

The Nunavik Lake Ice Service

Integration of Inuit Traditional Knowledge and Remote Sensing for monitoring of Char Resources

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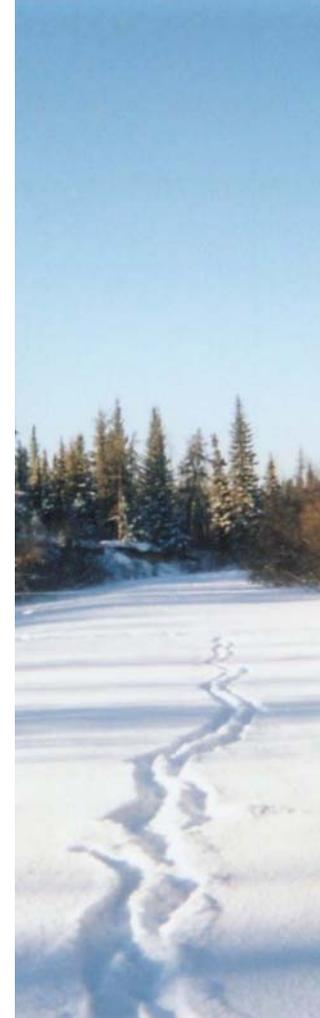
Strata360 Cartographic Services



Presentation Outline



- Background
 - Methods and technology
 - Results and product delivery
 - Future enhancements and expansion
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The Nunavik Region

- The Inuit territory of Nunavik is a vast Arctic/Sub-Arctic territory of over 660,000 square kilometres situated north of the 55° parallel
- The region includes 14 coastal Inuit communities along the shores of Hudson Bay, Hudson Strait and Ungava Bay
- The region is sparsely populated with approximately 10,000 people, mostly Inuit



Arctic Char and Inuit Subsistence

- The Inuit population of Nunavik largely relies on local living resources for food
- Arctic Char is especially important for subsistence fishing
- Char are found in large numbers around Ungava Bay, where over-winter and spawn in the frozen coastal lakes and rivers
- The health of Char population is very important to the local Inuit population and also a good indicator of the status of the ecosystem.



Impacts of Climate Change



- Climate changes affect Inuit communities as they depend on local resources as a primary source of subsistence
- It was noticed that the lakes of the Ungava region are generally freezing later and breaking up earlier than usual (Duguay et al. 2006).
- In 2002 there was a major fish die-off at Lake Tasikallak in which residents of the nearby community of Kangiqsualujjuaq found over 4,500 fish dead in the lake.
- The project monitors ice conditions in these areas of concern aiming to provide a better understanding of how climate change affects the ice cover in Nunavik and how this in turn affects Arctic Char over-wintering habitat



Importance of Inuit Knowledge

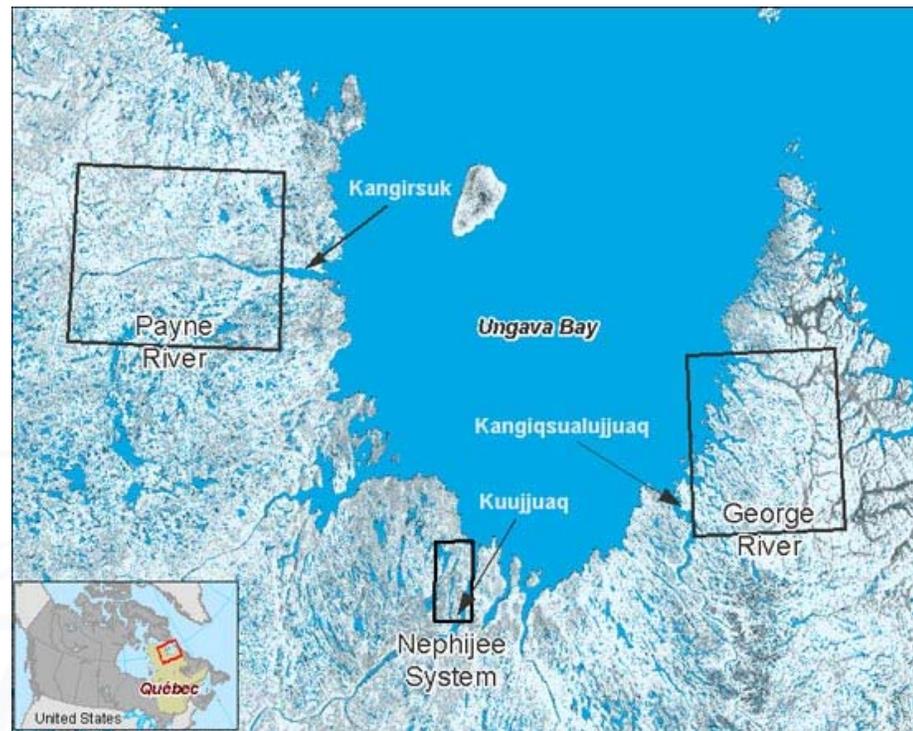
Traditional ecological knowledge (TEK) represents experience acquired over thousands of years of direct human contact with the environment (Berkes, 2005).

- The Nunavik Research Centre of Makivik Corporation has been collecting Inuit Knowledge as of the mid-1970s.
- Information is stored in a geospatial database, containing more than 86,000 records from over 400 interviews and with information (from memory) dating back to the beginning of the 20th century.
- Data consists of occupancy studies as well as of data on species, travel routes, important hunting and fishing sites, ecology, and ice information.
- Due to the long historical record of the Nunavik TEK database, the database also makes it possible to track changes over time.



