Jack Zamary & Kevin Fraley

Arctic Fisheries and Coastal Lagoons

WCS

Introduction

Project Partner: Wildlife Conservation Society

Study Area: Arctic Beringia Region (Coastal Lagoons)

Study Topics: Lagoon connectivity, ice coverage, algal blooms (monitoring environmental factors)

Project Objective: Identify changes in habitat characteristics and fish ecology to share findings with local fishing communities to promote sustainable fishing and prevent illness from fish catch

Study Area


Arctic Beringia Region
Region boundary
Selected protected area
River
Major road
0 300 Km
1 Wrangel Island Reserve World Heritage Site
2 Beringia National Park (5 sub-units)
3 Bering Land Bridge National Preserve
4 Cape Krusenstern National Monument
5 Kobuk Valley National Park
6 Noatak National Preserve
7 Utukok River Special Area
8 Colville River Special Area
9 Kasegaluk Special Area
10 Peard Bay Special Area
11 Teshekpuk Lake Special Area
12 Gates of the Arctic National Park and Preserve
13 Arctic National Wildlife Refuge
14 Ivavik National Park
15 Tarium Niryutait Marine Protected Area
16 Anguniaqvia Niqiqyuam Area of Interest
17 Tuktut Nogait National Park
18 Banks Island Migratory Bird Sanctuary
19 Aulavik National Park
20 Qikiqtaruk (Herschel Island) Territorial Park
21 Selawik NWR
22 Yukon Delta NWR
23 Togiak NWR
East Siberian Sea
Kolyma
Beaufort Sea
Wrangel Island
Pevek
Chaun
RUSSIA
Chukchi Sea
Barrow
Point Lay
Sachs Harbour
Banks Island
Paulatuk
Inuvik
Arctic Circle
Anadyr
Chukotka Peninsula
Kotzebue
Seward Peninsula
Gambell
Nome
Yukon
Fairbanks
CANADA
Mackenzie
ALASKA
Saint Lawrence Island
Bering Sea
Russia
United States
Whitehorse
Anchorage
Aleutian Islands
Gulf of Alaska
Dutch Harbor
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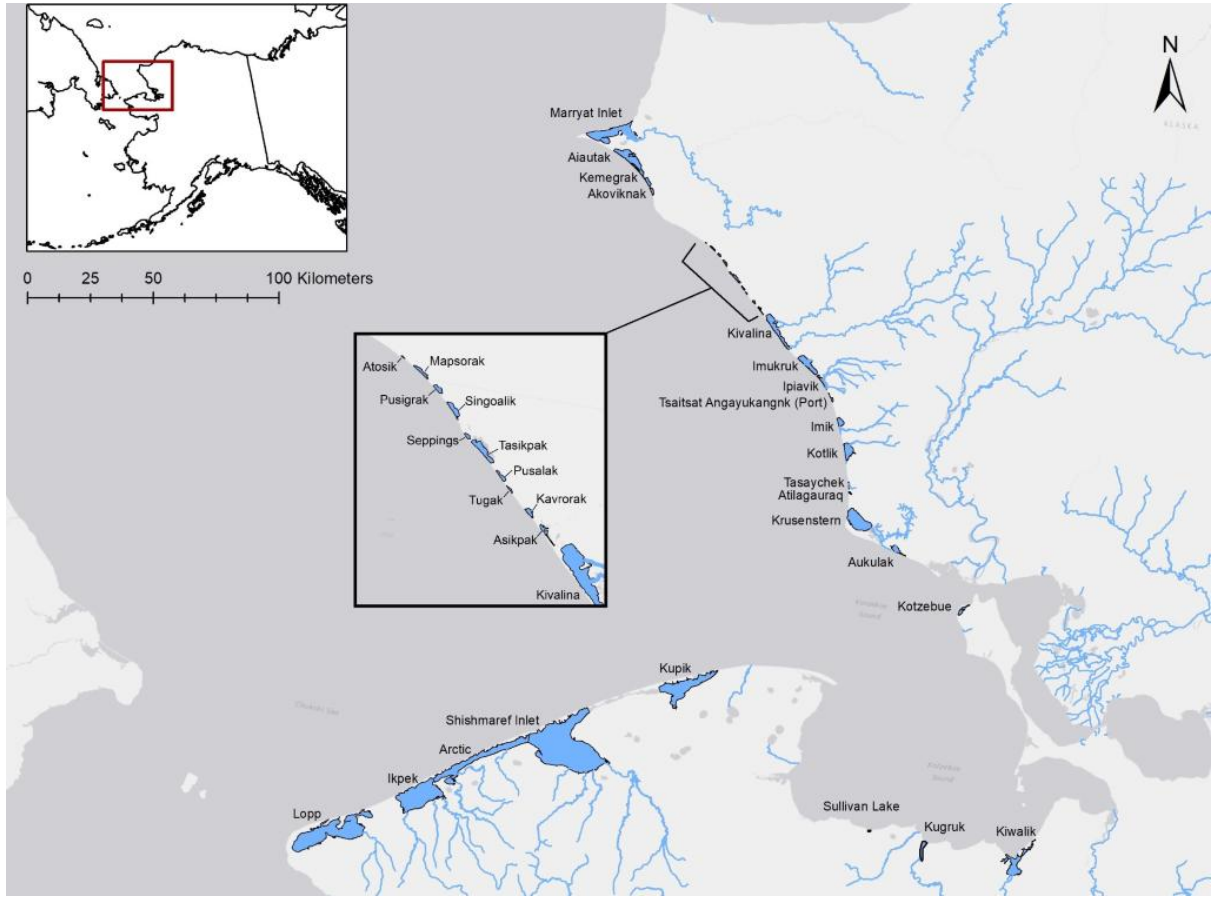
0 25 50 100 Kilometers
N
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Aukulak
Kotzebue
Atosik
Mapsorak
Pusigrak
Singoalik
Seppings
Tasikpak
Pusalak
Tugak
Kavrorak
Asikpak
Kivalina
Kupik
Shishmaref Inlet
Arctic
Ikpek
Lopp
Sullivan Lake
Kugruk
Kiwalik

