geoconvention
Virtual Event
September 13 - 15
2021

Nipiih potability study integrating western scientific method and traditional knowledge through a mentorship pipeline.

Chief Jim Badger and Eric Willier, Sucker Creek First Nation
Evangeline Eldridge, Shelley Alexander and Celia Kennedy University of Calgary
Joseph Leadley, Mount Royal University

Summary

Water quality issues in First Nations communities have been recognized by the Government of Canada for more than a decade. The Sucker Creek First Nation (SCFN) reserve lands encompass almost 60 km^2 along the southwest shore of the Lesser Slave Lake within the Treaty 8 region. The band language is Cree, with a registered population greater than 2,000 and a Council that supports: education, training, traditional land use and socio-economic development. The Lesser Slave Lake is situated in the Athabasca River Basin and covers an area of almost 1200 km^2. While surface water resources in this region are abundant, the community is adversely affected by poor drinking water quality and annual flooding. Since there is a strong desire within the community to be self-reliant, professionals with training in science, technology, engineering and mathematics (STEM) are needed to evaluate nipiih or water quality concerns and to demonstrate to local youth and elders the applicability of post-secondary training in STEM in daily life.

In the Cree language, NIYAK means *"for the future".* It is also an acronym for *Network for Indigenous Youth Academic Knowledge.* This paper and presentation will describe how NIYAK, a 3-year project, was launched in 2020 by the University of Calgary in partnership with the SCFN under NSERC's PromoScience initiative. NIYAK was envisioned as a mentorship pipeline, connecting graduate, undergraduate and high school students from across Canada. Its foundation is based on the incorporation of western scientific and traditional methods through engagement with elders and youth in their community. Our common goal is two-fold. Work together to identify the existence and source of the problem and possible solutions; and engage local youth in field and lab applications to demonstrate how post-secondary education in STEM disciplines will enable the community with the scientific training needed for informed independent decision-making in the future.

Introduction/Background

The Lesser Slave Lake was formed by the retreating Laurentide Ice Sheet 12,000 years ago. The ice sheet retreated and exposed a low, broad basin which captured glacial meltwater forming the proglacial lake referred to as Lake Peace. Over time, the water level of Lake Peace dropped to the present level forming present-day Lesser Slave Lake. The Lesser Slave Watershed is 20,000 km^2 of agricultural, recreational, traditional and residential lands. Five major rivers drain into the Lesser Slave Lake (i.e., the South Heart, West Prairie, East Prairie, Driftpile and Swan Rivers) and there is one main outlet (i.e., the Lesser Slave River) (Figure 1). Flow through the lake comes largely from the Swan Hills region, where the most precipitation and snowfall is received. The substantial size of the watershed makes the area resistant to long-term climate changes; however, this means lake levels can rise rapidly during runoff events causing flooding. Numerous studies have been published by the Alberta Government and the Lesser Slave Watershed Council since 1991, but none of these reports referenced comparisons with the *Guidelines for Canada's*

Drinking Water Quality. Instead, they describe the state of the lake and its tributaries in relation to *Surface Water Quality Guidelines for Alberta,* associated with aquatic life and recreational uses. Highlights from these reports are the presence of algal blooms and high levels of nutrients which have been identified as a concern for drinking water usage, recreational use, and aquatic life.[1] Paleolimnological studies suggest that the productivity of the lake increased substantially after the 1950s, when flood controls were built on many of the inflowing rivers.[2] It is also noteworthy that the Swan Hills Treatment Centre opened in 1987, as a national 1.3 km^2 facility for the disposal of hazardous waste, including polychlorinated biphenyl's (PCB's), some 80 km south of where the Swan River flows into the Lesser Slave Lake.