Study Areas

- Through local knowledge, three key areas around Ungava Bay have been identified for monitoring
- Monitoring sites focus on Char habitats in the coastal region of the communities of
 - Kangiqsualujjuaq (George River),
 - Kangirsuk (Payne River) and
 - Kuujjuaq (Nephijee River system)



Nunavik Lake Ice Service

- Methods

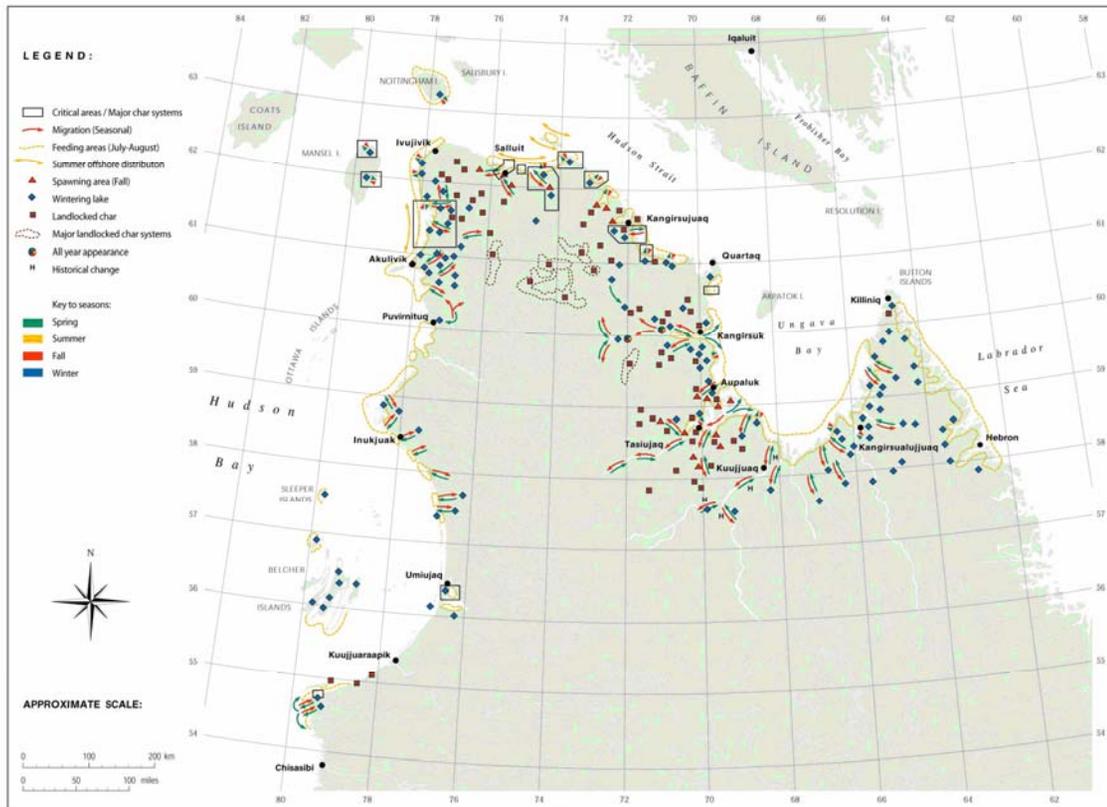
- Nunavik Lake Ice Service combines information from the following sources:
 - Historical and current Inuit traditional knowledge (TEK) data; used for site selections and validation of remote sensing data
 - Remote sensing data derived from RADARSAT and Envisat ASAR; current methods make use of pre-scheduled acquisitions and manual image classification
 - Local climate and atmospheric data; weather measurements (HOBO weather stations), and ice thickness measurements from a shallow water ice profiler (SWIP)
- Monitoring activities are on a seasonal basis, between the time of ice development in the autumn until the time of ice break-up in the spring
- Surges of activities during freeze and the break-up periods (products are delivered weekly to semi-monthly).



Historical TEK Data

- Previous studies on Arctic Char identified important over-wintering and spawning areas, areas of concern, travel routes and ice conditions.
- The LIS makes use of historical TEK information to identify monitoring sites, and track changes over time.

Generalized map of char ecology from existing TEK database.

