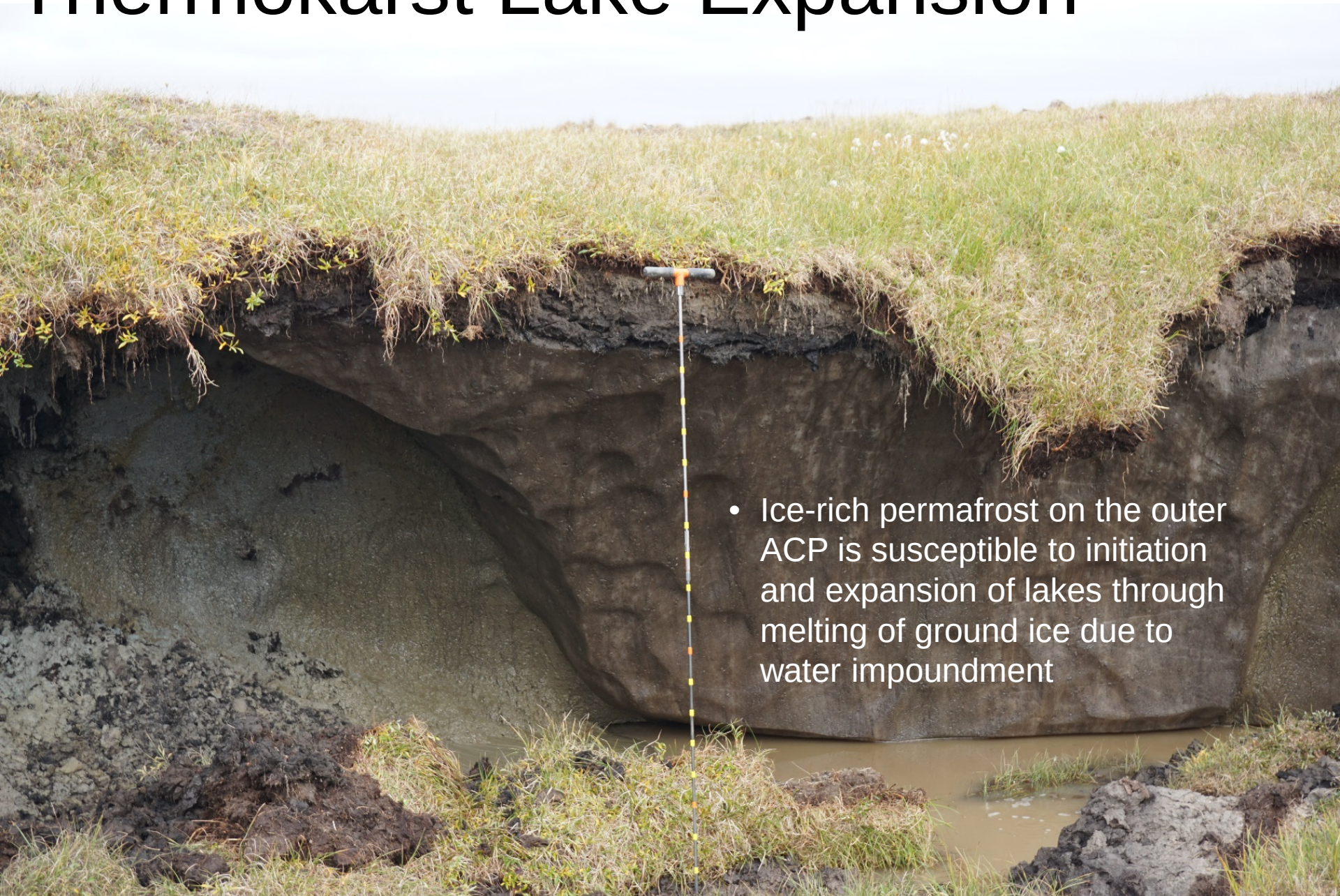
Outer Arctic Coastal Plain of Alaska (ACP)

- Barrow Peninsula
- Teshekpuk Lake Special Area

Lakes cover >25% of Land Surface Area



# Thermokarst Lake Expansion

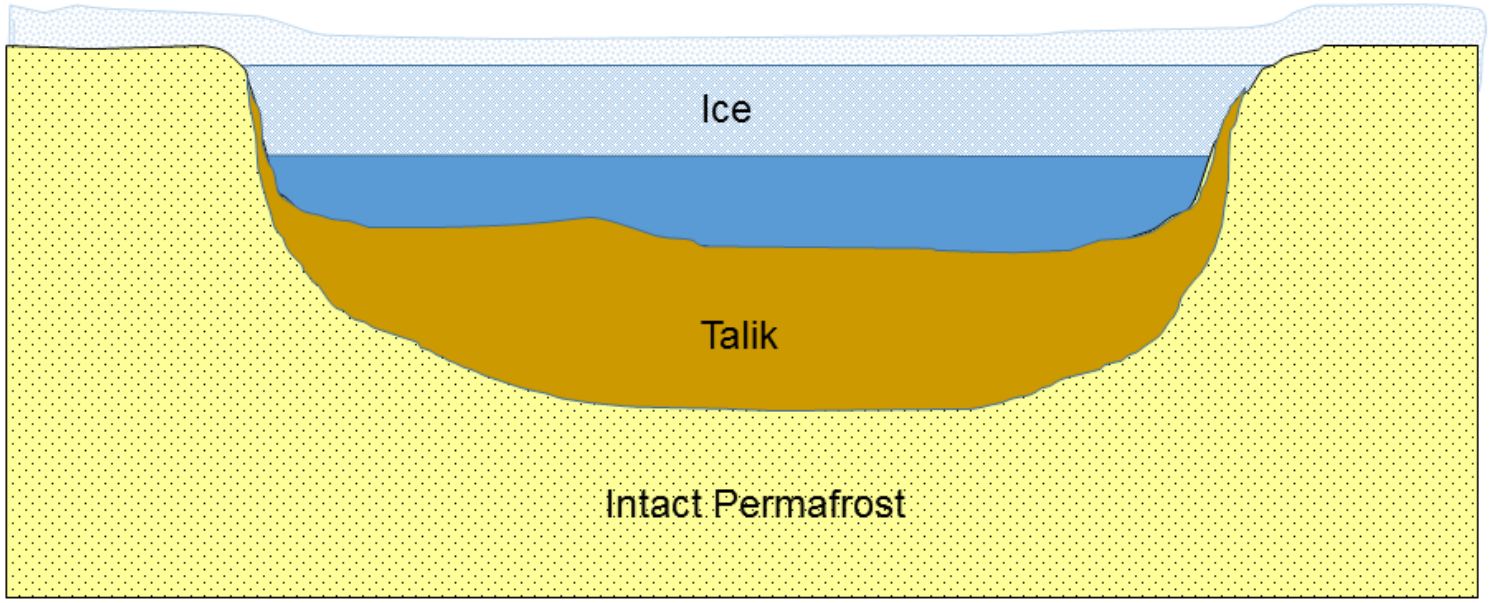


- Ice-rich permafrost on the outer ACP is susceptible to initiation and expansion of lakes through melting of ground ice due to water impoundment

