

# Arctic Fisheries and Coastal Lagoons

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# Project Partner



# Wildlife Conservation Society

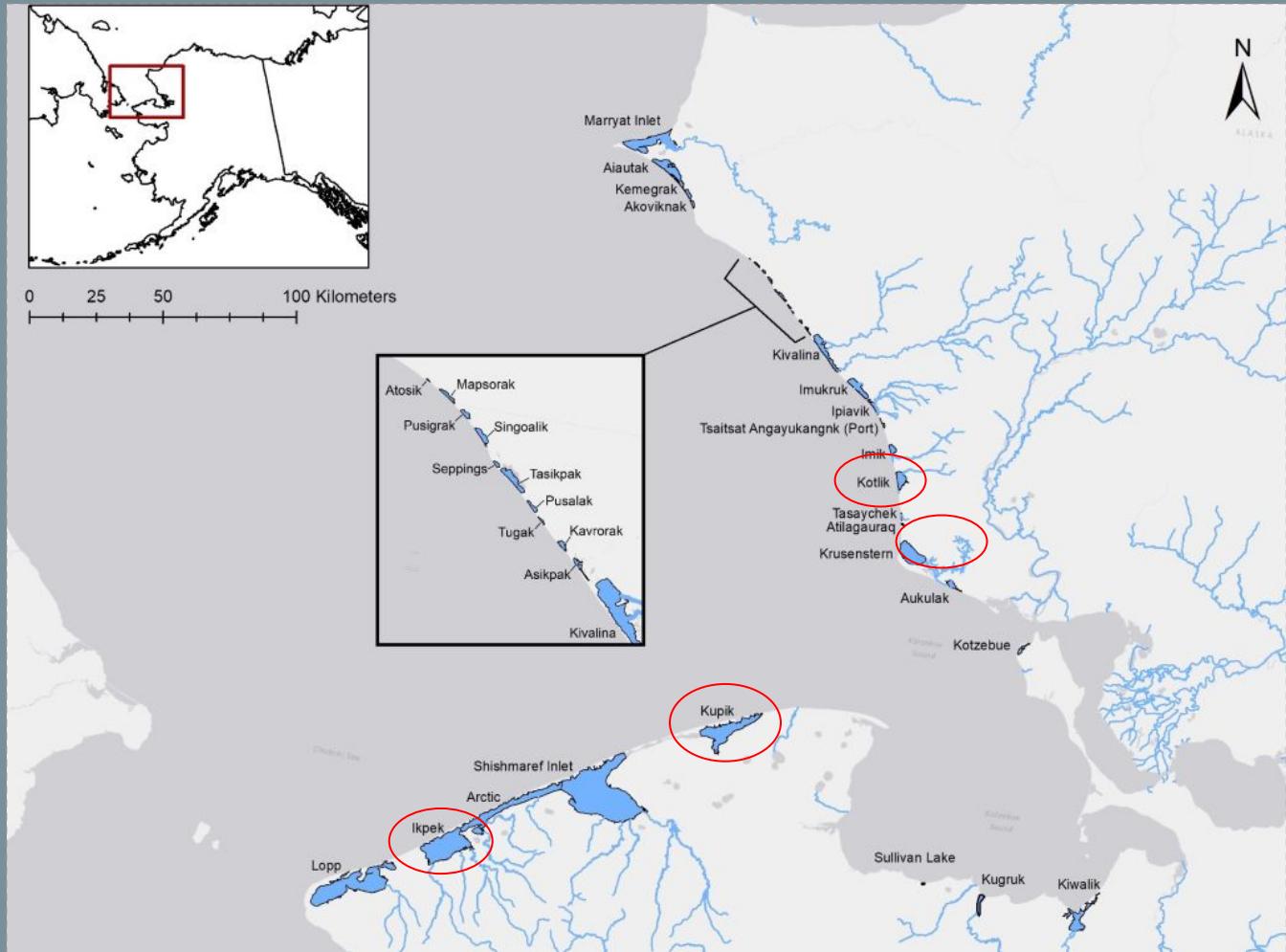


# Project Objectives

- Chukchi Sea lagoons
  - Identify changes in habitat characteristics and fish ecology
- Use Google Earth Engine API and satellite imagery to map connectivity, ice coverage, and algae blooms in coastal Alaskan lagoons
- Share findings with local fishing communities to promote sustainable fishing and prevent illness from fish catch