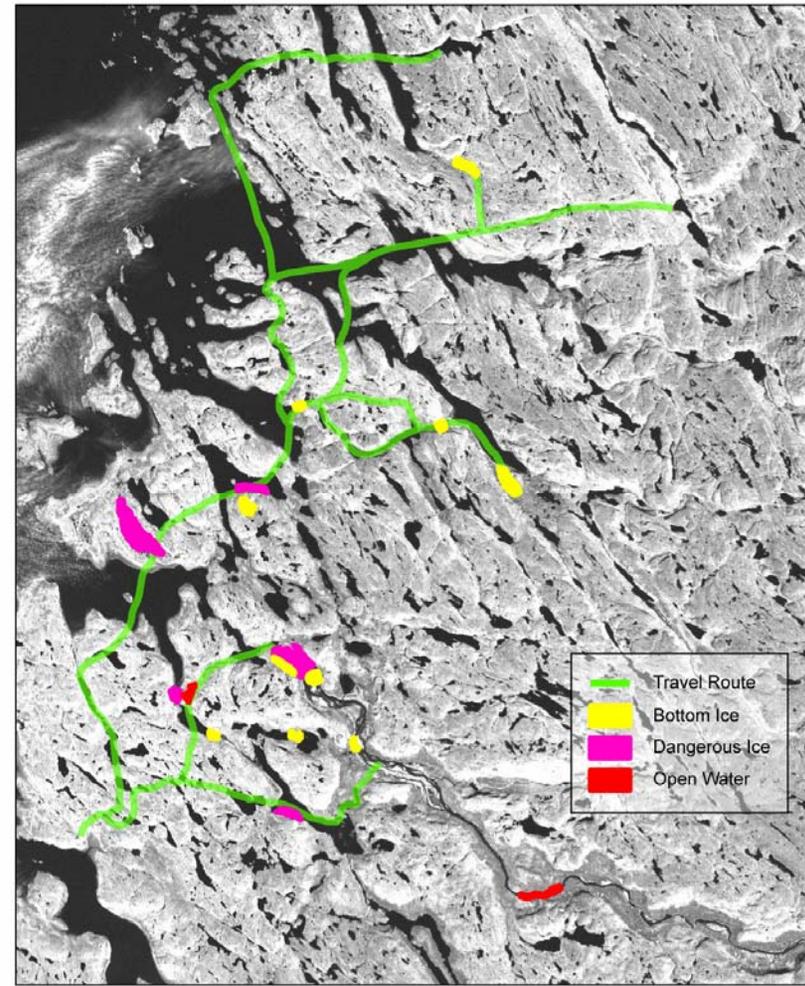
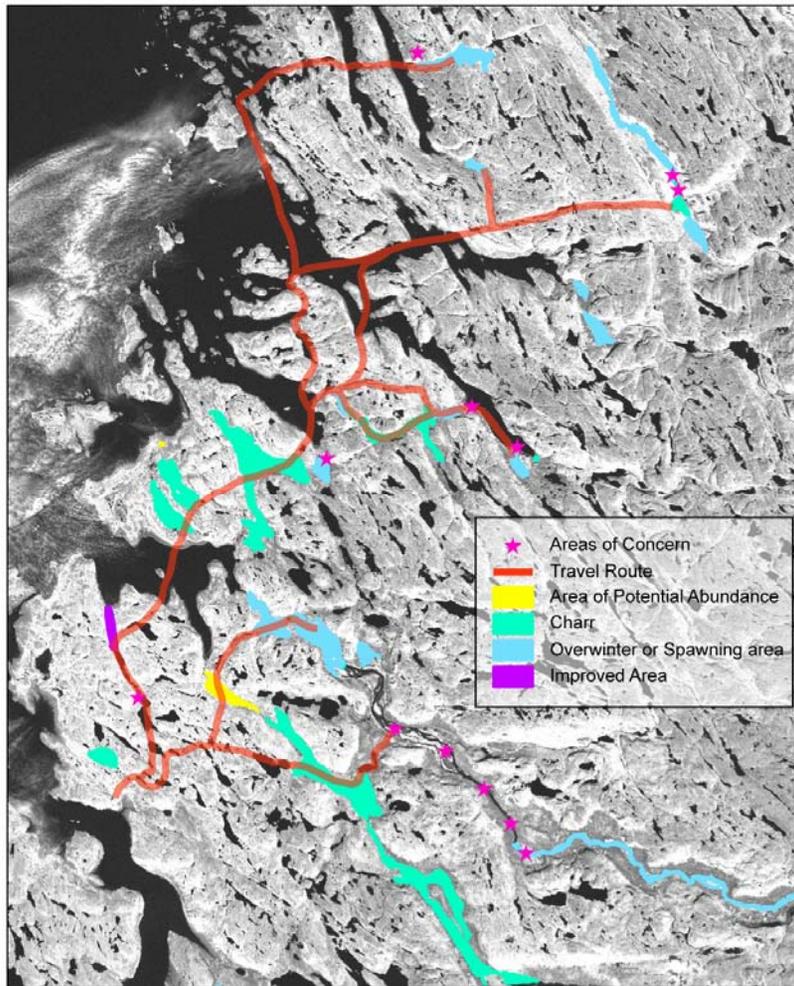


Current TEK Information

- New interviews included update of historical data and collection of new information
- Consultations also used to validate results derived from satellite images.
- Field maps developed based on LANDSAT and SPOT imagery and the Canvec topographic series.
- Field maps scanned, georeferenced and digitized to update the TEK database.
- Some information is also collected through the portal in form of field observations by local hunters
- In the future, TEK data collection will also include the Northern Village Data Collection System (NVDCS), an interactive online mapping system allowing users to record observations at any time via an Internet browser.



TEK Char and Ice Maps



Data Limitations



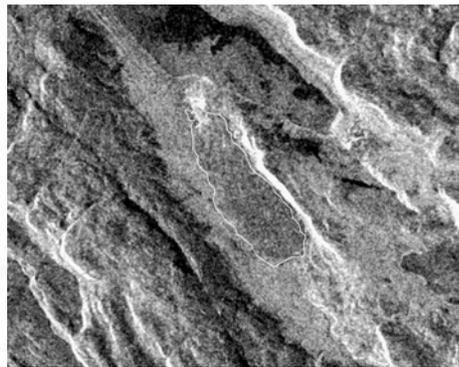
- Traditional ecological knowledge (TEK), while critically important for establishing baseline conditions and understanding historical trends,
 - typically is site-specific (limiting its extrapolation to areas and habitats that are not actively fished) and
 - can sometimes be retrospective rather than forward-looking (limiting its predictive value).
 - Collection of suitable remote sensing data limited by
 - large geographic areas requiring monitoring,
 - high logistical costs and
 - difficulties in extrapolating site-specific observations to larger areas of generally poorly known habitats.
 - The integration of Earth Observation (EO) data, along with traditional ecological knowledge, offers an ideal means of filling important data gaps that are not effectively addressed by existing approaches.
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Remote Sensing Data

- The remote sensing data used to classify the lake ice status are RADARSAT-1 and Envisat ASAR satellite images.
- Images are acquired during the winter season, from November to June.
- To increase observation frequency, a combination of ascending and descending RADARSAT-1 Fine Mode images is used to assess lake ice status.