Current Project Timeline

Fall 2024:

- Literature review
- Ice coverage scrips
- Connectivity analysis
- Initial Experience Builder development

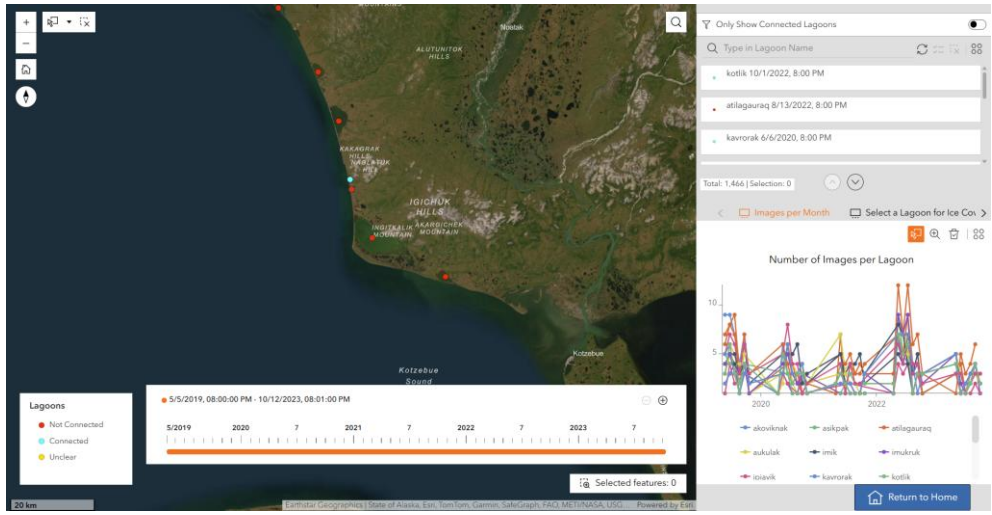
Spring 2025:

- Continued ice coverage analysis
- Continued Experience Builder development
- Initial algal bloom research and script development

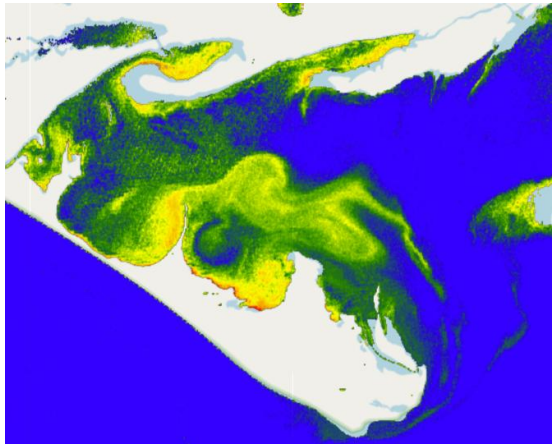
Fall 2025:

- Algal bloom analysis
- Experience Builder Updates
- GitHub Repository Creation

Experience Builder Web App



NDCI values applied to Sentinel-2 Satellite Imagery of Sisualik Lagoon



Algal Bloom Analysis

Sentienl-2, ESA

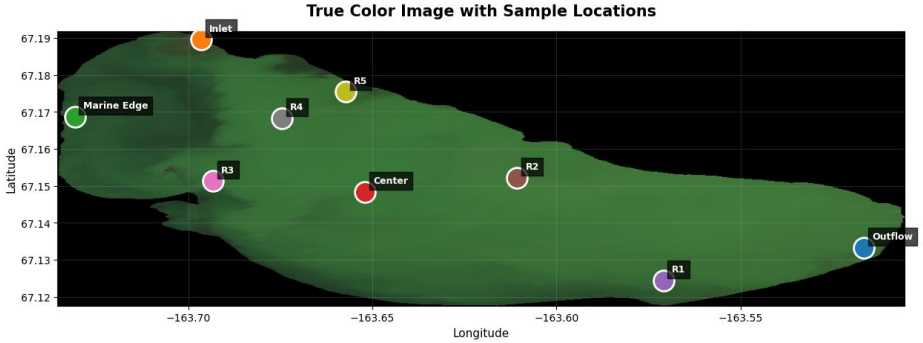
- Compare field samples to satellite data to create an index for classifying bloom severity
- We found a positive relationship between Blue Green Algae (Ug/L) and the Normalized Difference Chlorophyll Index (p = 0.004, R = 0.638)
- Jenks natural breaks were used to split data in groups of none, low, moderate, and high BGA in association with agal bloom severity
- None: < 0.0553, Low: 0.05553 - 0.0725, Moderate: 0.0725 - 0.1874, High: > 0.1874
- Calculations (Sentinel-2 Bands):

Normalized Difference Chlorophyll Index Calculation:

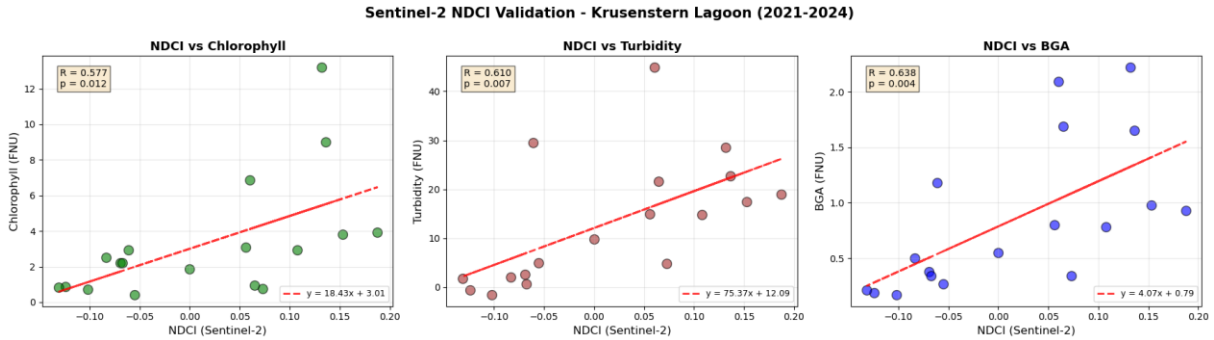
$$NDCI = \frac{B5 - B4}{B5 + B4}$$

Normalized Difference Chlorophyll Index Calculation (Wavelength):