# Lagoons



# Connectivity

- Changes in connectivity affect the distribution of fish populations
- Fishermen need to know when and where they can fish!



# Spring 2025 Goals

- Improve ice detection 
- Expand data collection 
  - Algae Blooms!!
- Improve app experience 



# Ice Detection

- Normalized Difference Snow Index
- Normalized Difference Water Index

$$NDSI = \frac{(Green - SWIR)}{(Green + SWIR)}$$

$$NDWI = \frac{(NIR - SWIR)}{(NIR + SWIR)}$$

Ice Cover % = # pixels classified as ice / total pixels in lagoon \* 100

# Ice Detection

- Multi-Index Approach
- Ice Classification rule: NDSI > 0.4 AND NDWI < 0
- Seasonal Context
- Quality Control
- Visualization

Results saved to: lagoon\_ice\_analysis\_20250425\_185925.csv  
[lagoon\\_ice\\_analysis\\_20250425\\_185925.csv](#)  
Click the link above to download the CSV file.

Preview of results:

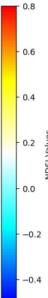
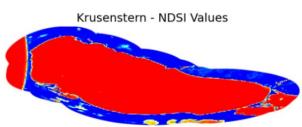
	lagoon	date	latitude	longitude	ice_coverage_pct	season	suspicious
0	Krusenstern	2019-02-12	67.150000	-163.640000	99.940000	winter	False
1	Krusenstern	2019-03-12	67.150000	-163.640000	74.280000	winter	False
2	Krusenstern	2019-03-26	67.150000	-163.640000	0.180000	winter	True
3	Krusenstern	2019-04-09	67.150000	-163.640000	0.600000	winter	False
4	Krusenstern	2019-04-23	67.150000	-163.640000	0.090000	winter	False
5	Krusenstern	2019-05-07	67.150000	-163.640000	0.530000	summer	False
6	Krusenstern	2019-06-04	67.150000	-163.640000	0.010000	summer	False
7	Krusenstern	2019-06-18	67.150000	-163.640000	0.000000	summer	False
8	Krusenstern	2019-07-02	67.150000	-163.640000	0.000000	summer	False
9	Krusenstern	2019-07-16	67.150000	-163.640000	0.010000	summer	False

Total records: 15  
Suspicious records: 1 (6.7%)

# Ice Detection

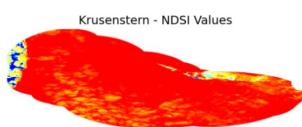
```
Enter lagoon name to visualize (or 'exit' to quit): Krusenstern
Enter date to visualize (YYYY-MM-DD): 2019-06-04
Getting imagery for Krusenstern from 2019-06-01 to 2019-06-07
Found 1 images. Creating median composite.
```

Krusenstern - 2019-06-04 - Ice Coverage: 0.03% (summer)



```
Enter lagoon name to visualize (or 'exit' to quit): Krusenstern
Enter date to visualize (YYYY-MM-DD): 2019-03-26
Getting imagery for Krusenstern from 2019-03-23 to 2019-03-29
Found 1 images. Creating median composite.
```