December 01, 2006



January 11, 2007



June 11, 2007

Image Acquisition Plan



- The primary data source is RADARSAT-1, with images acquired from every orbit cycle (24-days).
- Envisat ASAR images provide a secondary data source that fills gaps during the crucial time of ice freeze-up or ice break-up.
- Image acquisition planning is an important component of the LIS and takes place at the beginning of the winter season.
- Acquisition plans are constantly reviewed and can be modified according to changing conditions and priorities.
- Table lists the EO data planned for acquisition for Year 2008-2009

Phase (Year)	Study Area	Satellite (EO Data)	Total No. of Image Planned	Total No. of Products
Phase 4 (2008-2009)	George River	RADARSAT-1	18	18
		Envisat ASAR	3	3
	Payne River	RADARSAT-1	34	17
		Envisat ASAR	3	3
	Nephijee System	RADARSAT-1	28	18
		Envisat ASAR	4	4

Image Pre-processing

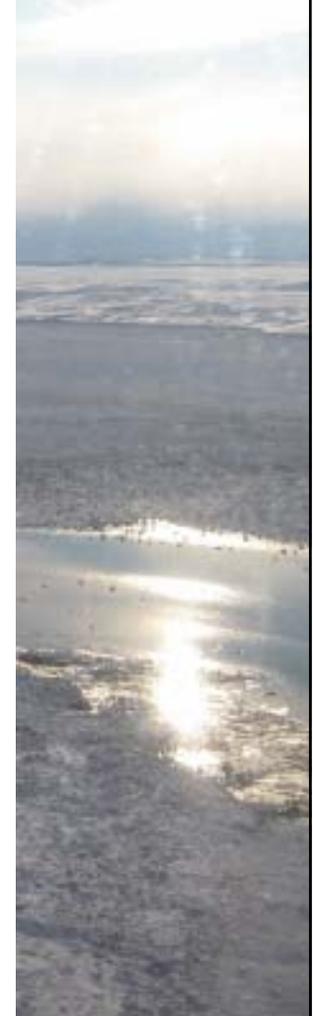


- Both of the EO sensors capture Synthetic Aperture Radar (SAR) data
- Data require a number of pre-processing steps before it can be used for interpretation and analysis.
- These tasks are accomplished using PCI Geomatica image processing software.
- The following steps are performed for each dataset received:
 - Importing from raw image data to image processing software;
 - Calibration – conversion to 32bit dB (backscatter value) data;
 - Speckle filtering to increase the coherence of the imagery; and
 - Ortho-rectification to spatially position the imagery.

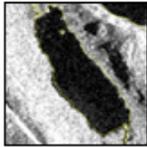
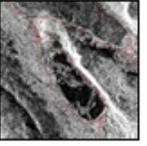
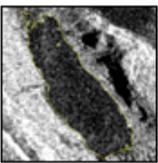
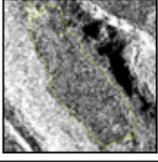


Image Interpretation

- Standardized methods used to interpret image data and generate consistent products
- Standards developed by the Canadian Ice Service, Manual of Standard Procedures for Observing and Reporting Ice Conditions (MANICE)
- Interpretation key based on the understanding of microwave response on freshwater ice formation. Snow cover was not directly taken into consideration but the effects of wet snow on image interpretation were considered.
- Each of the study lakes were then interpreted and classified to provide the following information:
 - Lake ice status ;
 - % Area frozen; and
 - General observations.



LIS Classification Criteria

Ice Stage (status)	Description Level 1	Description Level 2 (% area frozen)	RADARSAT-1 Fine Beam (F1N)	Parameters to Consider	Backscatter.. Range
Open Water (Light Blue)	Open water with no ice formation on lake surface			Above 0°C at prior to and at the time of acquisition	-25 to -22 dB (Mean dB)
Initial Freeze-up (Blue)	Initial ice formation on lake surface but does not cover entire lake	< 10%		Below 0°C at prior to and, at the time of acquisition for at least 5 days	-20 to -15 dB (Mean dB)
		10% - 25%			
		25% - 50%			
		> 50%			
Newly Formed Ice (Yellow)	Newly formed very thin sheet of ice			Below 0°C at prior to and, at the time of acquisition for at least 10 days	-19 to -18 dB (Mean dB)
Complete Freeze-up (Pink)	Complete ice cover on lake surface. Thickness is unknown			Below -5°C prior to and, at the time of acquisition	-12 to -13 dB (Mean dB)
Initial ice Break-up (Red)	Initial ice breaking, thinning over lake surface. Open water may be visible	< 10%		Above 0°C prior to image acquisition for at least 10 days	-19 to -18 dB (Mean dB)
		10% - 25%			
		25% - 50%			
		> 50%			