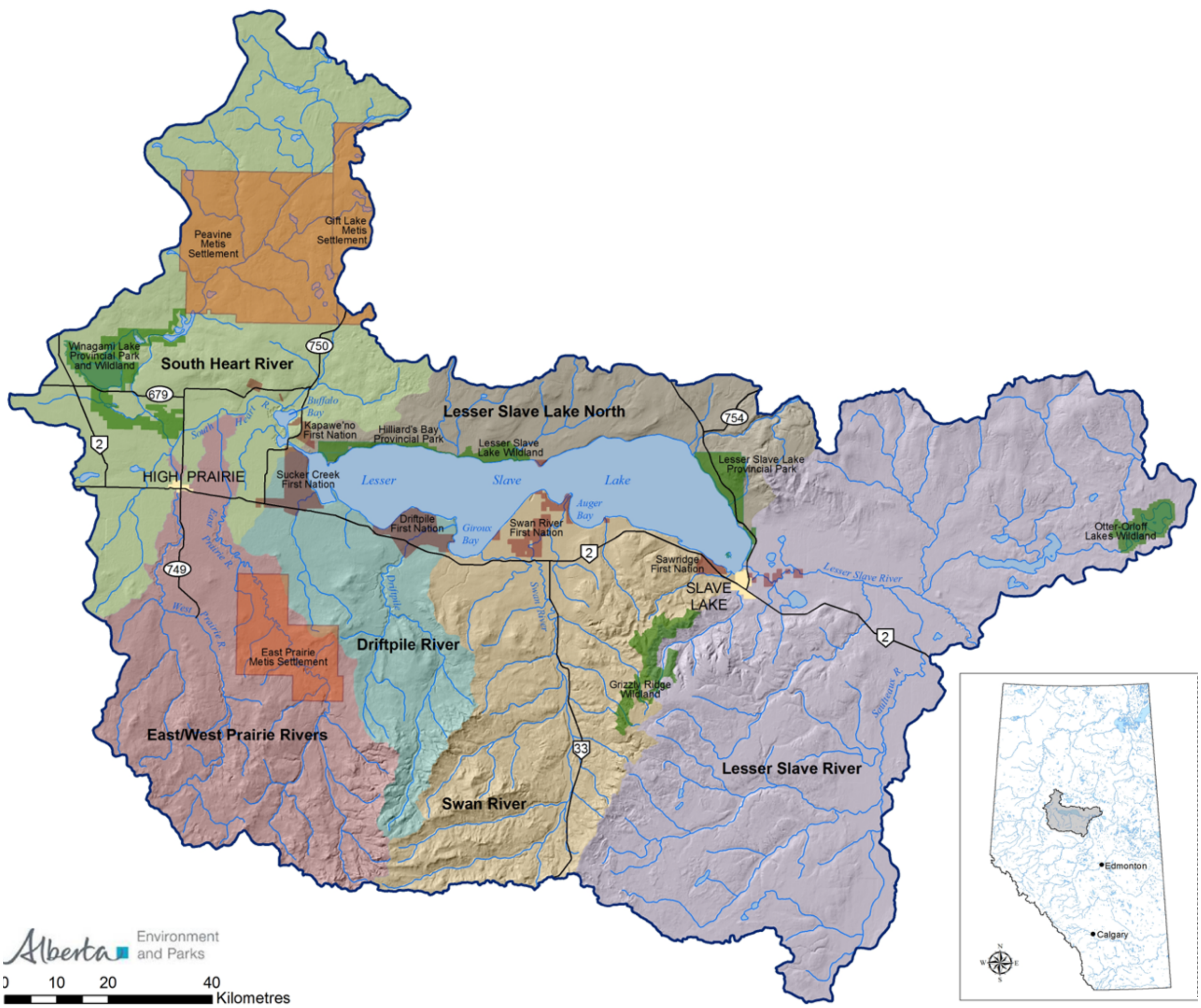

Figure 1. Lesser Slave Lake Watershed and its major sub-basins[3] within the Province of Alberta and proximity to Calgary and Edmonton.

Ways of Knowing Science

These authors are not aware of any publications documenting the integration of Indigenous ways of knowing with western scientific method in a hydrogeological study. Consequently, these methods have been jointly determined in a thoughtful way. In August 2019, reconnaissance sampling was conducted with local youth and the concept of a mentorship pipeline was discussed with the Chief and Council. A literature review was conducted in the winter-spring of 2020 and the framework of a 3-year water quality study was established.

Year 1 of the study was launched in September 2020, with a meeting of researchers from U.Calgary and elders from SCFN. In an innovative combination of academic presentations of documented findings and a talking circle of undocumented historical information, knowledge was shared, cultural differences were respected, concerns were heard, and potential solutions were discussed. During the meeting, maps, photographs and flip-charts were used to identify seven geo-referenced sample sites of concern. Decision-making was based on several criteria, including: river inflows and outflows, land uses near shorelines and tributaries (including industrial, agricultural and waste treatment), experiences associated with anomalies like changes in water levels, turbidity and odour, and regions of the lake where fish morphology and health changed resulting in loss of food source.