# How do shorelines erode?

Ice shove

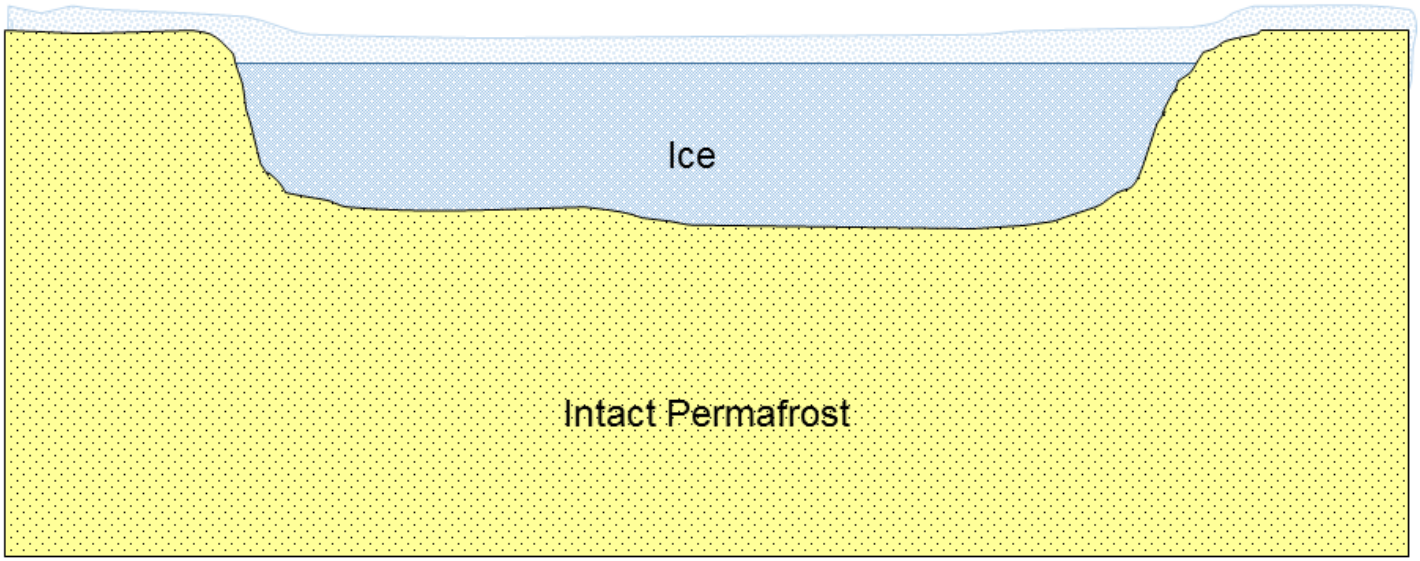
# Lake Ice Regimes




Floating Ice Lake (Winter)

- Lake Depth exceeds maximum ice growth
- Formation of talik beneath lake
- Ice pan with liquid water beneath

# Lake Ice Regimes

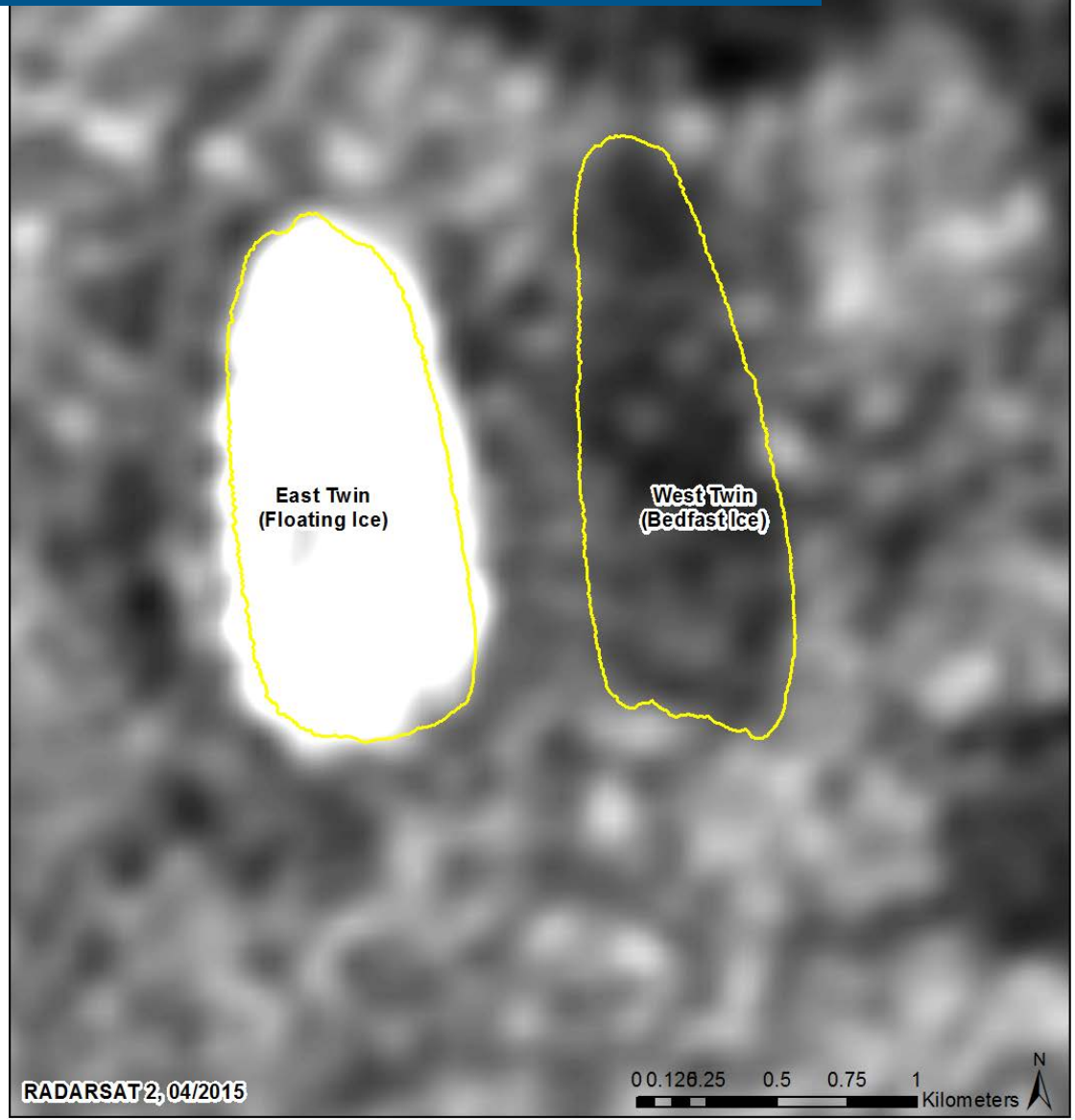



Bedfast Ice Lake (Winter)

- Ice growth exceeds lake depth
- Sublake Permafrost remains intact
- Ice pan anchored to bed

# Using SAR to identify ice regime

- Floating ice lakes appear bright in SAR
- Bedfast ice lakes appear dark



# Using SAR to identify ice regime

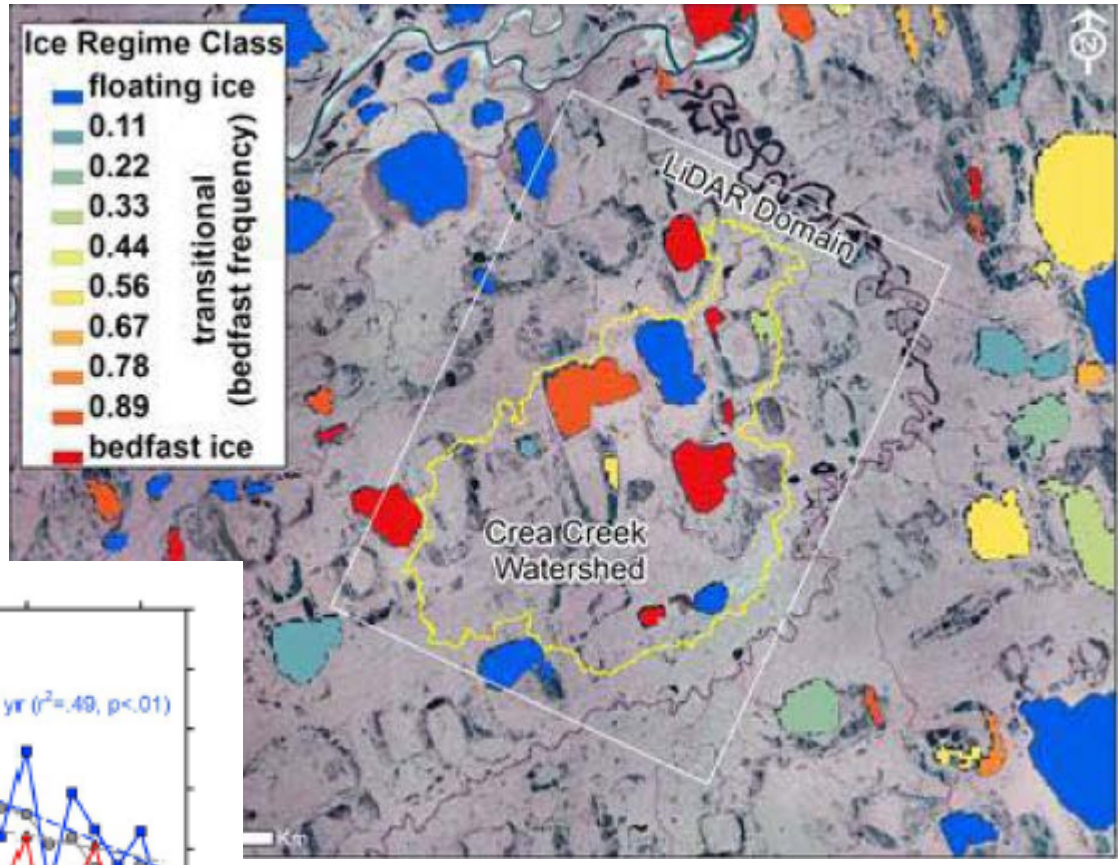
- Ground truthing of radarsat 2 image within 21 days of acquisition