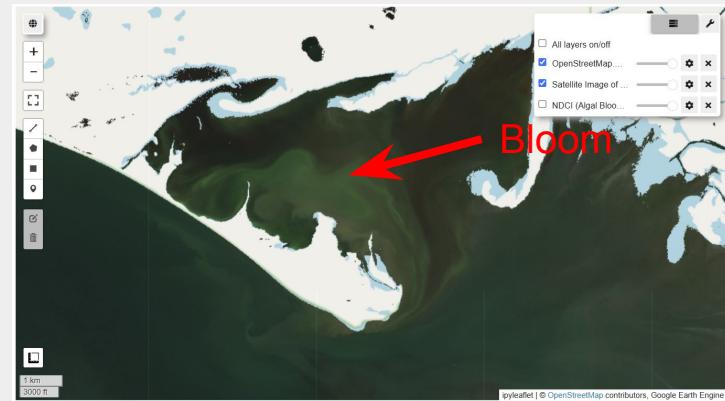
Krusenstern - 2019-03-26 - Ice Coverage: 0.02% (winter) △ Potentially inaccurate



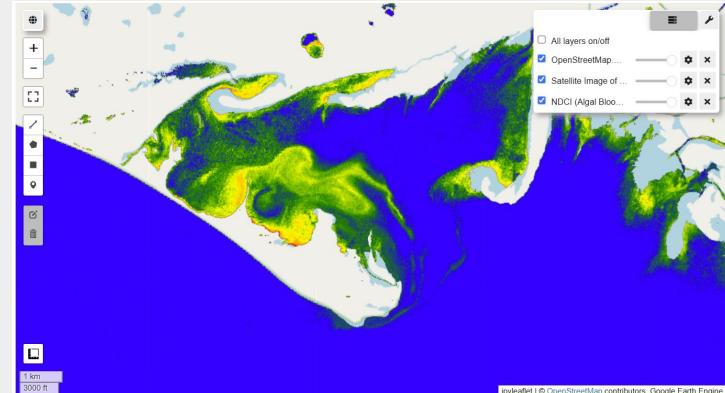
# What are algal blooms?

- A rapid increase in the concentration of algae (**particularly phytoplankton**)
- Detected using satellite-derived indices like the **Normalized Difference Chlorophyll Index (NDCI)**
- Blooms often occur seasonally and can signal ecological changes in the water, such as nutrient enrichment or warming conditions
- Monitoring blooms is important for understanding water quality, ecosystem health, and potential risks to local fisheries or wildlife

Sentinel-2 Satellite Imagery of Sisualik Lagoon



NDCI values applied to Sentinel-2 Satellite Imagery



# Algae Bloom Detection

- Detected using **Sentinel-2 satellite imagery** by calculating the **Normalized Difference Chlorophyll Index (NDCI)**, which highlights chlorophyll-a concentrations in water
- Filters images for low cloud cover, masks out land using the **NDWI**, and calculates **NDCI** using bands 5 and 4
- For each image, we compute the **mean, max, and min NDCI values** over a selected lagoon polygon. Elevated mean NDCI values (typically  $> 0.25$ ) suggest potential bloom activity, allowing temporal patterns to be identified across months and years

## NDCI Calculations

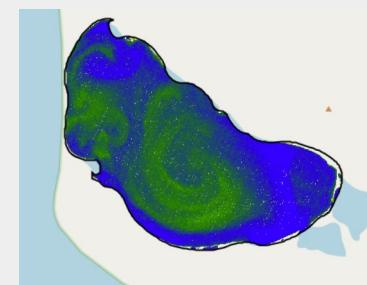
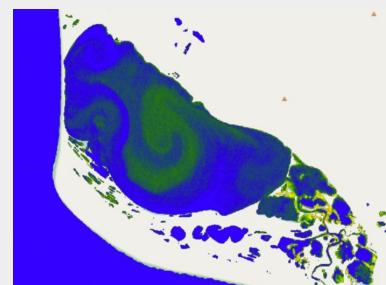
Normalized Difference Chlorophyll Index Calculation:

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

Normalized Difference Chlorophyll Index Calculation (Wavelength):

