Annual Report 2017/18

Contents

NSERC Canadian LakePulse.ca Network

How healthy are Canadian lakes?

The NSERC Canadian LakePulse Network is a scientific initiative on environmental issues affecting lakes. To assess lake health, we carry out multi-disciplinary activities:

- The LakePulse Survey extensively samples 680 lakes selected to represent the millions of lakes across Canada.
- The LakePulse Web Portal linked to our environmental database will deliver data, stewardship tools, and interactive maps on the health of Canadian lakes and regional threats.
- Our research projects will culminate in the first national assessment of lake health by 2021.

In today's context of global environmental change, lakes can be impacted by multiple stressors such as pollution, land-use changes and climate change. LakePulse aims to better understand and report on these changes to provide the best knowledge for lake stewardship.

LakePulse improves our capacity to collect, analyze, interpret, and share environmental data on lake health, throughout Canada. We collaborate at local, regional, and national levels and conduct regional comparisons across Canada in order to meaningfully engage with policy.

By cost-effectively sharing knowledge, LakePulse aims to help decision makers, municipalities/districts, stakeholders and others better manage lake resources by providing them with up-to-date information needed to meet sustainable development objectives.

LakePulse is an academic-government partnership hosted at the Université de Sherbrooke in Quebec and receives funding for five years (2016-2021) through the Strategic Partnership Network program, an initiative of the Natural Sciences and Engineering Research Council of Canada.

LakePulse is conducting an assessment of lake health across Canada, to understand how lakes have changed and to predict how they will respond to key stressors in the future.

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Director's Message

In our second year, the NSERC Canadian LakePulse Network has met ambitious goals that highlight our collective capabilities to carry out an innovative research program to provide the first national assessment of lake health and to develop an integrated Web Portal for sharing and mapping lake data.

Working together

LakePulse's second year was successful thanks to the teamwork, openness and enthusiasm of our many participants. Achieving our research and communication goals has required hard work and determination. This report highlights the efforts that allowed LakePulse to meet its goals from April 2017 to May 2018.

LakePulse Survey in 2017 and 2018

Planning the first summer of the LakePulse Survey involved many challenges, especially from April to July 2017: planning the itineraries for 5 field teams sampling 217 lakes across 5 provinces; organizing a tremendous amount of materials and thousands of sampling bottles; creating the LakePulse Field Manual that allows standardized protocols to be applied across Canada; training over 30 field participants based on the LakePulse Field Manual; and organizing all the shipping of lake samples from remote locations in Quebec, Ontario, New Brunswick and Nova Scotia.

These were just a few of the challenges surmounted thanks to our LakePulse participants and the continual support of many people at the Université de Sherbrooke.

We are now on track for our second summer of the LakePulse Survey in 2018, which is even more ambitious: sampling over 230 lakes in 7 provinces!

The LakePulse Survey is possible because of the tireless efforts of our LakePulse students, postdocs, research professionals, and trainees who spend months working collaboratively across Canada to collect samples for all the Network projects. These "Highly Trained Personnel" (HQP) are the lifeblood of our Network.

LakePulse's 2nd Annual Meeting

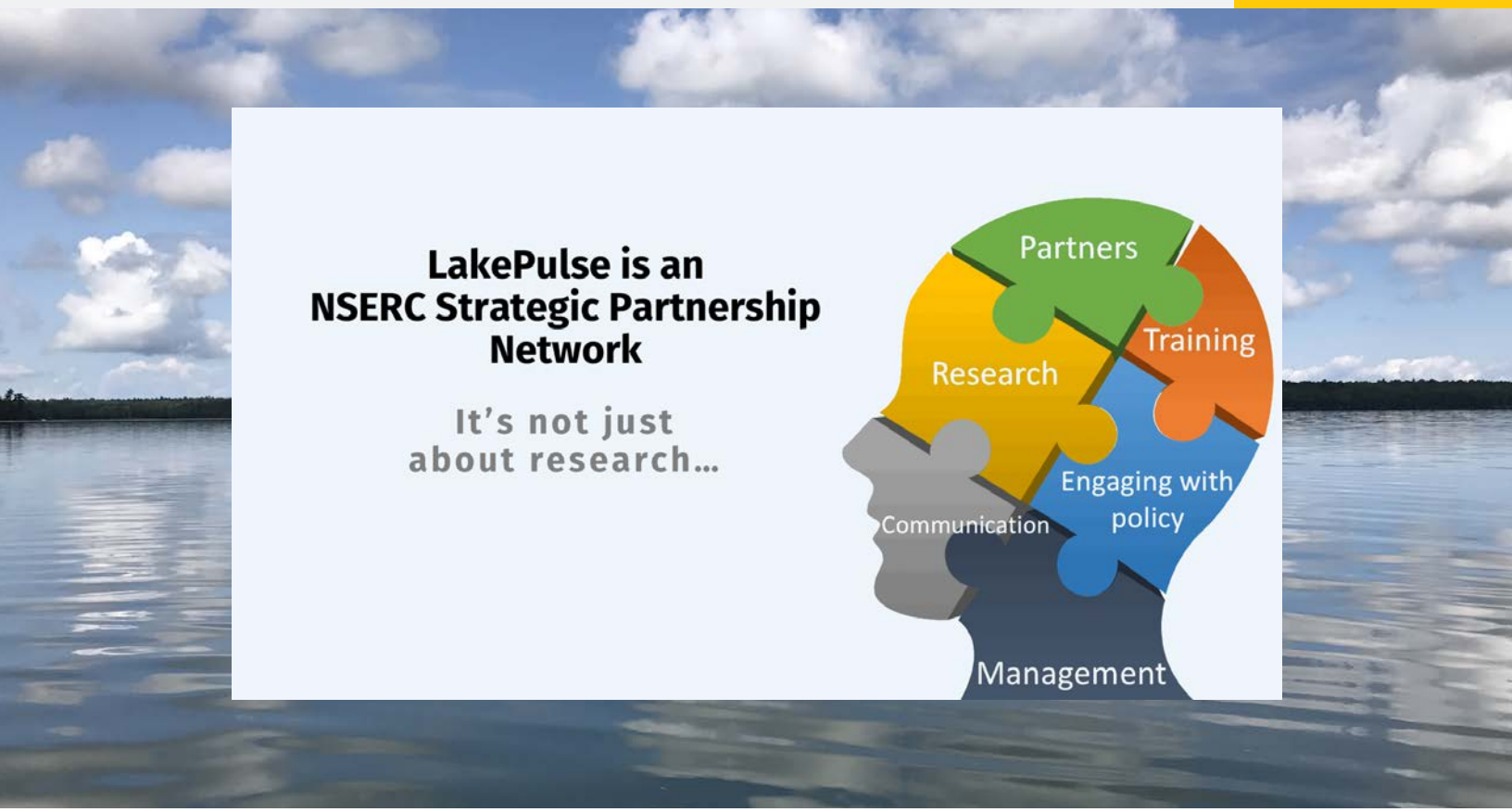
In November 2017, we held our 2nd Annual Meeting. We had over 40 participants including researchers, HQP and partners. The meeting was a special time to congratulate our field teams and to discuss the research projects, data processing, and data sharing. We also received feedback on the LakePulse Survey and started planning the next sampling season! Our invited speakers highlighted the importance of communication and public engagement in supporting evidence-based policies, which relates to our LakePulse Web Portal and Stewardship Tools.