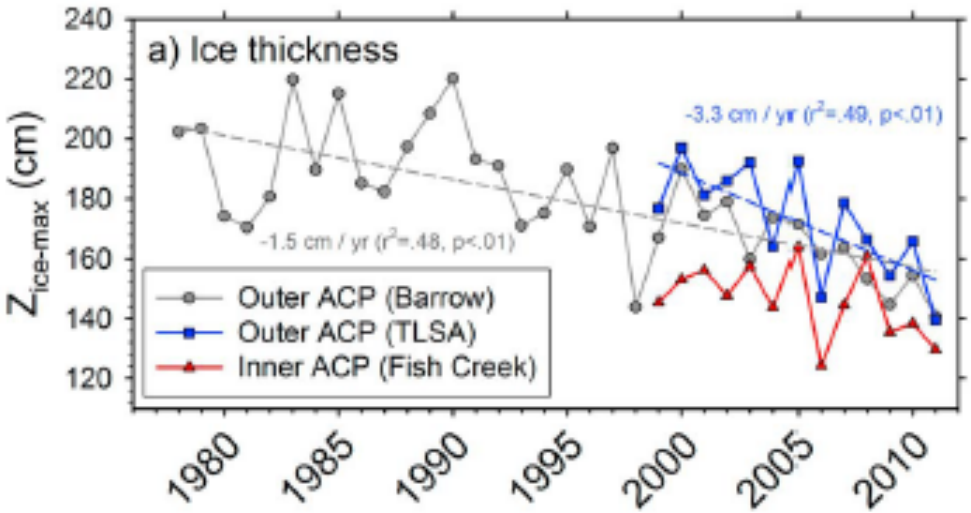
# Transitional Ice Lakes

Transitional ice lakes are those near the threshold of average maximum lake ice thickness

- Some years, they have bedfast ice
- Some years, they have floating ice

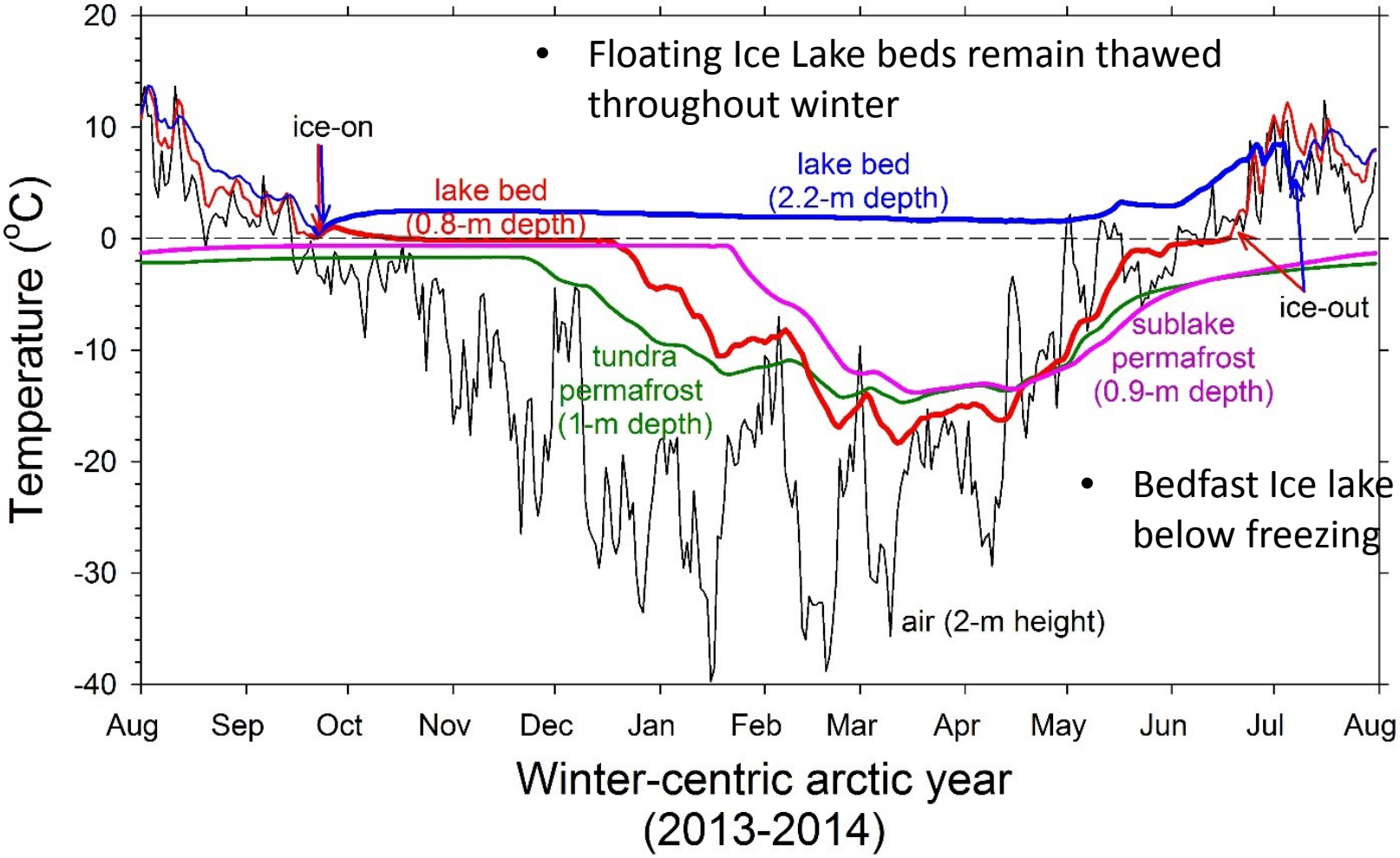
If the trend of thinning Arctic lake ice continues, there could be more and more lakes of a floating ice regime