$$NDCI = \frac{705nm - 665nm}{705nm + 665nm}$$

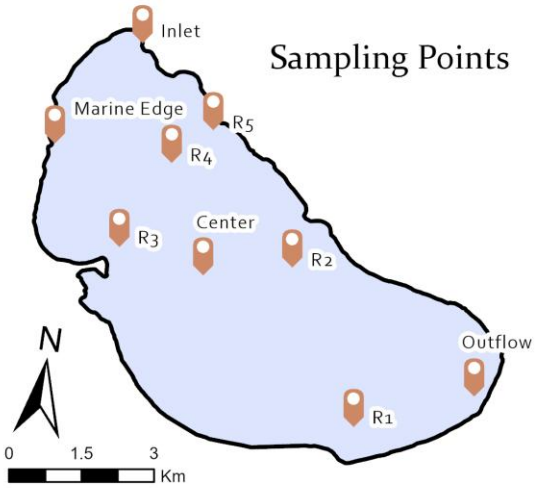


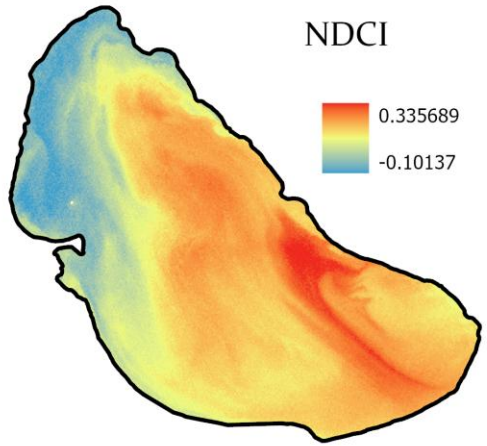
Date	Location	Turbidity (FNU)	Chlorophyll (FNU)	BGA (FNU)
06/22/2021	Center	2.06	2.5	0.5
06/22/2021	R3	-0.63	0.86	0.19
06/22/2021	Marine Edge	-1.53	0.74	0.17
06/22/2021	R2	0.62	2.23	0.34
06/22/2021	Inlet	1.73	0.82	0.21
08/21/2021	Outflow	19.9	9.36	1.87
08/21/2021	R1	13.13	7.54	1.78
08/21/2021	Center	20.24	7.52	1.96
08/22/2021	R3	5.89	3.22	1.21
08/22/2021	Marine Edge	8.89	5.12	1.55

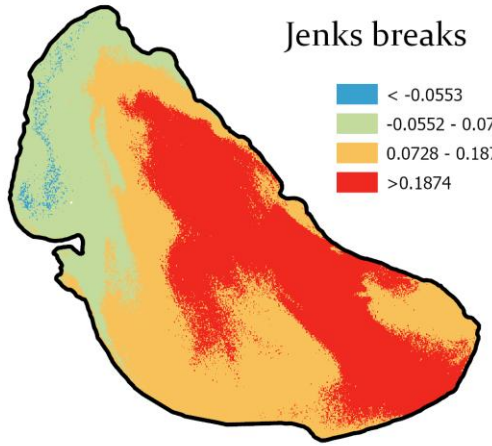


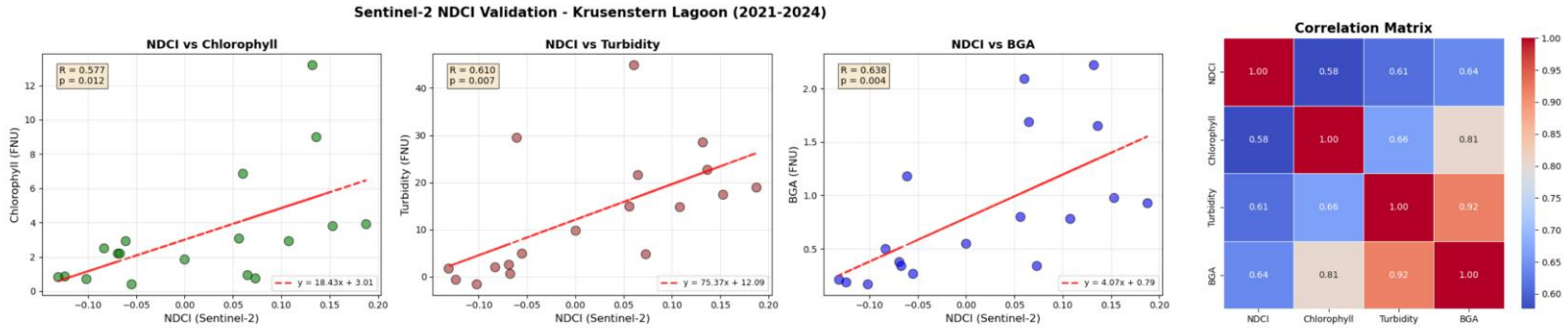
Initial Assessment of Harmful Algal Blooms in Krusenstern Lagoon

Krusenstern Lagoon provides critical habitat for fish, birds, and marine mammals vital to Indigenous food security. Field samples (2020-2024) were compared to Sentinel-2 imagery to validate the Normalized Difference Chlorophyll Index (NDCI) as a proxy for algal bloom detection. A strong correlation (R = 0.638) between NDCI and blue-green algae enabled classification of bloom severity into four categories using Jenks natural breaks: none, low, medium, and high.