Results emerging from the LakePulse Survey

Our researchers and HQP are working to understand the patterns beginning to emerge from our datasets. Many of them are busy analyzing samples and processing data from the LakePulse Survey in 2017. In LakePulse, we emphasize the advantages of collaborative research and sharing knowledge, and we are excited as many collaborations are taking shape. Researchers are also starting to submit abstracts to present initial findings at conferences. Our Scientific Committee is tracking the projects and providing advice on Network research.

I sincerely thank everyone who has worked so hard to put LakePulse's bold vision into action. Special thanks to Catherine, our Manager, for showcasing our achievements in this report. This year, we have shown that there is much to gain from working together: ***LakePulse is a Network that works!***

Yannick Huot
Director, NSERC Canadian LakePulse Network



Our research program has three main purposes:

1. **Improving our understanding of lake characteristics and functioning on large scales and their response to human impacts.**

   Each lake is different, but we can identify general responses to stressors that vary regionally and with lake characteristics. LakePulse aims to understand this variability and to predict lake responses.

2. **Developing knowledge, monitoring tools, and technologies that can support evidence-based policy making and sustainable lake management, particularly in the context of human impacts on lakes such as pollutants, climate change, and land-use changes.**

   LakePulse is examining new models and methods that could be used to improve our ability to diagnose and monitor lakes.

3. **Sharing lake data and information as broadly as possible.**

   LakePulse is developing an integrated Web Portal for lake health data to address Canada's growing environmental challenges and to enable evidence-based decision making at local, regional and national levels. Our Web Portal aims to ensure that lake and water quality observations as well as scientific results from LakePulse projects are presented in a user-friendly, accurate, engaging and accessible manner.

   Better access to lake data and information can enable public engagement at all levels of government, and support the implementation of proposed federal reforms to environmental assessment, fish habitat protection, and navigation protection laws.

Government & NGO Partners

Our partners include federal, provincial and territorial government agencies and departments who contribute their regional expertise to the LakePulse Survey and their historical monitoring datasets to our lake database for the pan-Canadian lake health assessment

Ontario Ministry of the Environment and Climate Change

Québec

British Columbia

Newfoundland Labrador

Alberta Environment and Parks

Yukon Government

Northwest Territories

New Nouveau Brunswick

OURANOS

Environment and Climate Change Canada / Environnement et Changement climatique Canada

Public Health Agency of Canada / Agence de santé publique du Canada

Yukon and New Brunswick joined LakePulse in 2017

We are expecting a new provincial partner to join in 2018 as well as the IISD-Experimental Lakes Area (see Appendix A). Our partner collaborators are listed in Appendix B.

Our partners are involved in all aspects of LakePulse from planning to analyses, including data collection and publications. Appendix C lists our partner's contributions for the past year. Overall, our partners are on track for providing their expected contributions, and some plan to exceed them.

Our partners can provide key regional information for the LakePulse Survey. Local knowledge is essential for planning lake access and identifying lake chacteristics. Our partners also provide advice on selecting lakes. Some partners contribute their personnel for the LakePulse Survey, and others support students either financially or through co-supervision of their research projects.

Many partners are preparing and sending us their historical monitoring datasets that will be used by LakePulse for the pan-Canadian lake health assessment (see LakePulse Database section on page 24).

Academic Institutions

LakePulse brings together 17 researchers from 13 universities across Canada with environmental managers and governments in an exciting partnership

Experts from various fields are working together to assess lake health

Appendix D lists the 17 investigators in the Network and their affiliation.

A collaborative approach is required to tackle the complexity of assessing and predicting lake health because of the many potential threats to lakes and their cumulative impacts, as well as the immense number of lakes across Canada and the diversity of biota and other characteristics among lakes.

The Network's scientific breadth is one of its key strengths. LakePulse brings together expertise on diverse topics to assess and forecast the health status of Canadian lakes and to carry out research in limnology, remote sensing, ecology and other related sciences. See Appendix E for a list of the Network projects.

These experts are leading different research projects and supervising graduate students and postdocs (Appendix F). A few changes have been proposed to better match students and projects (Appendix G).

Research for Understanding & Monitoring

LakePulse's Scientific Objectives:

1. To assess the health status of Canadian lakes, identify their key stressors (including emerging ones), and understand how these stressors have altered and are altering lake biogeochemical functioning.
2. To forecast probable future changes in the health status of Canadian lakes using climate and land-use scenarios.
3. To develop new observational approaches, such as genomics and remote sensing (past, new and future sensors), to provide managers with new stewardship tools to understand lakes and to provide policymakers with essential knowledge to inform decision making.

LakePulse is advancing innovative research through funding and support of Network projects.

See Appendix H for a list of some early achievements by our researchers, postdocs and students.

See Appendix I for an overview of our Network milestones from year 1 through to year 3

Our research program is comprised of highly interconnected projects working together and sharing samples and data. Data flows from individual labs to our shared, centralized database. The milestones and deliverables of individual Network projects are tracked using an online reporting system. All projects are reviewed at 6-month intervals by the Scientific Committee (see Appendix J for a list of the members). Issues that are identified are brought to the attention of the Board of Directors (see Appendix K for a list of the members).

Our research program is organized under 4 themes comprised of many projects to assess the health status of Canadian lakes and predict the impacts of watershed and climate related stressors

Theme 1

Where, by how much, and why have Canadian lakes changed during the Anthropocene?

Theme 2

How do taxonomic, molecular and biochemical features of planktonic, benthic and microbial communities change with lake alteration and which ones can most effectively be used as indicators of the health of Canadian lakes?

Theme 3

What are the optical, morphometric and watershed properties of Canadian lakes that can be applied to “scale up” assessments of health to groups of lakes through remote sensing and spatial modelling approaches?