Arp et al. 2012a

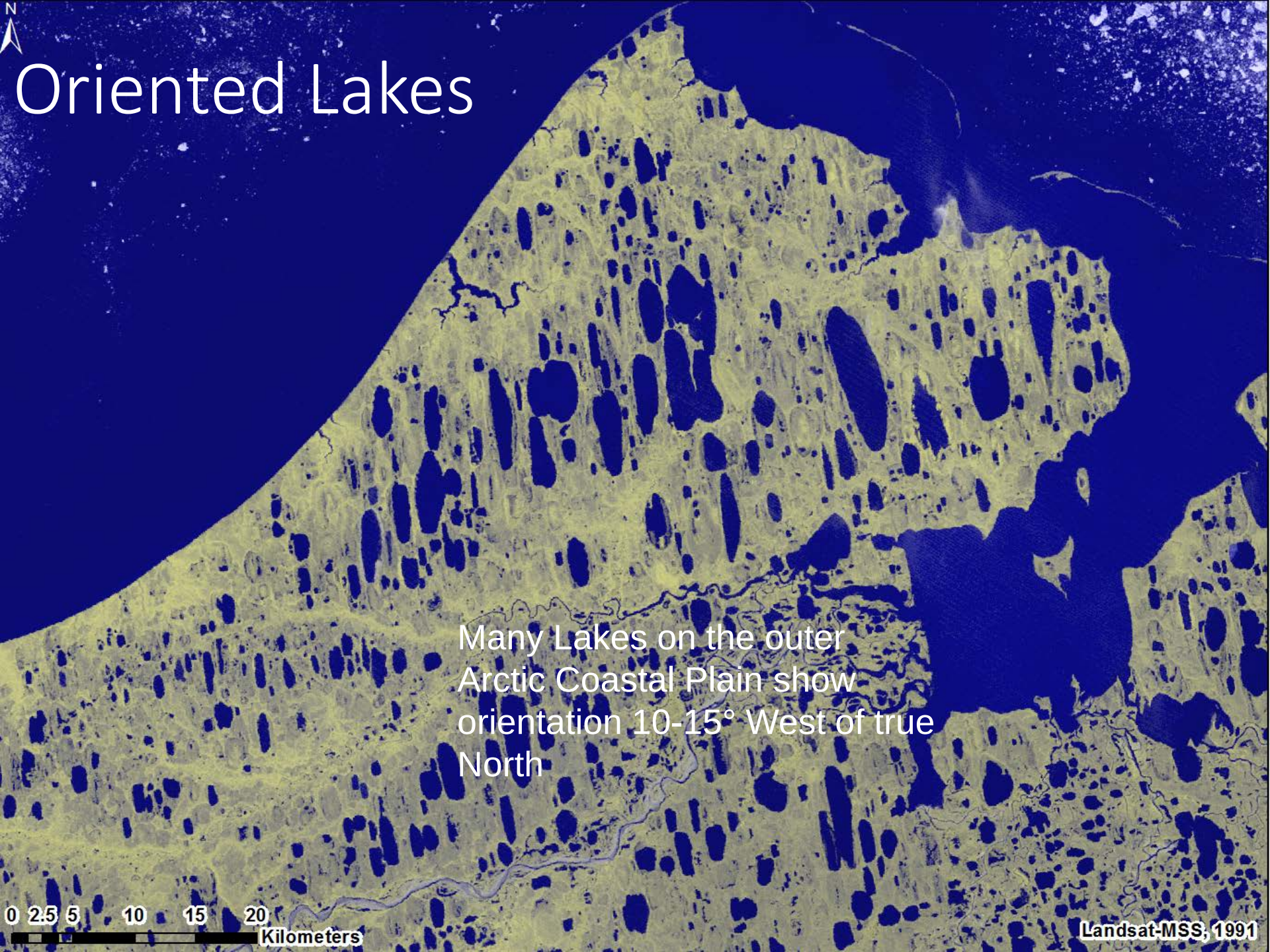
# Why would ice regime affect erosion rates?



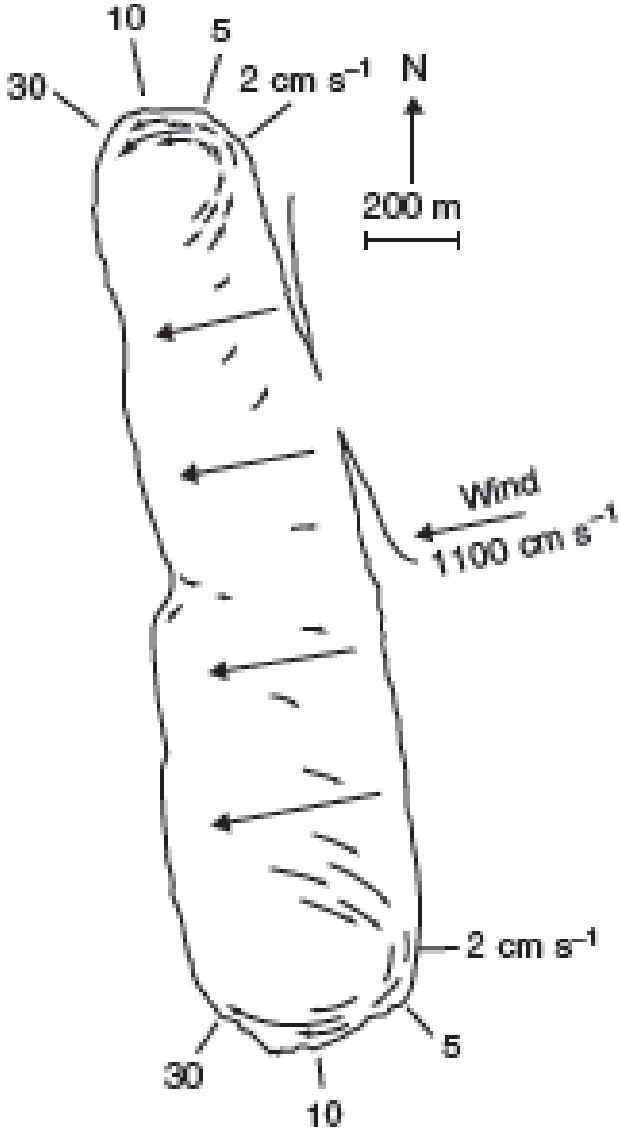

- Floating Ice Lake beds remain thawed throughout winter
- Bedfast Ice lake beds below freezing