Water samples were collected by boat September 10-11, preserved in coolers and delivered to a commercial lab for analysis within 24 hours. Since objectives of the study are to characterize the lake water at different seasonal highs and lows and to test for potential contaminants of concern related to land use activities, analysis parameters were jointly selected, including: major ions, nutrients, isotopes, metals, dioxins, furans and *Escherichia coli (E. coli)* bacteria, along with field metrics (of pH, dissolved oxygen, temperature, electrical conductivity and total dissolved solids) and flow velocities. It was assumed that the lake was well-mixed and unstratified at the time of sample collection (i.e., late summer), and all samples and measurements were taken at 60% of the depth of the water column at each site.

Using year-1 major ion analyses results, a baseline characterization or hydrogeologic facies was constructed to understand the sources of dissolved constituents in the lake water (Figure 2). Most natural waters contain (positively-charged) cations and (negatively-charged) anions in chemical equilibrium; in balance. The most common cations are the highly soluble alkali metals, sodium (Na^{1+}) and potassium (K^{1+}), and the harder alkaline earth metals, calcium (Ca^{2+}) and magnesium (Mg^{2+}). The most common anions, like carbonate-bicarbonate ($CO_3^{2-} \leftrightarrows HCO_3^{1-}$), represent weak acidity (due to incomplete H-dissociation), or strong acidity (with complete dissociation), as in the case of sulfate-sulfuric acid ($SO_4^{2-} \leftarrow H_2SO_4$) and chloride-hydrochloric acid ($Cl^{1-} \leftarrow HCl$). Results indicate that the dominant cations from all samples were calcium and magnesium, and the dominant anions were weak carbonate acids, which is not surprising, given the calcereous nature of the underlying Wapiti and Puskwaskau geologic formations[5,6].

This presentation will explain the results of the year-1 baseline sampling. Going forward, local youth and members of the community will continue to be involved in fieldwork, analyses and interpretation of lab results, as well as decision-making in fieldsite modifications and source water protection.

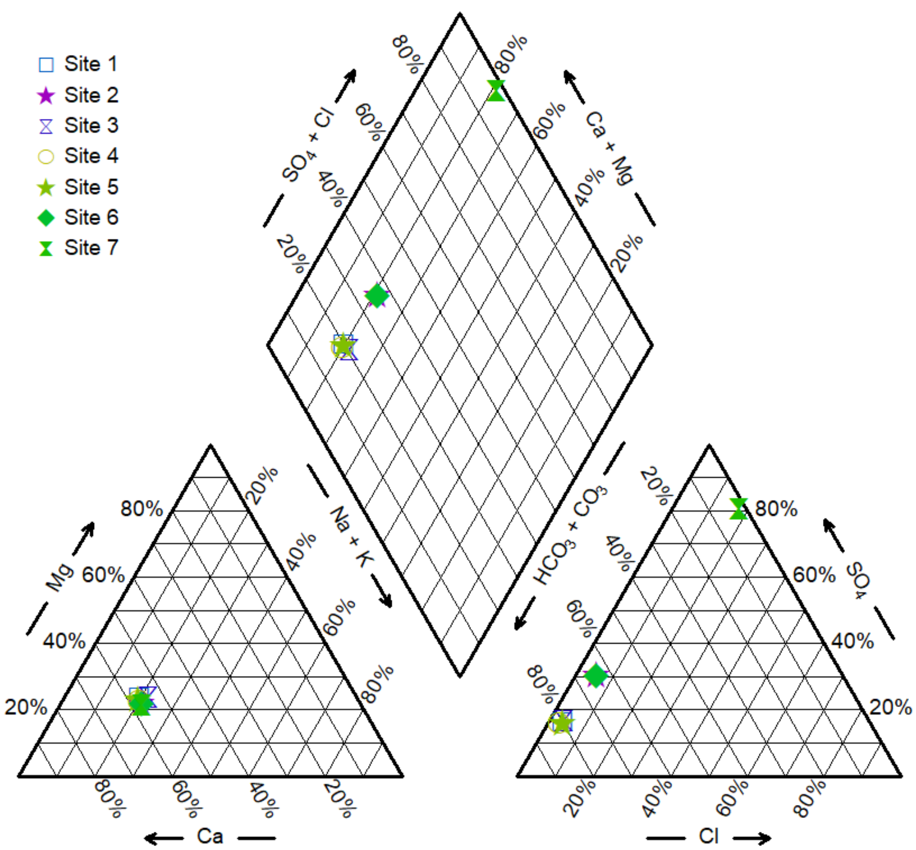

Figure 2. Hydrogeologic facies of water samples collected from seven study sites along the Lesser Slave Lake in September 2020. Two trilinear Piper[4] plots of the most common major ions are shown, with cations (Ca, Mg, Na and K) on the left and anions (CO_3, HCO_3, SO_4 and Cl) on the right. These two triangles are combined on the centre diamond to yield a characterization summary. Data plotted was the result of major ion analyses completed by Bureau Veritas Laboratories using AqQA (Rockware.com). The pH of flowing water measured at most sites was alkaline (7.7 to 8.1), while sites 2, 6 and 7 were acidic (4.1 to 6.3).