Theme 4

How will lake ecosystems and their services respond to different scenarios of environmental change?

As a Network, LakePulse goes well beyond supporting individual research projects in two key ways:

1) Key Network activities are led by the Administrative & Specialist teams at the Université de Sherbrooke

These activities include the Canadian LakePulse Survey, a centralized database and Web Portal, and extensive geospatial analyses, which would not be possible by smaller projects.

2) Integration of knowledge through collaborative science

LakePulse has two research themes specifically focused on integrating the outcomes of the individual projects in syntheses that cross cut through the Network.

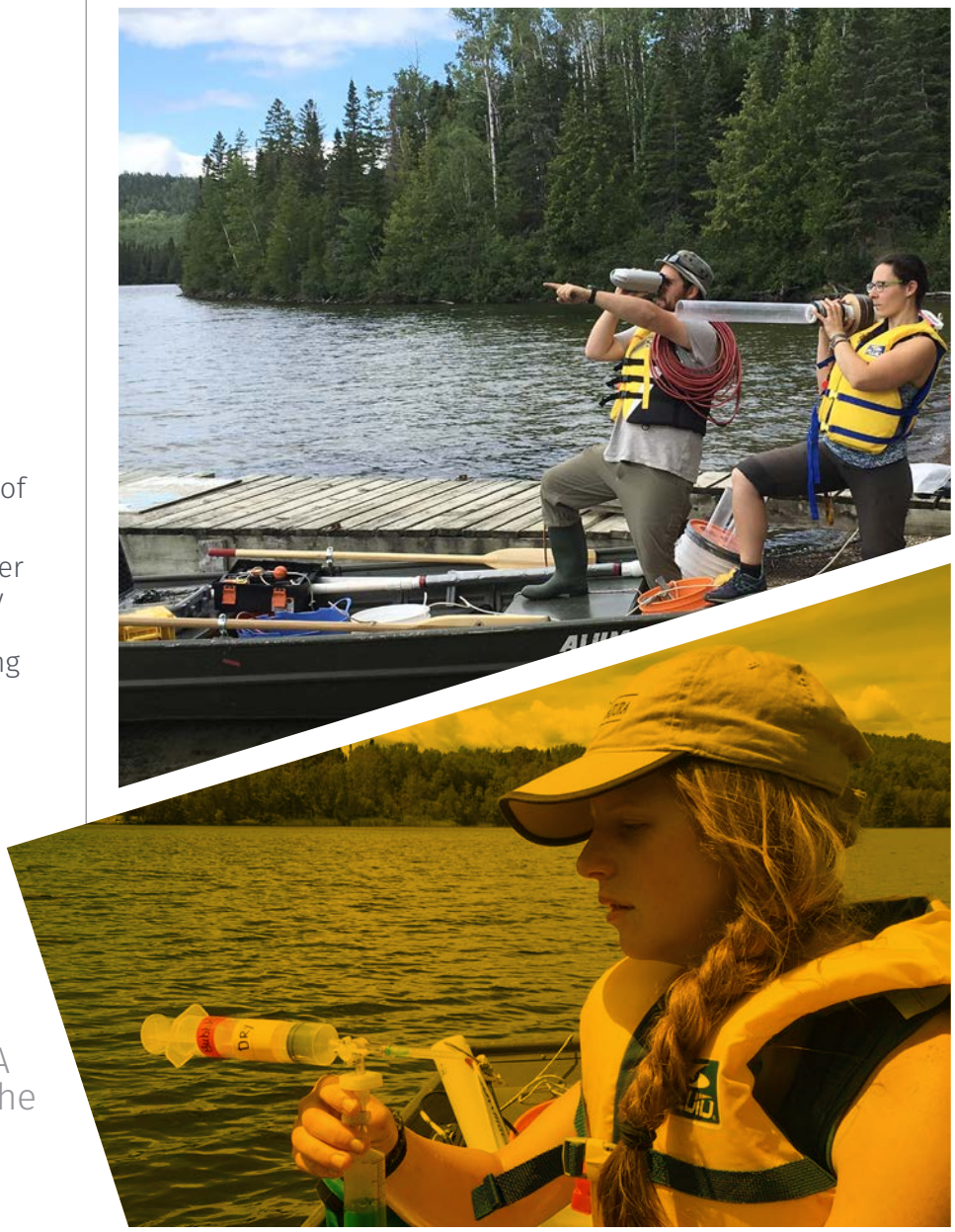
- **Theme 3** focuses on spatial modelling techniques and remote sensing. Information from the 680 lakes in our LakePulse Survey and the historical monitoring datasets from our partners will be extended geographically beyond the sampled lakes to provide near nationwide coverage of hundreds of thousands of lakes.
- **Theme 4** uses the results of the other 3 themes to look at the vulnerability of ecosystem services to change; integrating knowledge; and extending results into the future through forecasting.