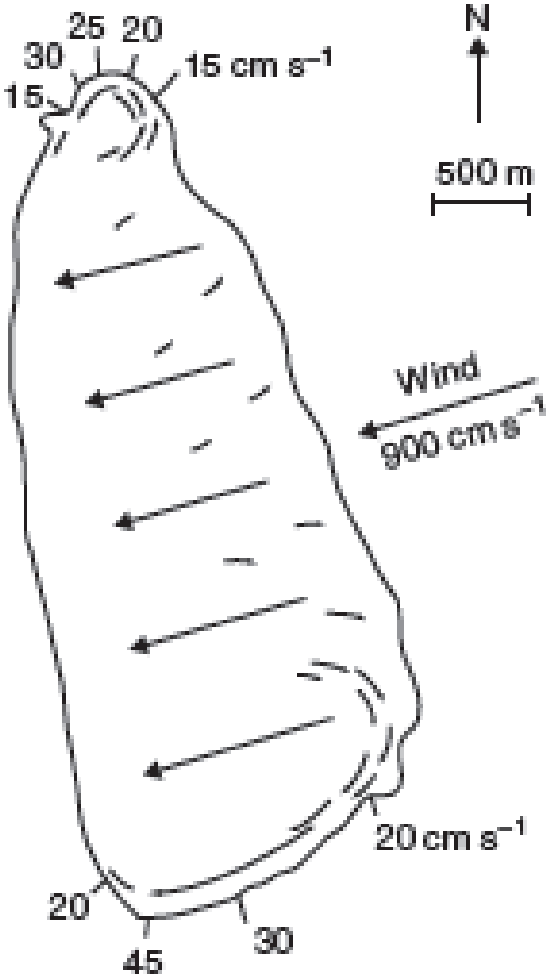
Arp et al. 2016

# Oriented Lakes

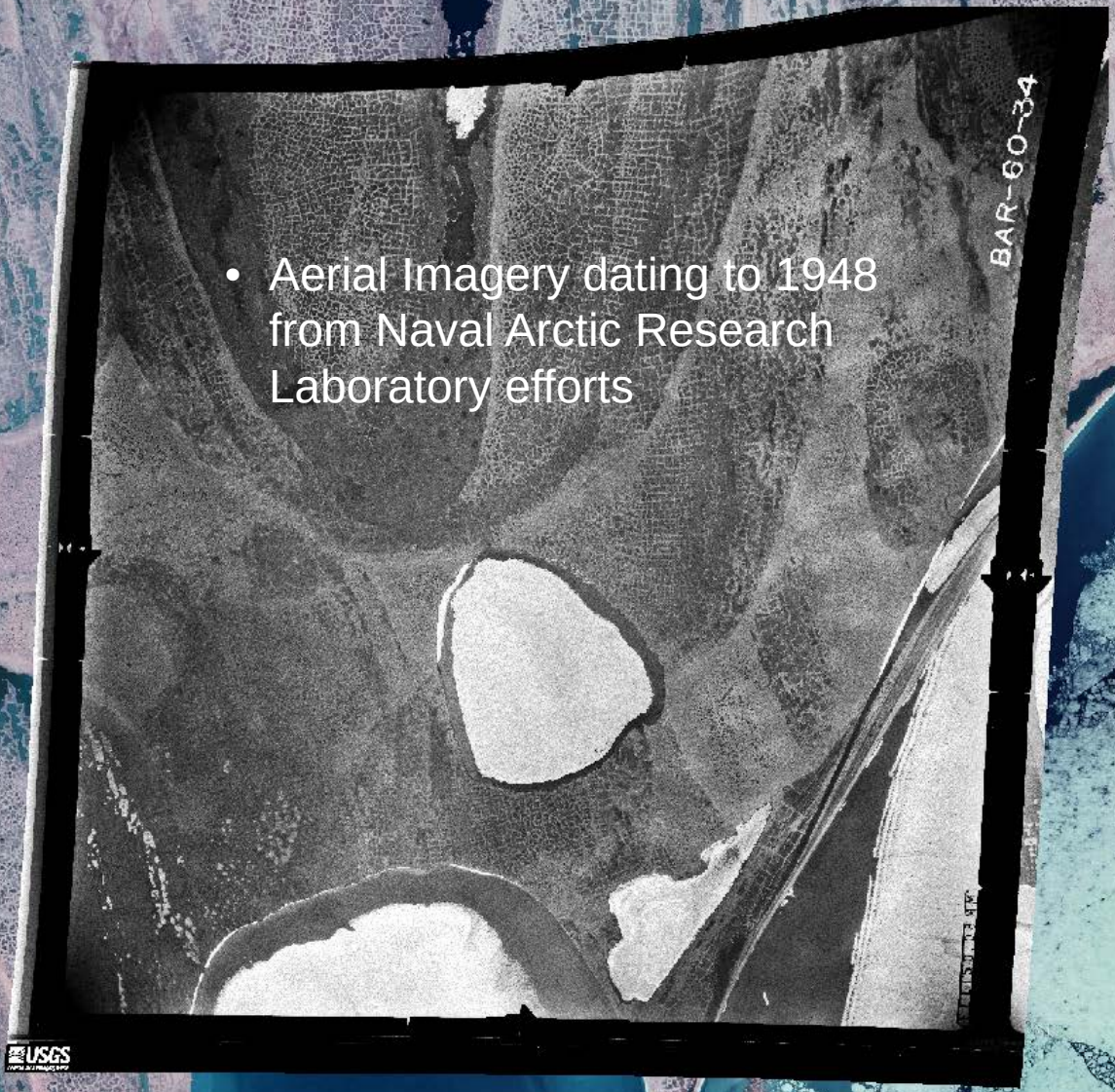


# Oriented Lakes

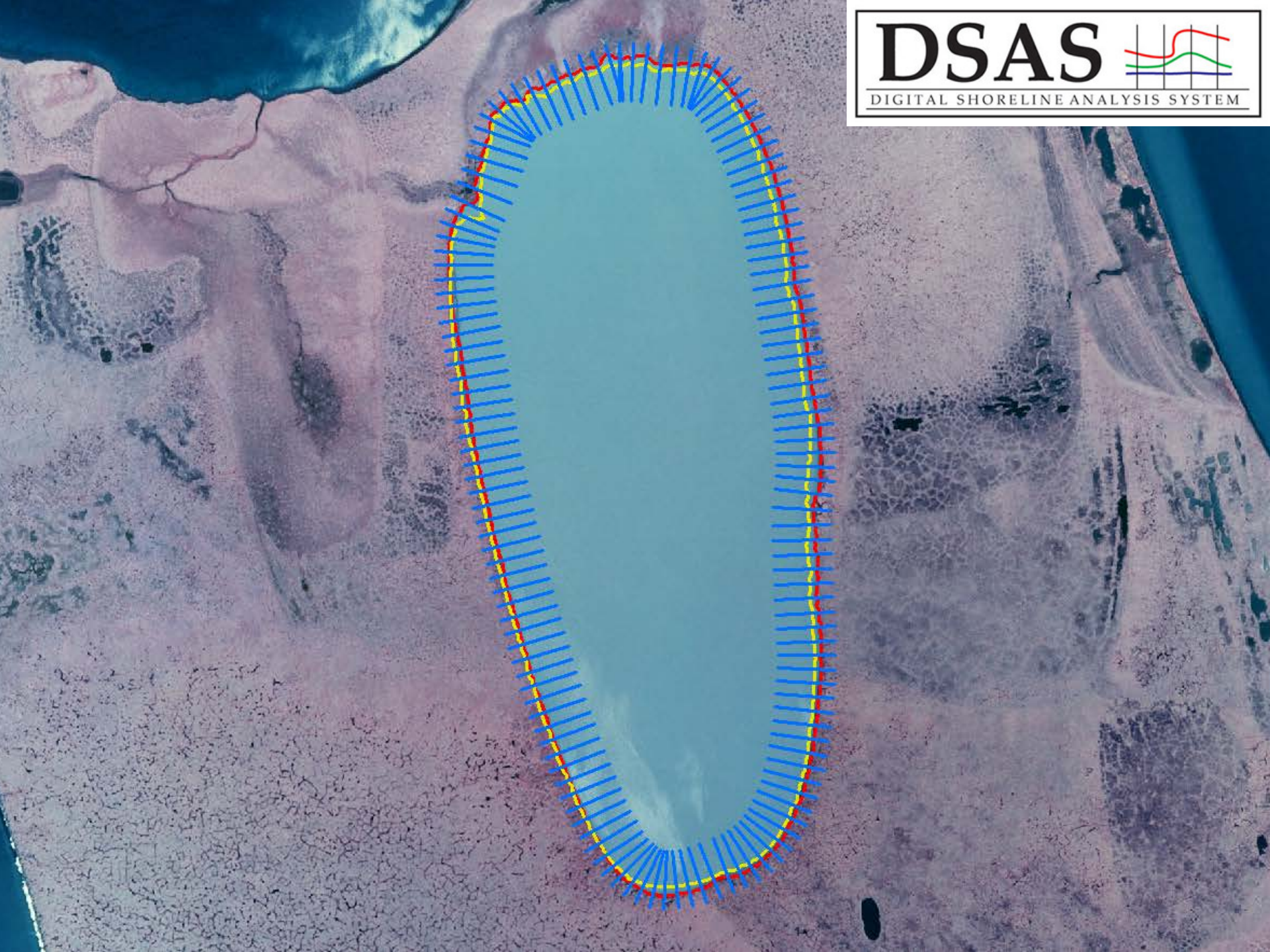


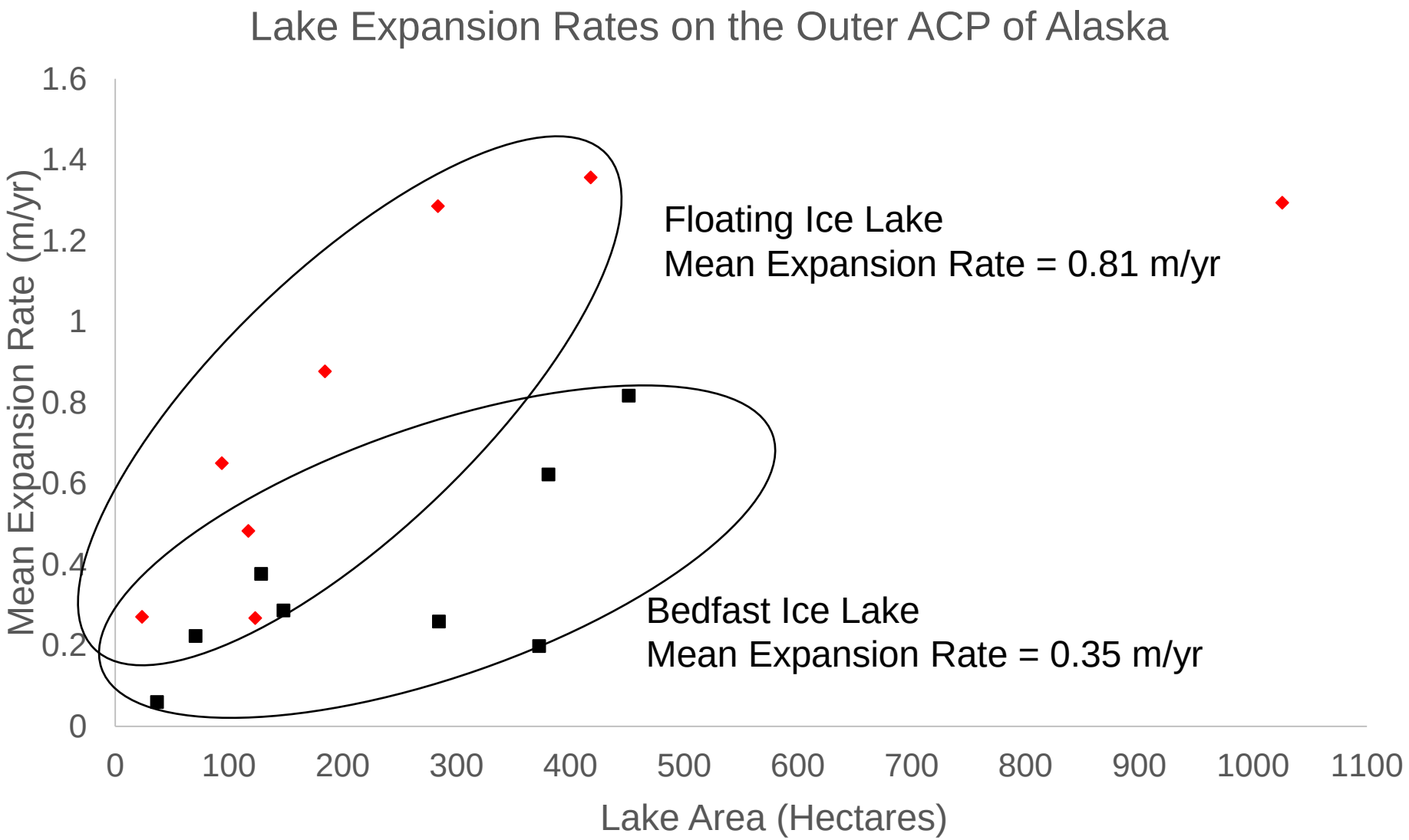

Carson & Hussey, 1962



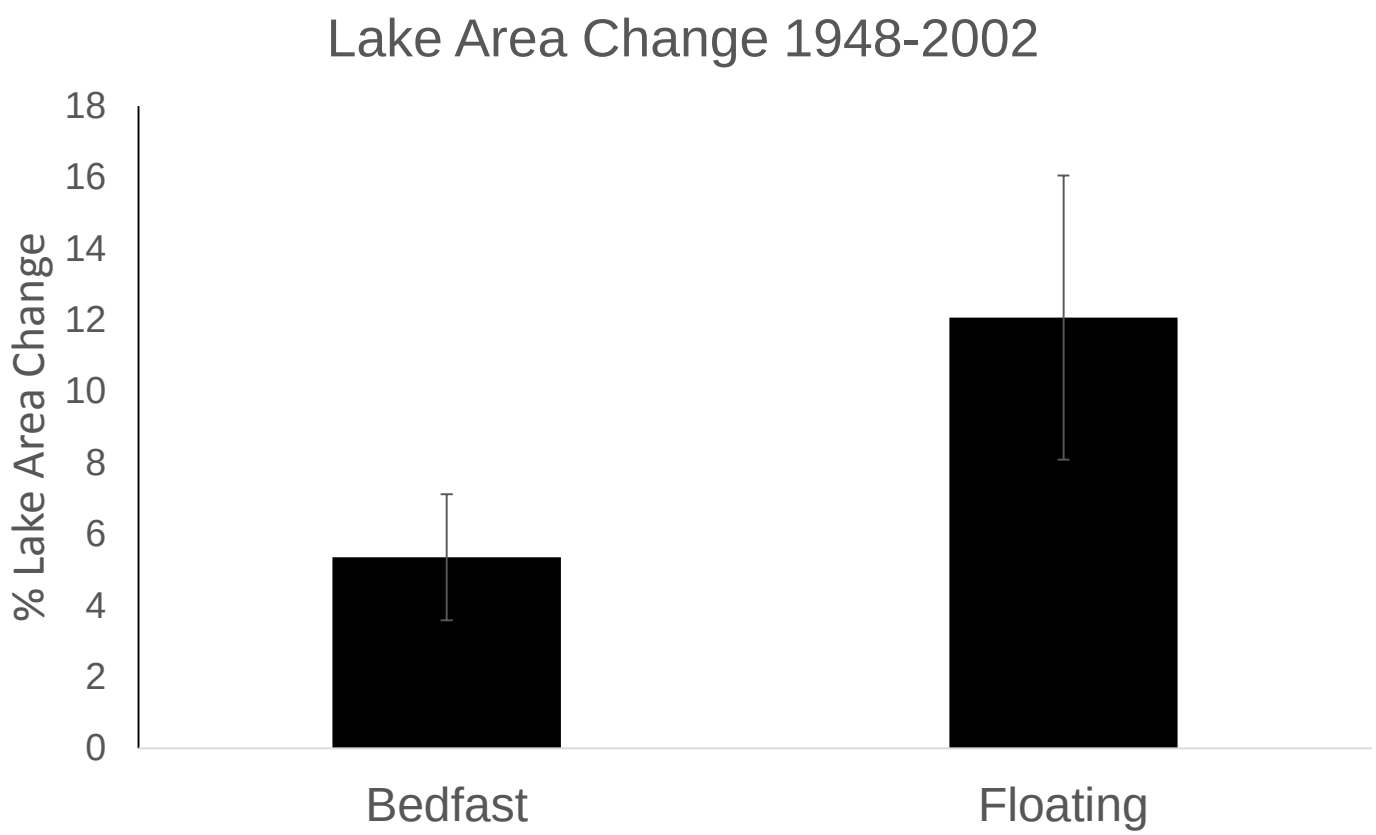

- Aerial Imagery dating to 1948 from Naval Arctic Research Laboratory efforts


DSAS
DIGITAL SHORELINE ANALYSIS SYSTEM

# Results


Lake Expansion Rates on the Outer ACP of Alaska
Mean Expansion Rate (m/yr)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
500
600
700
800
900
1000
1100
Lake Area (Hectares)
Floating Ice Lake
Mean Expansion Rate = 0.81 m/yr
Bedfast Ice Lake
Mean Expansion Rate = 0.35 m/yr