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

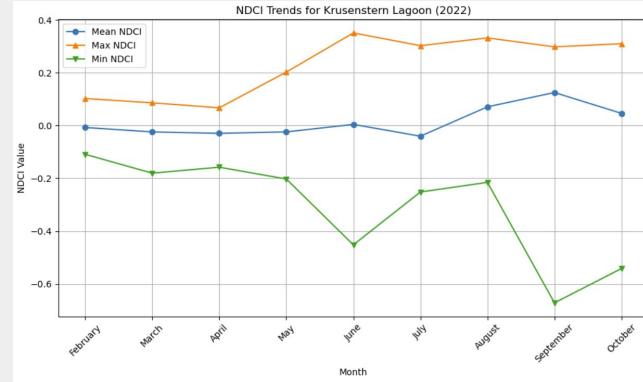
NDCI data from Krusenstern lagoon before and after NDWI mask



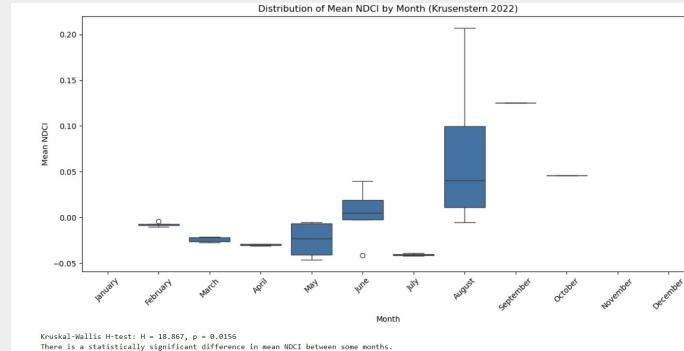
# Looking ahead

- Begin to look at some overall trends and statistical data
- The results indicate a **statistically significant difference** in mean NDCI between months (Krusenstern Lagoon, 2022; Kruskal-Wallis  $H=18.87$ ,  $p=0.016$ ). Visually, algal activity is minimal through winter and spring, begins to rise in June, and peaks sharply in August, with high variability indicating strong bloom events. These findings highlight the **seasonality of algal blooms**, with August being the most bloom-prone month.

NDCI Trends in Krusenstern



Significant difference in mean NDCI



# Web App Progression

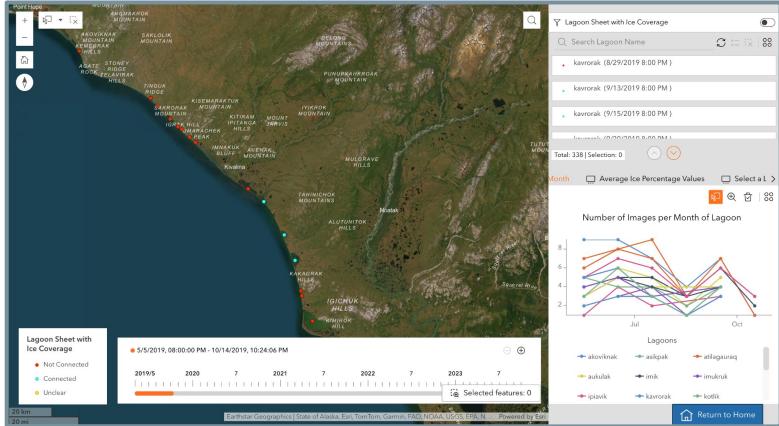
Welcome to the Chukchi Sea Lagoons Application, a powerful tool designed to help you explore the seasonal shifts of the Chukchi Sea's coastal lagoons. Developed in partnership with the [Wildlife Conservation Society](#), this app uses historical satellite imagery to track the connectivity between lagoons and the ocean—essential information for understanding the region's unique ecosystems.

**Explore Lagoon Connectivity**  
Our app provides detailed historical data showing when the Chukchi Sea's lagoons connect to the ocean, helping our understanding of critical changes in water pathways. These seasonal connections are key for navigation, fish migration, and the health of lagoon ecosystems that are important for waterbirds, marine mammals, and other wildlife. By analyzing past data, we offer valuable insights into when boats can safely traverse these waters.