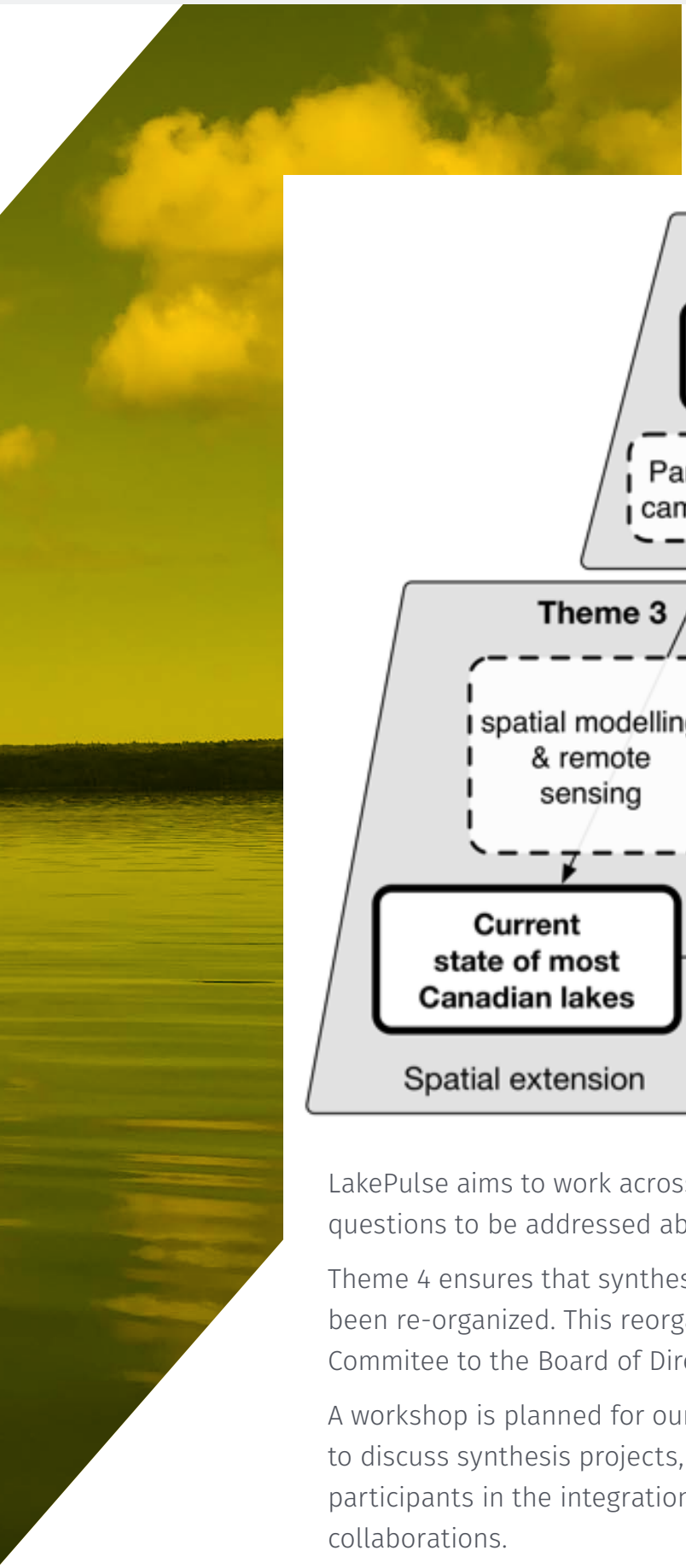
To present LakePulse to the scientific community, a publication is in preparation:

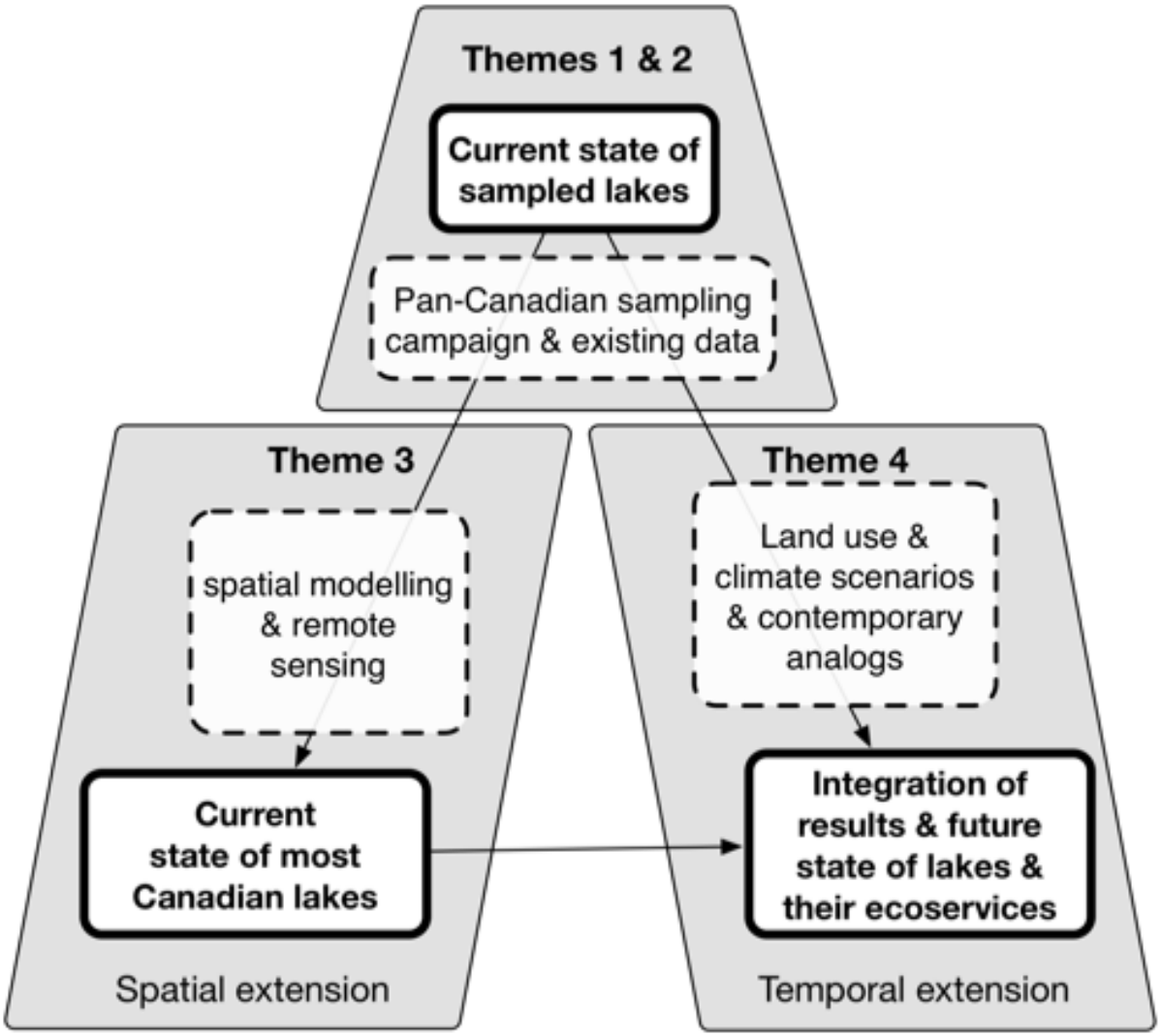
Huot et al. "The NSERC Canadian LakePulse Network: A pan-Canadian assessment of the state of Canadian lakes"

Ambitious ideas require cooperation

- To provide a pan-Canadian perspective on lake health.
- To develop better metrics to quantify ecosystem function.
- To use the past and present to develop future scenarios of change in aquatic ecosystems in different ecozones.







LakePulse aims to work across broad temporal and spatial scales to allow questions to be addressed about baselines, current states and future trends.

Theme 4 ensures that synthesis projects cross cut Network projects and it has been re-organized. This reorganization was recommended by the Scientific Commitee to the Board of Directors for implementation.

A workshop is planned for our 3rd Annual Network Meeting in November 2018 to discuss synthesis projects, to encourage the involvement of LakePulse participants in the integration studies, and to develop and strengthen collaborations.