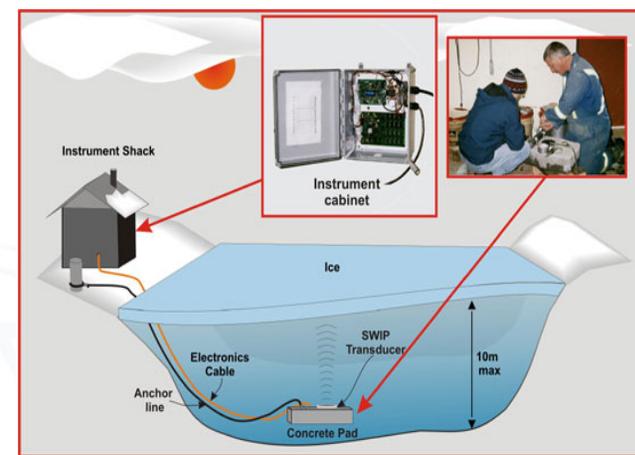
Real-time Weather Data

- The LIS also integrates weather information from different sources including:
 - Temperature and weather conditions at the time of image acquisition;
 - Daily temperature regimes (minimum, maximum and average)
 - Thermal degree days (how many consecutive days the temperature has been low enough to freeze the lakes ($< 0^{\circ}\text{C}$) and
 - Wind information
- Weather data from Environment Canada is recorded hourly at the community airports and accessed through an XML based data service.
- Two HOBO weather stations installed at Lake Tasikallak (Kangiqsualujjuaq) and the at Payne River (Kangirsuk).
- From the weather stations, live data is transmitted from data loggers, downloaded every ten minutes, and transmitted to the Portal.



Weather Data Integration

- Climate data integrated into the LIS portal by a custom-developed software application and presented in both table and graph format.
- This weather information is useful for lake ice status interpretation from radar imagery
- The LIS is also using a Shallow Water Ice Profiler (SWIP) instrument, which is currently installed at the bottom of Lake Tasikallak, in the George River study area.
- SWIP is recording ice thickness data measured by an echo-sounding device, during the winter months.
- SWIP is currently gathering data using a data-recorder, but will ultimately be transmitting live data that will also be integrated into the portal as a live data feed.
- At other locations, Inuit hunters are measuring ice thickness by taking ice cores from the lake or river ice. In-situ ice thickness measurements are used to validate data being collected through remote sensing.



Results and Product Delivery

- Products are currently delivered through a public Community Portal in English and Inuktitut (www.nunavik.lakeice.ca)
- Web Portal focuses on presenting the classification and status of ice.
- Includes real-time and archived weather information
- Created using a custom-developed ASP.net web-application, and a MySQL database to render thematic image overlays of lake ice status by image date.
- The resulting map provides a regional overview of lake ice in the study area for a specified date.
- Printed map products integrate TEK and remote sensing data, providing information on lake ice status, key Char lakes, sensitive areas and traditional travel routes.





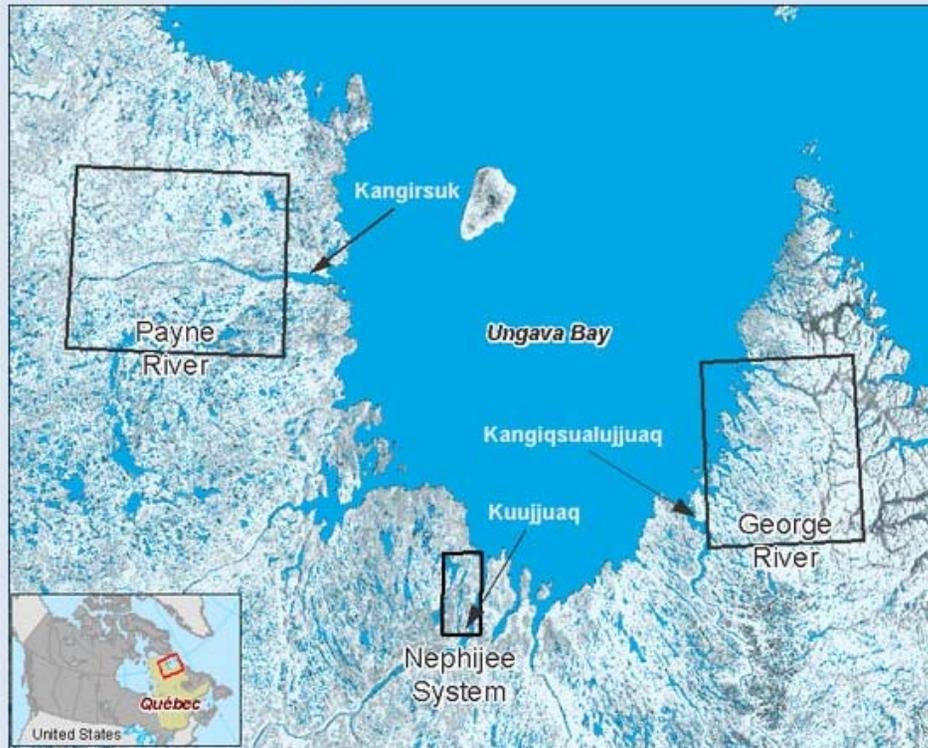
lake ice service weather conditions about contact us

polar view portal nunavik project portal

Ungava Bay George River Payne River Nephijee System



Select a lake ice study area



LAKE ICE MONITORING

Using Earth Observation satellites, real time weather data, and local environmental knowledge, ice conditions for several key lakes near the communities of Kangiqsualujuaq and Kangirsuk are reported through this portal.