Evolution of the Program

NIYAK evolved from the REDEVELOP program that is covered in a separate contribution to this conference. While REDEVELOP's mission is to train graduate students, the under-representation of Indigenous students in that program was indicative of systemic barriers to undergraduate opportunities in STEM disciplines. Reconnaissance discussions with SCFN youth, parents, elders and numerous academic partners facilitated some brainstorming to determine some first steps.

- High school students need access to post-secondary mentors from STEM disciplines to form relationships, build trust and ask questions about financial assistance, housing and how to navigate the application process.
- REDEVELOP students can serve as friendly, accessible, informative mentors through an interactive NIYAK website to facilitate communication at regular intervals using a cell phone, since not all high school students have access to computers or reliable internet at home.

- SCFN students need access to scholarship funding for high school upgrading to gain eligibility into STEM programs at university or college.
- Communication must be equitable; meaning that SCFN students need guided visits to universities and colleges with their REDEVELOP mentors. Similarly, REDEVELOP mentors need guided visits to the SCFN community for meaningful discussions and to conduct fieldwork.
- Experiential learning is invaluable. When SCFN students visit post-secondary institutions, guided by REDEVELOP mentors, they will spend time in each institution's cultural support offices and in geoscience and/or engineering labs on more than one occasion to build confidence in their decision-making about career choices and living away from their community.
- Transparency of both the water quality study and the student mentorship program is critical for success. A late summer banquet held in the SCFN community, where high school students and their mentors have an opportunity to share the year's findings, open the floor for discussion and to bring people together.

Summary and Outlook

NIYAK's progress was impeded in 2020-21 by the many challenges associated with COVID. Advances in research and student outreach, albeit slower, have continued. This year, at the REDEVELOP conference, 20 students (presenting at GeoConvention) prepared a special outreach event for high school students in the Indigenous communities they engaged with in 2021. Since we were "shut down" again due to COVID, the students recorded their talks, videos and testimonials, each containing a personal message for the high school students. Plans are in the works for this event to be delivered in-person at each community during the summer of 2021.

Acknowledgments

The NIYAK program is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC) PromoScience initiative in collaboration with the University of Calgary and the Sucker Creek First Nation. The authors acknowledge Emily Calliou, Ryan Badger and the Elders of the SCFN for their patience and support. We further acknowledge the efforts of these collaborators: Steven Saddleback (Indian Resource Council), Karen MacDonald (Writing Symbols Lodge), Chelsea Benally (U.Alberta), Thalia Aspeslet (Pieridae Energy), Michael Nightingale & Farzin Malekani (U.Calgary Geoscience Laboratories), Noah Arney (Mount Royal University) and Jennifer Dunn (SAIT).

References

1. Wolanski, A. (2006). Lesser Slave Lake Results of Water Quality Survey Conducted by Alberta Environment in 2000-2002. Alberta Environment, 24 pp.
2. Jamison, T. (2009). State of the Lesser Slave Watershed 2009. Carson Forestry Services Inc. Prepared for Lesser Slave Watershed Council. High Prairie, AB. 116 pp.
3. Lesser Slave Watershed Council. (2017). Watershed Maps. Available at https://www.lswc.ca/watershed_maps. Last accessed May 19, 2021.
4. Piper, A.M. (1944). A graphic procedure in the geochemical interpretation of water-analyses. Transactions, American Geophysical Union 25: doi: 10.1029/TR025i006p00914.
5. Fanti, F. & O. Catuneanu. (2010). Fluvial Sequence Stratigraphy: The Wapiti Formation, West-Central Alberta, Canada. Journal of Sedimentary Research, 80: 320-338. doi: 10.2110/jsr.2010.033.
6. Alberta Geological Survey & Alberta Energy and Utilities Board. (1999). Geological Map of Alberta.