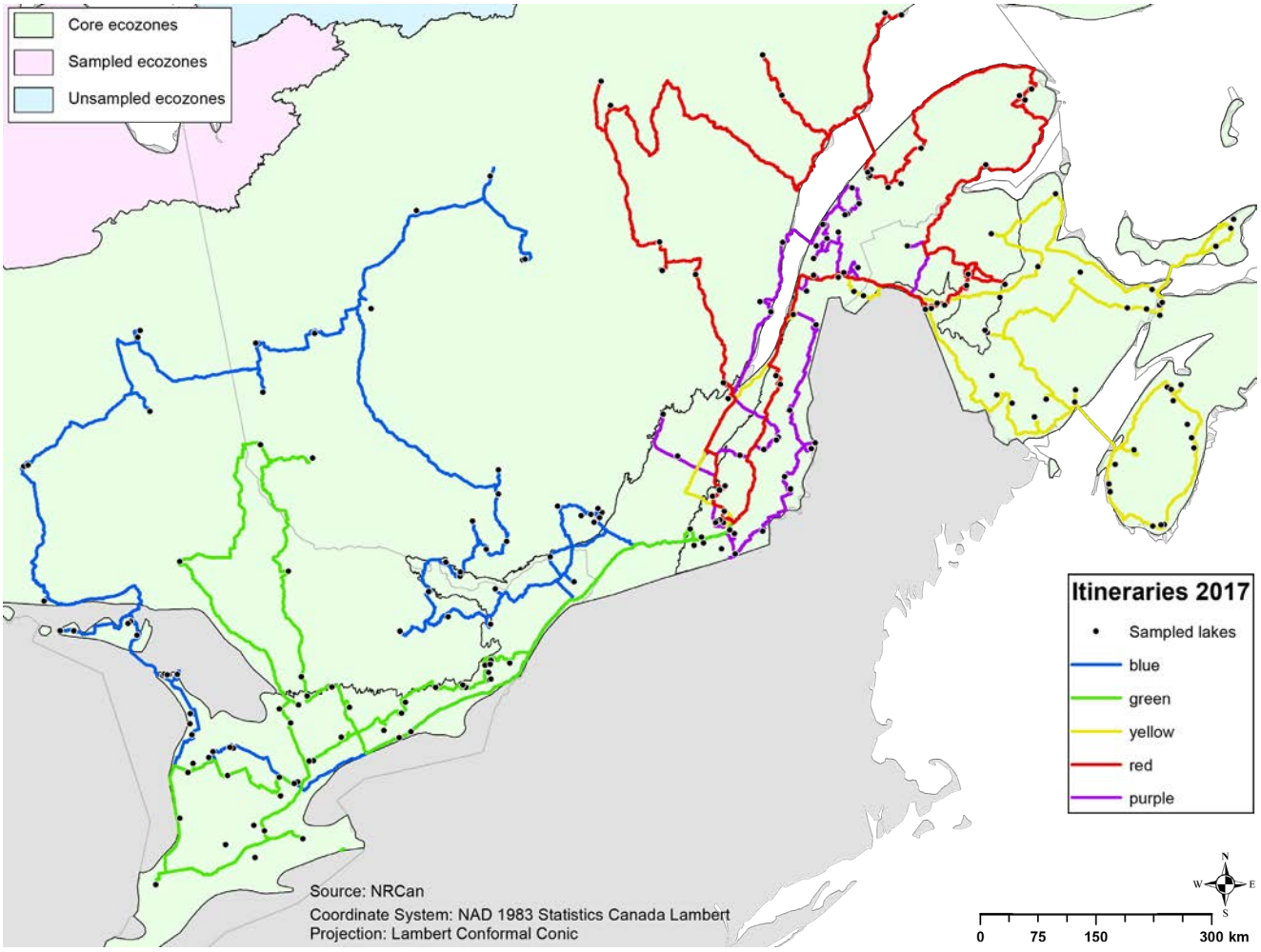
LakePulse Survey

To carry out a cross-country assessment of lake health, we selected 680 lakes: large and small, pristine and polluted. Our extensive sampling program over 3 summers is essential to assess and compare lake health in 13 ecozones across Canada.

Summer 2017: Five field teams (32 team members) sampled 217 lakes to obtain a large suite of variables to support projects ranging from baseline analyses for water quality monitoring to cyanobacterial toxins to emerging contaminants (e.g., pharmaceuticals, personal care products).

Summer 2018: We are currently planning to sample over 230 lakes in 7 provinces: British Columbia, Saskatchewan, Alberta, Manitoba, Ontario, Nova Scotia, and Newfoundland and Labrador.

Summer 2019: Our field teams will travel to lakes in British Columbia, Yukon and the Northwest Territories to complete the LakePulse Survey. Thanks to the blue, green, yellow, red and purple teams!



In July 2017, our five field teams launched the first summer of the LakePulse Survey. Some teams spent 6 weeks on the road, others over 10 weeks. Each week, samples were sent to the Université de Sherbrooke for sorting, storing and shipping to labs for analysis.

The LakePulse Survey is one of the most challenging aspects of our Network: our field teams are traveling continuously; they sample rain or shine; and they often have long working days and weeks.

Preparing for each summer of the LakePulse Survey requires many hours of work by our Administrative & Specialist teams who prepare numerous details:

- All the protocols in the LakePulse Field Manual;
- Training over 30 field participants in 2017;
- All logistical aspects and materials;
- Selecting the lakes, including back-up lakes, based on geomatics analyses; and
- Preparing all the necessary software and the database to collect data from the field.

Students, postdocs and interns are involved in many aspects:

- Preparing lake packets and protocols;
- Organizing sampling materials for each lake;
- Maintaining a mobile lab, boat, truck and trailer;
- Organizing meals and accomodation for their team;
- Contacting lake associations and municipalities; and
- Carrying out the sampling activities!