Information on freeze-up, ice presence and ice break-up are available and are supported by additional information, such as weather and real time ice thickness. The Lake Ice Service also features a comment log where community members can enter information about lake ice, travel to the lakes and hunting/fishing conditions.

Please select the desired study area, using the map (left) to obtain additional details on the specific lake of interest.

To obtain more information on Polar View and the Lake Ice Service Portal, please go the [about page](#).



lake ice service status:

Next Planned Update Most Recent Update

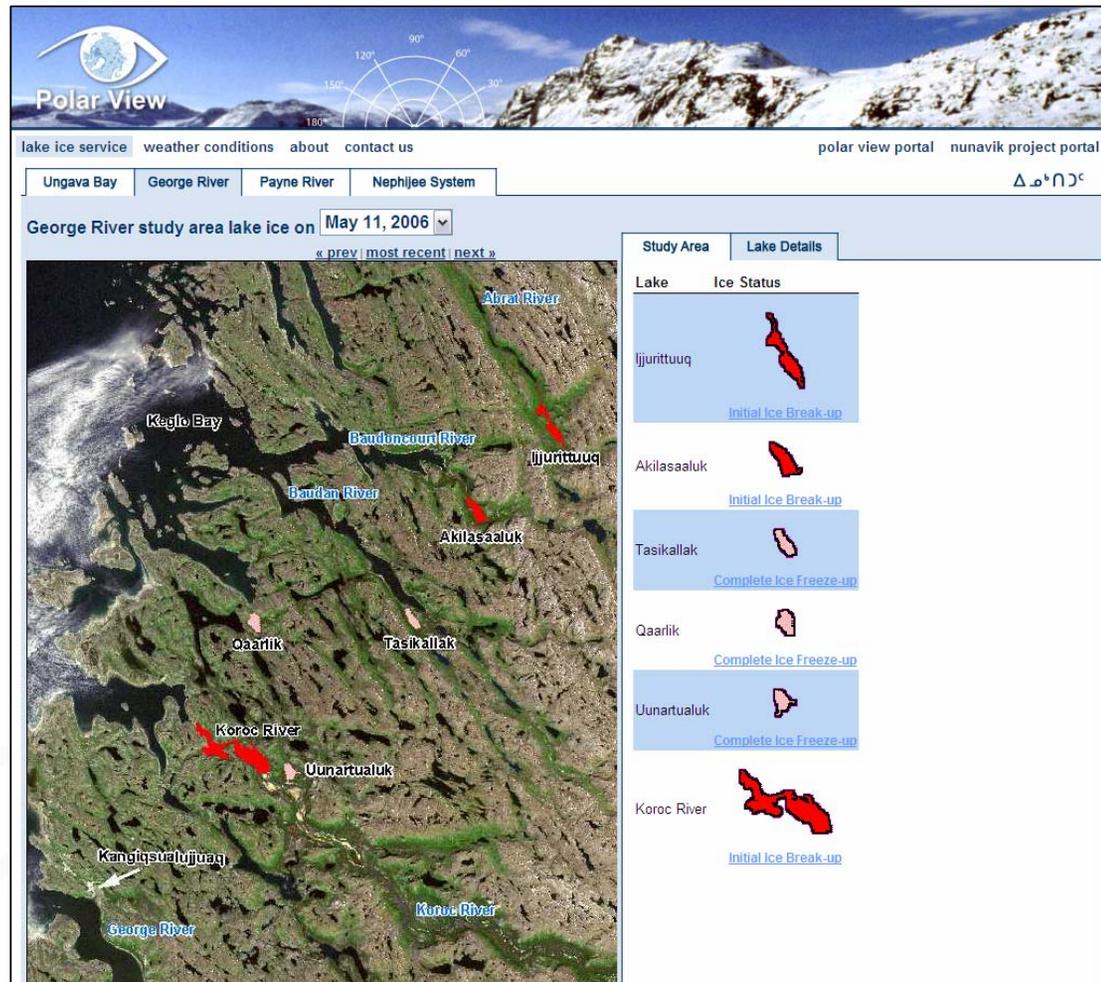
George River Area Lake Ice

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Jun 24, 2009

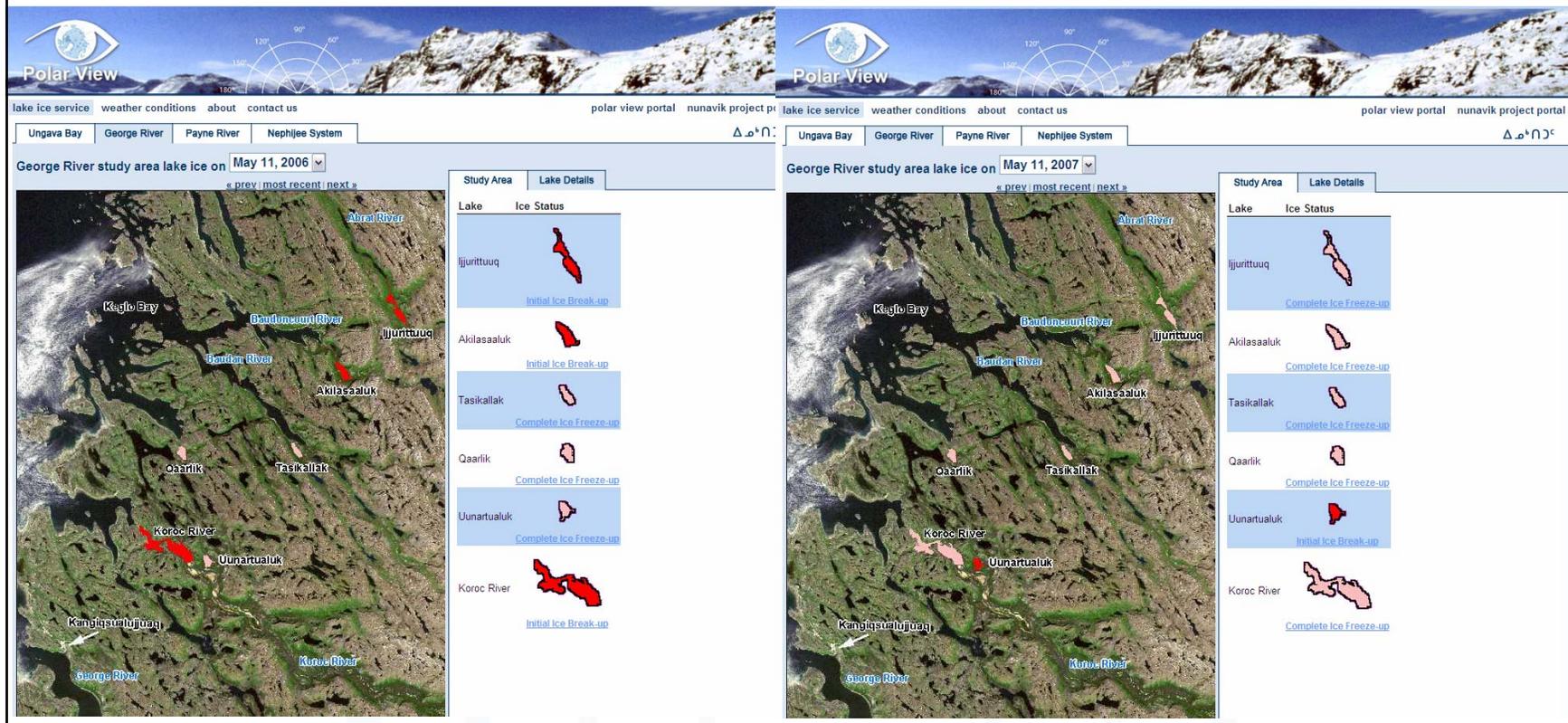
Lake Ice Status

- Display of contextual information – weather data, ice thickness, etc.
- Lake details provided by clicking on the lake
- User can move between image dates and observe the changing ice status.
- Multi-year display of ice conditions
- Local Inuit can input comments and observations online