**Monitor Ice Coverage Over Time**  
Gain a deeper understanding of the region's changing ice conditions with historical ice coverage data. Our app tracks the percentage of ice coverage across the lagoons, showing how these vital waterways freeze and thaw throughout the year and across multiple years. This data helps us see the bigger picture of how climate patterns are affecting Arctic environments.

**Supporting Wildlife Conservation**  
As part of the Wildlife Conservation Society's ongoing efforts to protect the Arctic's fragile ecosystems, the Chukchi Sea Lagoons Application offers valuable tools for researchers, conservationists, and local communities. By understanding these seasonal changes, we can make more informed decisions to protect wildlife and preserve the region's unique habitats in context of possible threats such as industrial development and coastal erosion. For more information on WCS' Chukchi Sea coastal lagoon monitoring and research, see the website here: <https://chukchi.wcs.org/home/chukchi-sea-coastal-lagoon-monitoring/>

[Explore](#)



## Welcome to the Chukchi Sea Lagoons Application How-To Guide!

Thank you for exploring the Chukchi Sea Lagoons App! This guide will walk you through how to navigate the key features of the application, with a special focus on using the interactive timeline and map to explore data. The chart section to the right of the main page provides dynamic charts that accompany the map on the left. The map helps visualize lagoon connectivity over time. By adjusting the timeline, you can see how connectivity of various lagoons change over time by looking at the points changing colors. The points on the map will flash orange or blue, providing insights into the connectivity of lagoons over time.

Timeline	Filter	Search	Charts
<ul style="list-style-type: none"><li>Locate the Timeline After clicking the <b>Explore</b> button on the homepage, you'll be taken to a page with a map and some charts. The timeline is displayed beneath the map, represented as a horizontal bar with dates.</li><li>Adjust the Time Period To explore the data for a specific time period, you can use the orange slider. Slide Left or Right: Drag the slider to the left or right to move backward or forward through time.</li><li>Adjust Time Range: To change the span of time being displayed, hover over the edges of the slider.</li></ul>	<ul style="list-style-type: none"><li>Locate the Filter The Connected Lagoons Filter allows you to focus on viewing only the lagoons that are connected during a specific time period. This filter helps you analyze the relationships and changes between the lagoons over time.</li><li>Apply the Filter When the filter is enabled, only the lagoons that are connected at the selected time (what is represented on the timeline) will appear on the map.</li><li>Once the tool is turned on, navigate to the points on the map that represent the lagoon you would like to see. Highlight the points associated with the lagoon, and watch the chart update to show ice coverage.</li></ul>	<ul style="list-style-type: none"><li>Locate the Search Bar The Lagoon Search Bar allows you to easily find specific lagoons by name. Because data is collected at different points in time, there may be multiple results for a single lagoon. Here's how to use the search feature:<ul style="list-style-type: none"><li>Search for a Lagoon Simply type the name of the lagoon you're looking for in the search bar. Options should pop up after you type a few letters into the search bar. Since data is collected over different time periods, you will see multiple results for the same lagoon. These results represent the lagoon at various points in time.</li><li>Select a Result Once the tool is turned on, navigate to the points on the map that represent the lagoon you would like to see. Highlight the points associated with the lagoon, and watch the chart update to show ice coverage.</li></ul></li></ul>	<p>Ice Percentage by Date Chart: To best use this chart, users must use the selection tool at the top left of the map, here highlighted in orange.</p> <p>Once the tool is turned on, navigate to the points on the map that represent the lagoon you would like to see. Highlight the points associated with the lagoon, and watch the chart update to show ice coverage.</p>

# Let's Go!

<https://experience.arcgis.com/experience/8ed468e285634b5f974ba3df4b8ee857/>