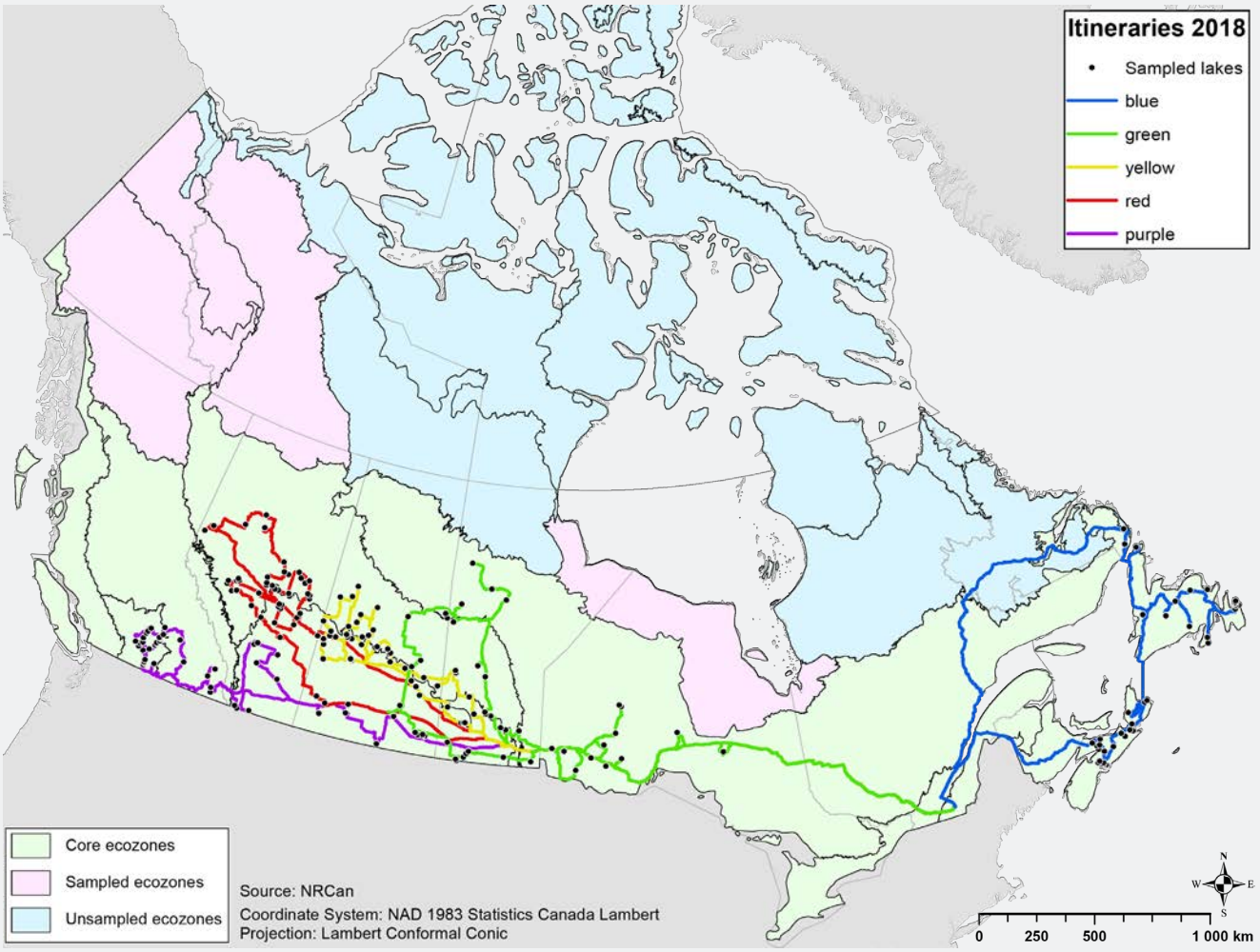
In 2017, an electronic data collection system was developed by our Database Specialist in collaboration with the Field Coordination team. Our five field teams recorded and stored field data using electronic logsheets on tablets. The data was uploaded to a centralized server when an internet connection was available. The system was successful, efficient and reduced errors from handwritten logsheets. The electronic data collection system is being further improved for the LakePulse Survey in 2018.

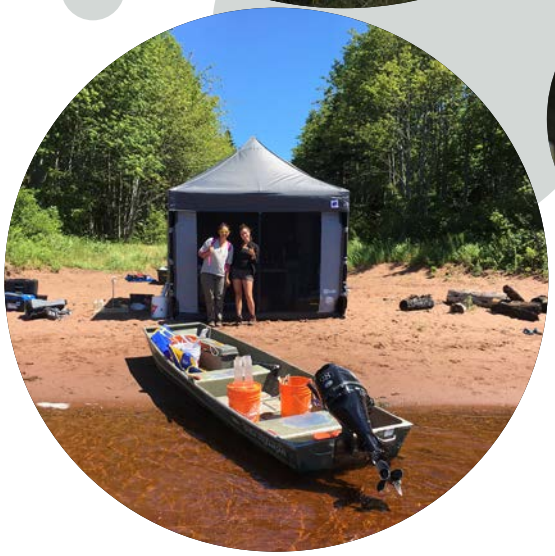
In 2017, the first summer of the LakePulse Survey was a success and we sampled 217 lakes. The table below lists some of the challenges faced in 2017 and the approaches being taken to improve the LakePulse Survey in 2018.

Challenge	Solution for LakePulse Survey in 2018
Some total phosphorus samples were highly variable.	A series of tests will be conducted in the spring of 2018 for the next field season. Stringent quality control applied to data from the LakePulse Survey in 2017. Improving protocols and training.
Lost pH from approximately 2/5 of lakes due to broken sensors.	Sensor protection increased; sending back-up pH sensor with all teams. Offering specific training on pH sensor calibration.
High value of chlorine in some samples.	Problem traced to HCl cleaning solution. Improving the cleaning/rinsing protocols.
In situ oxygen calibration not carried out properly.	Changing protocols. Offering specific training on dissolved oxygen sensor calibration.
Lost many bacterial samples due to long storage/shipping times.	Incubations will be carried out by field teams.
Some samples lost during shipping.	Packing protocols improved during 2017 campaign to correct this problem.
Reception of samples from all field teams at the Université de Sherbrooke took too much time of the Field Coordination team.	Hiring two interns who will receive samples part time and one masters student in Sherbrooke who will coordinate the reception work for several weeks. Exploring possibility of adding barcodes to samples for faster processing/scanning and improved tracking of samples. The interns will also be trained as field participants in case we need emergency replacements.
Time lost by field teams and Database specialist to find 'back-up' lakes during the field season.	Teams will be trained to select back-up lakes and be provided with a tablet with back-up lakes to improve their efficiency in selecting alternative lakes.
Excessive number of participants in the field campaign leading to complex logistics.	Participants have to commit to the full field season in 2018.
Some lakes were difficult to access by field teams.	Field teams must plan lake access during the spring for the lakes they will be sampling by contacting local residents, lake associations, municipalities, etc. This will also reduce the number of last-minute 'back-up' lakes required.