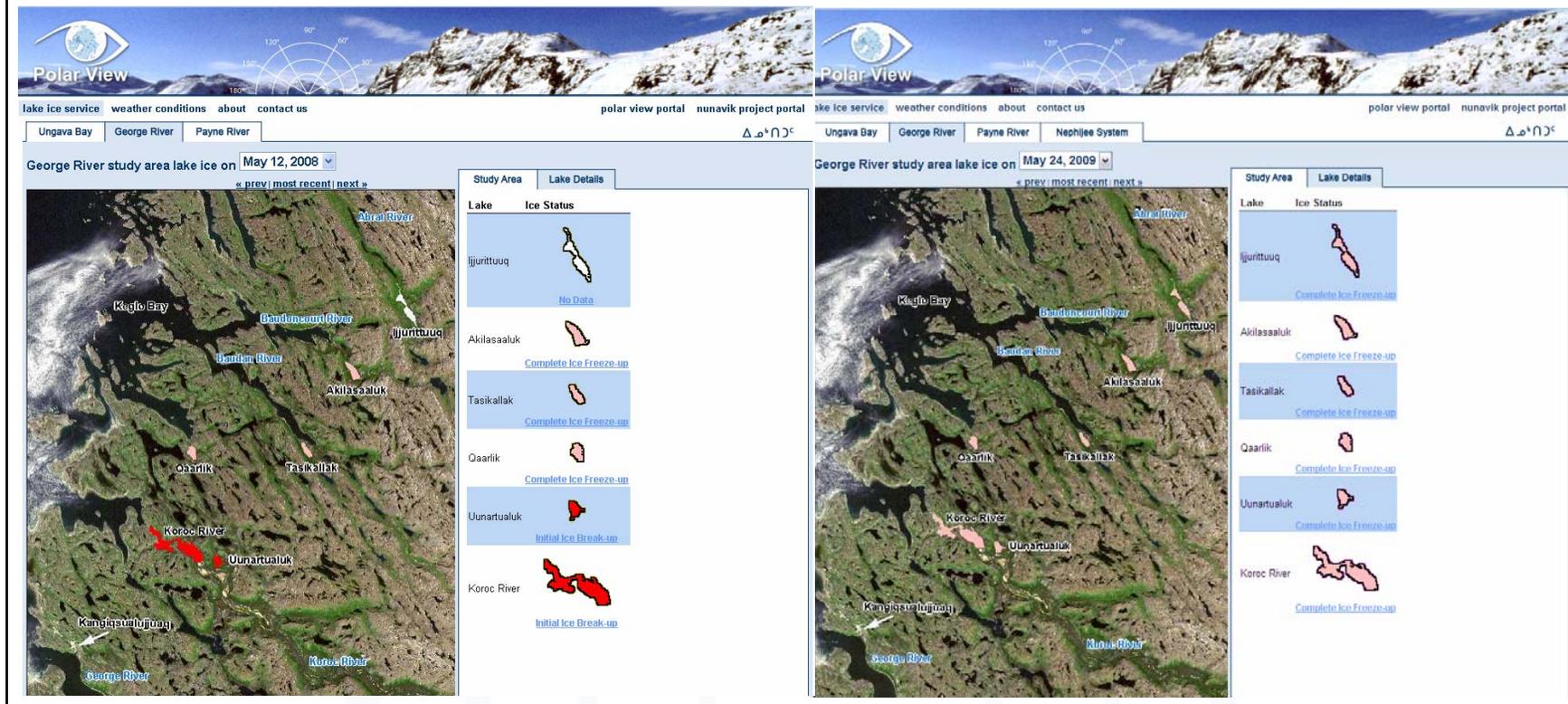
Comparing Lake Ice Status

The following Figures compare the lake ice status for four consecutive years for critical time period of ice break-up.



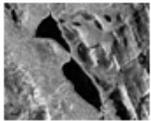
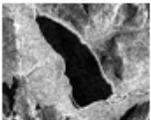
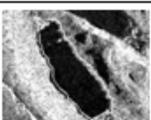
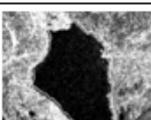
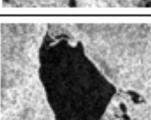
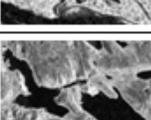
Comparing Lake Ice Status

The earliest ice break-up in the George River area occurred in 2006 when three out of six lakes surveyed were in the break-up stage, while in 2009 there is no break up on any of the lakes by May 24, 2009.



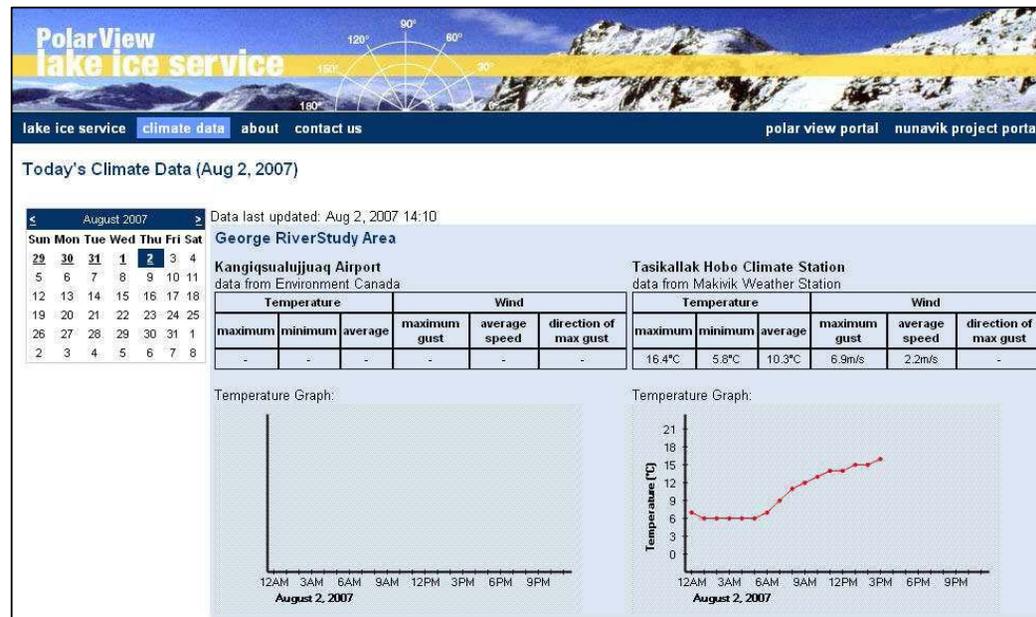
Lake Ice Status – General Trends



Lake / River Section	Thumbnail	Open Water – Ice Free	Initial Ice Freeze-up	Newly Formed Ice	Complete Ice Freeze-up	Initial Ice Break-up	Open Water – Ice Free
<u>Ijuituuq</u>		October	Early - December	End - December	Early - January	Mid-May	Mid-June
<u>Akilaaluk</u>		October	Early - December	End - December	Early - January	Late-May	Mid-June
<u>Tasikallak</u>		October	Early - December	End - December	Early - January	End-May	Mid-June
<u>Qaariik</u>		October	Early - December	End - December	Early - January	End-May	End-June
<u>Uunartualuk (Kaqoq Lake)</u>		October	End - November	End - December	Early - January	End-May	End-June
<u>Kaqoq River</u>		October	End - November	End - December	Early - January	Mid-May	End-June

Accessing Weather Information

- Web Portal provides access to real-time and archived weather information.
- The HOBO weather stations were installed in July 2007, so data is only available from that point onwards
- Environment Canada data collected at the regional airports is available from November 2005 onwards.



Future Improvements (2010-2014)

- The Lake Ice Service is currently in its fourth year of operation.
- Initial focus was on developing an operational service, and building local capacity to maintain the service.
- Next phase will extend the service to all fourteen communities in Nunavik, and provide an enhanced service level with new products and the possibility of automating the imagery classification.
- Other planned enhancements for the service include the travel safety component that will offer information on the ice status along travel routes to hunting and fishing areas.
- Training and field data gathering by Inuit hunters will also be expanded.



Thank You

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