# Lake Area Change

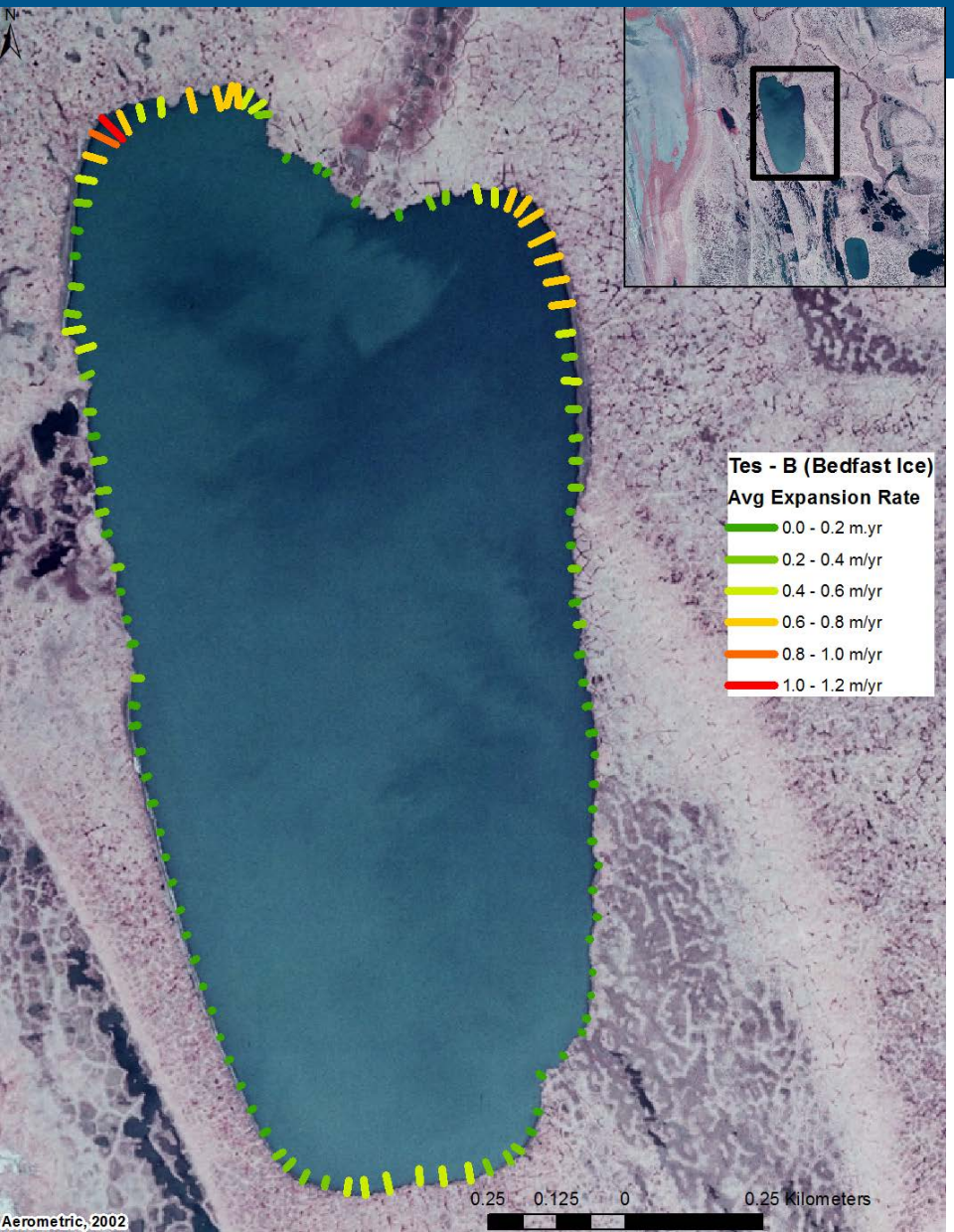


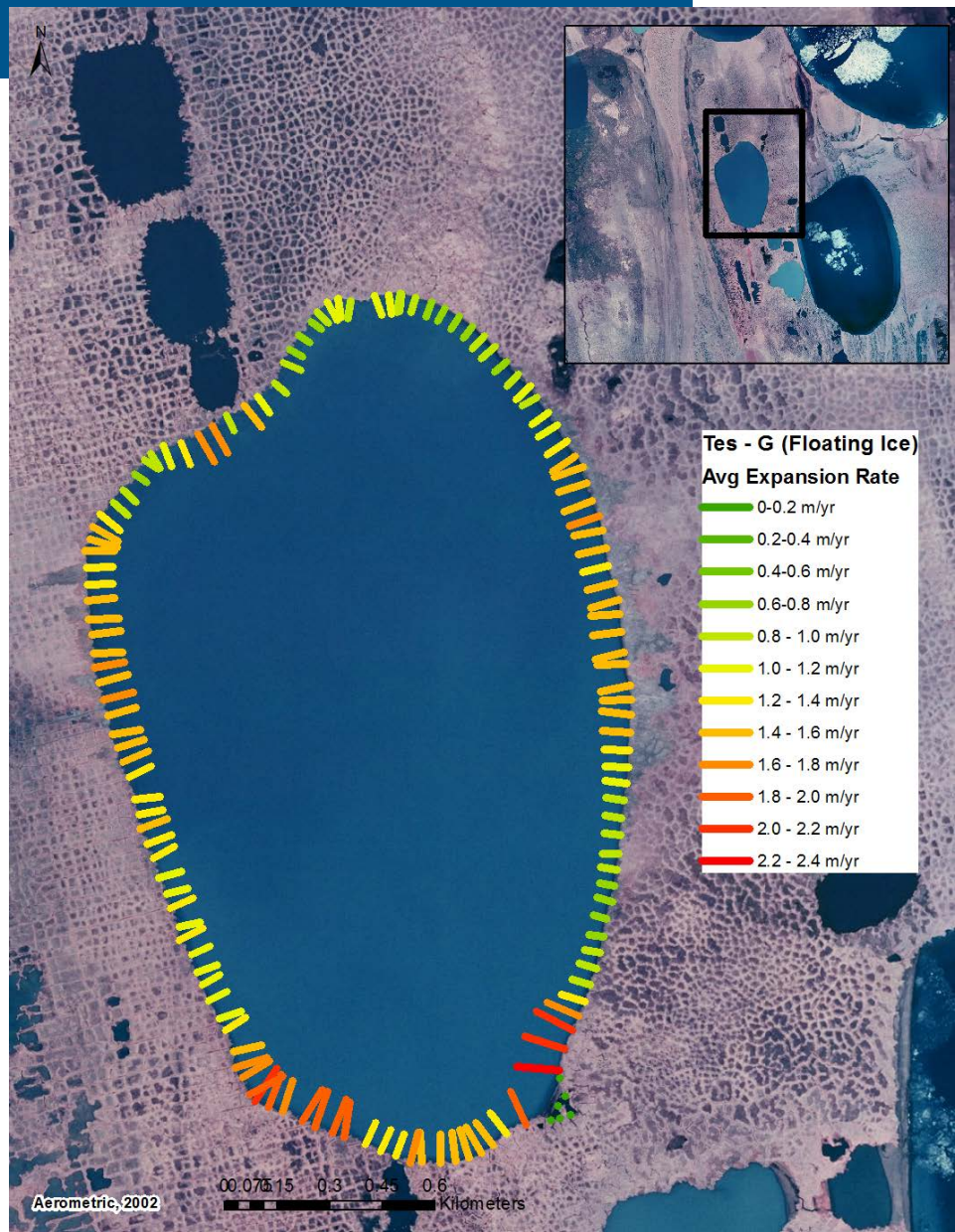

Bedfast Ice Lake Area Increased by 5.35%

Floating Ice Lake Area Increased by 12.06%

# Changing Erosion Rates

# Where do shorelines erode?

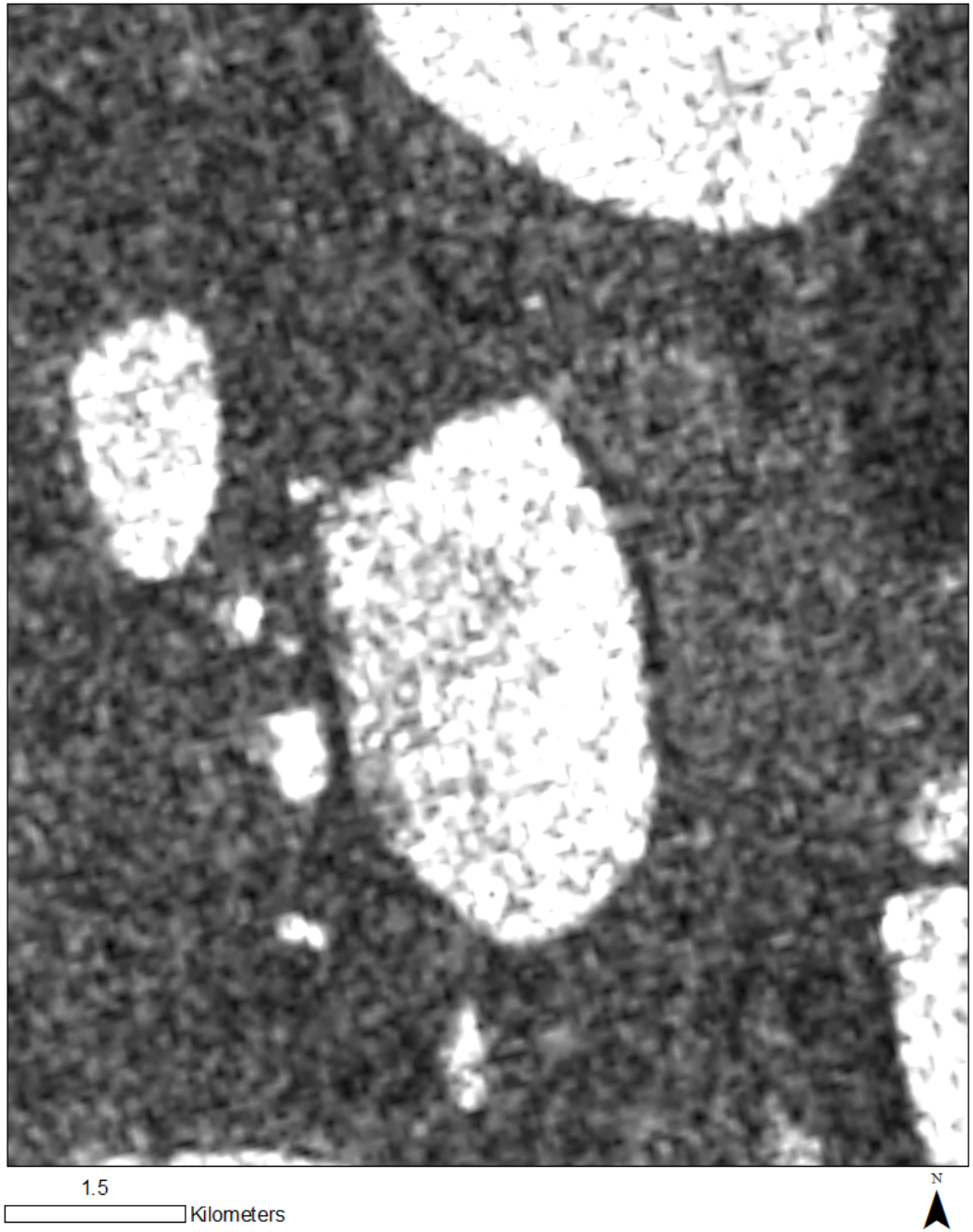


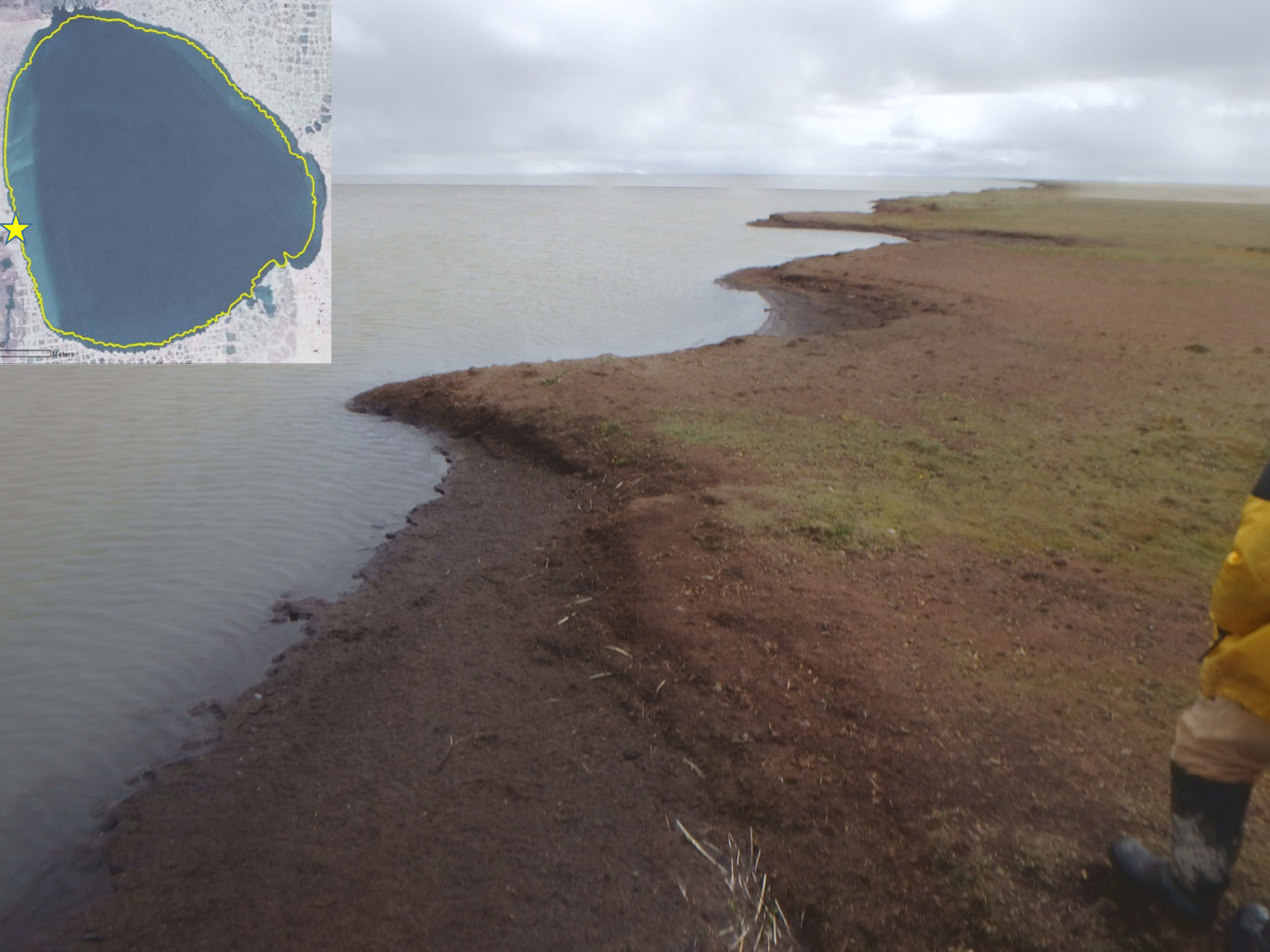
# Next Steps

## Intra Lake Processes controlling erosion

- Shoreline ice regime classification from SAR



# Terrain Unit Analysis


Meters

0
Meters

# Conclusions and Implications

# Implications

Hydrologic

- Changes in evaporative processes between ice regimes
- Potential changes in connectivity due to future lake drainage

Permafrost

- Increased Degradation of permafrost

Infrastructure

- May be affected by accelerated lake expansion

# Conclusions

- Floating ice lakes show increased erosion rates compared to bedfast ice lakes
- Decreasing ice thickness means increases in the number of floating ice lakes
- As lakes near the ice thickness threshold shift from bedfast to floating ice, we may see an acceleration in expansion rates
- Increased rates of expansion will lead to increased degradation of permafrost