For the LakePulse Survey in 2018, our 5 field teams (23 team members) from across Canada are preparing for the field season by contacting lake associations and municipalities to ensure that they can access the lakes selected for the survey.

The map below shows the itineraries of our five field teams, which was produced by a geomatics analysis based on a stratified random sampling design. The stratification is within ecozones to select lakes according to size and human influence in the watershed.





LakePulse Field Manual

Our field teams spend a full day at each lake and sample for over 100 variables. In total, we are collecting over 66,000 samples. For our research projects, it is criticial to have a consistent methodology for data collection across Canada, which allows for results to be compared with other datasets. From a broader perspective, LakePulse encourages standardizing data collection at the local, regional and national levels.

The LakePulse Field Manual (154 pages) is a comprehensive set of protocols for our field teams that describes every step from the morning set-up for sampling to the weekly shipping of samples:

- Robust, clear, standardized protocols for data collection and recording;
- Quality assurance and quality control methods;
- Integration with provincial, Environmental Protection Agency's (EPA) National Lakes Assessment (NLA), academic and other data collection methods as much as possible to facilitate broader scale data comparison;
- Easy-to-follow quick reference guides and schematics for the field;
- Currently field tested on 217 lakes; and
- Over three summers, will be tested on 680 lakes across Canada.

Once fully tested, the LakePulse Field Manual will be made public to help standardize sample collection in monitoring programs, support other large lake sampling activities and guide other limnological scientific studies.

Spring & summer 2017: The LakePulse Field Manual was compiled. A 3-day workshop was held at the Université de Sherbrooke with over 30 participants. The purpose of the workshop was to review the protocols in the LakePulse Field Manual, and for our HQP to network and to meet our Administrative & Specialist teams. During the field season, the five field teams were in daily communication with the Field Coordination team at the Université de Sherbrooke for assistance. The protocols were applied to 217 lakes in 5 provinces.

Fall & winter 2017: Researchers, students and postdocs worked with our Field Coordinator to contribute new schematics to improve the Field Manual. Protocols were examined if the data processing identified issues with data quality. Plasticized sheets were also developed as quick reference guides for the field.

Spring 2018: The improved LakePulse Field Manual is ready for the second summer of the LakePulse Survey. It will be used to train over 25 participants during the 3-day HQP training workshop in June 2018.

Education & Training

LakePulse students, postdocs and trainees receive multidisciplinary training in our highly collaborative Network. They are our "Highly Trained Personnel" (HQP). They fully participate in the LakePulse Survey to collect data for the entire Network, and they contribute to key deliverables such as the LakePulse Field Manual and the lake health database. Our HQP are also involved in the development of our policy engagement aspects as they will contribute to and provide feedback on our Web Portal. LakePulse provides an exceptional learning environment to train 21st-century researchers who can communicate effectively across disciplines.

HQP-led Workshop - November 6, 2017, Université de Sherbrooke, Longueuil campus

The day before our Second Annual Network Meeting, we welcomed 17 HQP who participated in a workshop organized and led by HQP. Each participant participated in a networking activity called "Connections across Projects", which focused on learning about the various research projects and examining potential collaborations. In the LakePulse Survey, all HQP help to collect samples for other projects, and they expressed interest in the different research projects and how each sample is used. In response, activities were prepared linking each sample "bottle" handled by the field teams to researchers, HQP and their projects. This underscores how multidisciplinary training fosters interest and communication among disciplines.

The Field Coordinator led a discussion to gather feedback on the first summer of the LakePulse Survey in 2017, and the HQP worked in groups to plan the LakePulse Survey in 2018. The HQP also discussed the database and iPad usage with the Database Specialist. Finally, the HQP selected their representatives for the HQP committee. The current HQP representatives are Lisa Lahens (Université de Sherbrooke) and Cindy Paquette (Université de Québec à Montréal).

Second Annual Network Meeting - November 7 and 8, 2017

At our Second Annual Network Meeting, we highlighted the achievements of our HQP in the LakePulse Survey. Students were invited to prepare videos or PowerPoint presentations that focused on their research projects and field experience in 2017. Many of these students are returning - some as field team leaders - for the LakePulse Survey in 2018. One of our doctoral students produced a video that was selected by the public among the top 25 videos in the NSERC "Science Action" competition in 2018 (watch the video on NSERC's YouTube channel: https://www.youtube.com/watch?v=kMpHq_AP3as). Many HQP have also presented their work at various meetings (see Appendix H, p. 67 and 68).

The LakePulse HQP are essential and full participants in many Network activities. Communication and collaboration are integral to our functioning throughout the year, and LakePulse HQP are provided with abundant networking activities.

LakePulse Survey 2017

One of LakePulse's major achievements this year was the success of the LakePulse Survey in July and August 2017.

LakePulse HQP

In total, we are currently training 13 PhD students, 4 Masters students, and 8 undergraduates. We also have 5 research professional and 2 postdocs.

Research projects

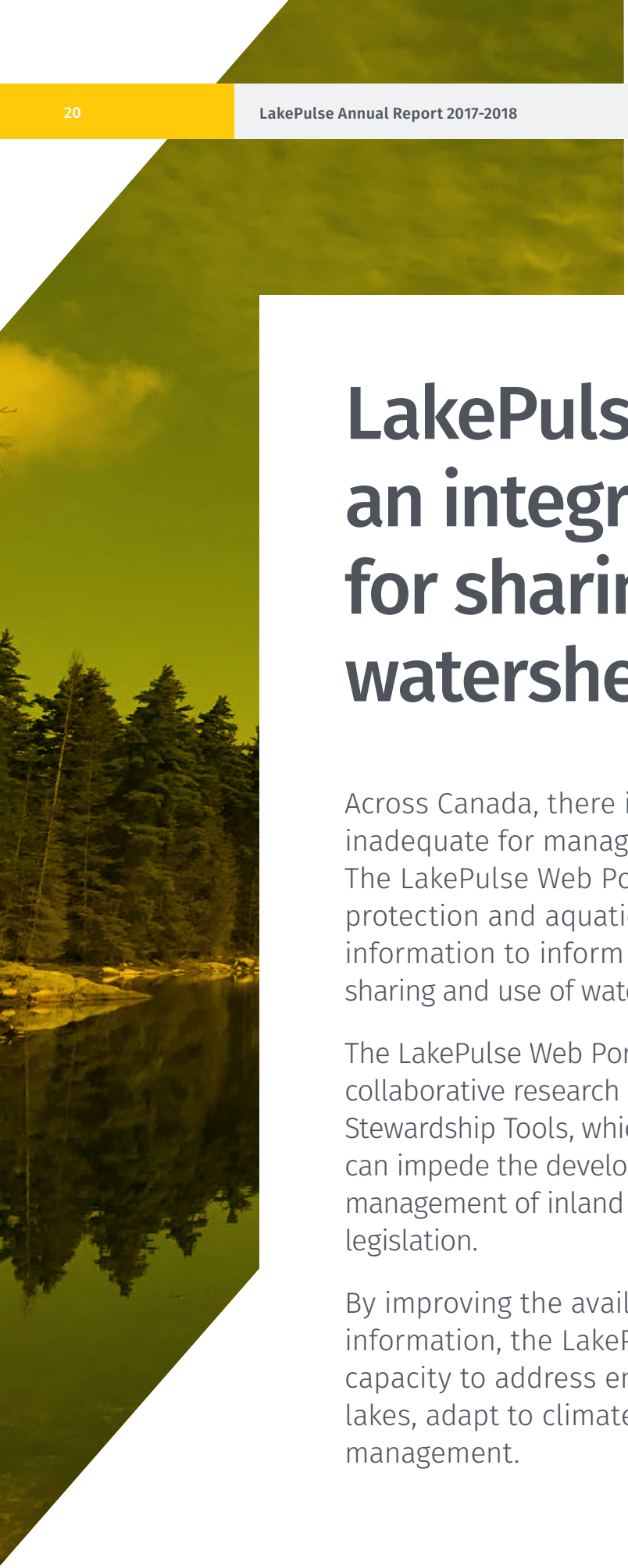
HQP work with the project leaders to collect and analyse samples from the LakePulse Survey, from cutting edge methods to detect emerging contaminants to genomic analyses and a suite of measurements for cyanotoxins, mercury, and water quality indicators.