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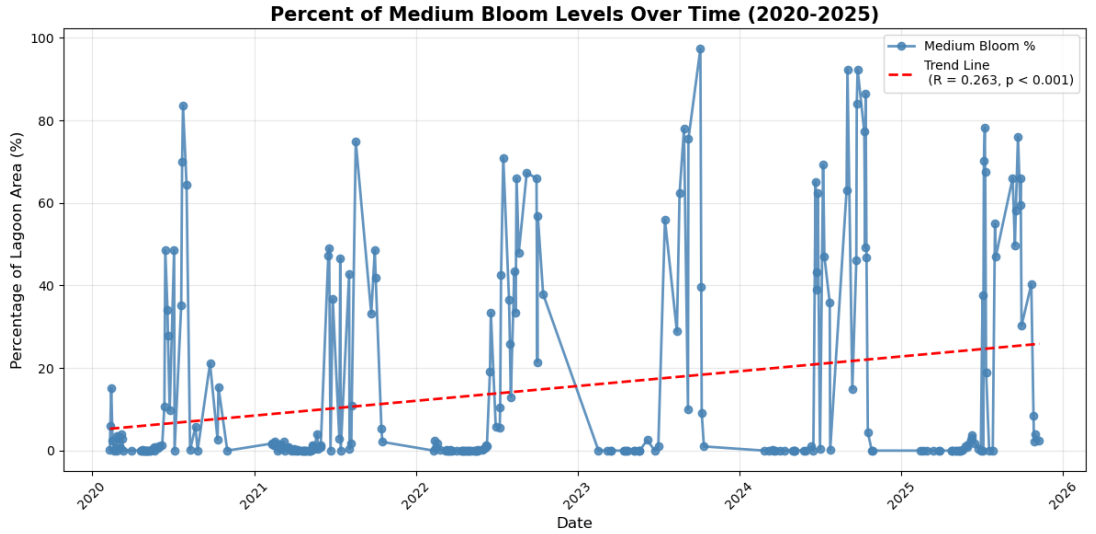
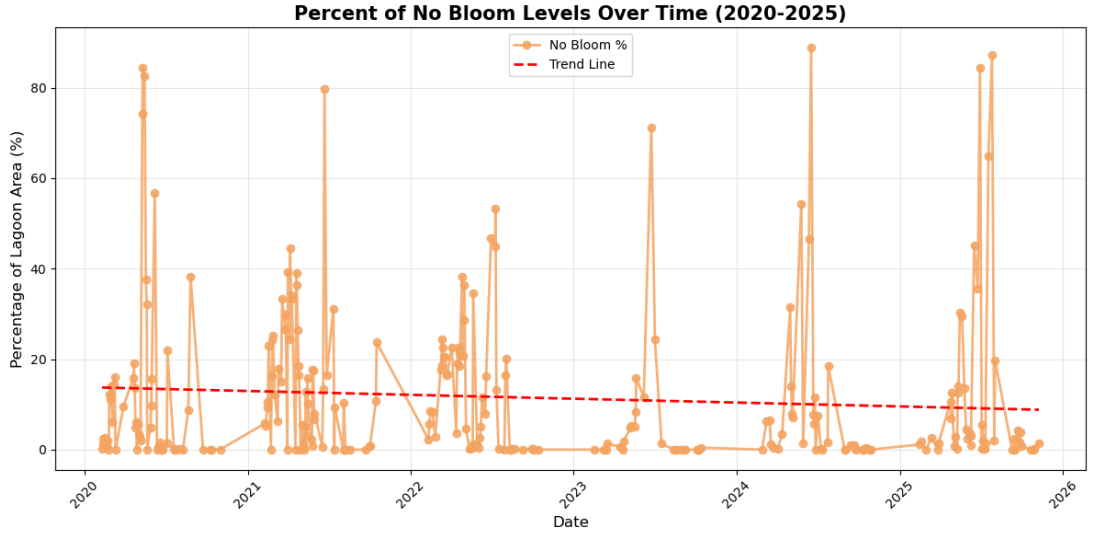
Credits: Jack Zamary, author | Data courtesy of ESA Sentinel-2 Satellite | maps projected in Alaska Albers Equal Area Conic | Created 12/11/2025.

Initial Time Series Results

- Slight positive trend in medium bloom percentage over time (NDCI = 0.0725 - 0.1874) and a slight negative trend in no bloom levels (NDCI < 0.0553)
- R = 0.263, p < 0.001





Looking Ahead

- GitHub repository allows for better collaboration for future groups
- Finalize agal bloom data and add it as a metric to the Experience Builder site
- Collect data from 2017 – 2019 to complete analysis
- Further analyze bloom trends to better understand the warming climate in the arctic and its ecological effects
- Work towards an article or publication highlighting the change

Krusenstren Lagoon, Alaska

Thank You

A special thanks to Professor Rose, Kevin Fraley, the Wildlife Conservation Society and IIC for their continued support on the project