HQP webpages

Our HQP have contributed information for their LakePulse webpages to showcase their research and Network activities: www.LakePulse.ca/HQP

Visits to partners and international labs

We expect that our HQP will start to visit our partners and international labs in 2018. This is a unique opportunity offered by LakePulse to complement the HQP training.



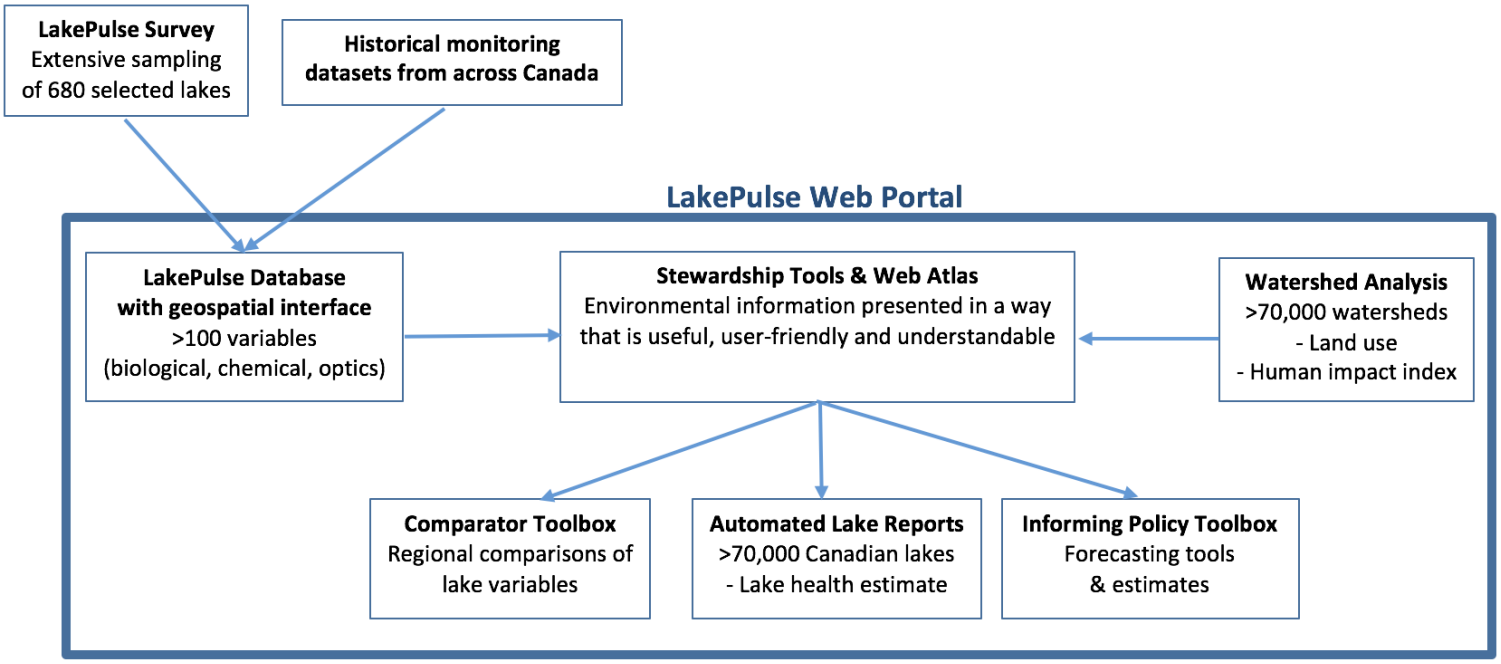
LakePulse Web Portal: an integrated system for sharing lake & watershed data

Across Canada, there is concern that data availability is inadequate for managing and protecting lake resources. The LakePulse Web Portal aims to contribute to freshwater protection and aquatic ecosystem health by gathering useful information to inform decision making and by facilitating the sharing and use of water information across Canada.

The LakePulse Web Portal is integral to carrying out our collaborative research projects and to developing our Stewardship Tools, which help to bridge information gaps that can impede the development of evidence-based policies, the management of inland waters, and the implementation of legislation.

By improving the availability and accessibility of lake health information, the LakePulse Web Portal will enhance Canada's capacity to address environmental challenges affecting lakes, adapt to climate change and enable sustainable lake management.

Storage and access to environmental data in a way that supports decision making is a global challenge. LakePulse is addressing this challenge by developing a user-friendly Web Portal for sharing and mapping information on lake and watershed health.



This multi-variable, pan-Canadian platform will provide robust data collected from over 680 lakes using consistent protocols described in the LakePulse Field Manual, historical datasets from our partners, and data from spatial and temporal modelling. The components of the Web Portal are described in the following pages.

Key aims of the LakePulse Web Portal

- Accessible water data – Provide information to support transparent and evidence-based decision making for policies, plans and management by all levels of government, industry, lake associations and others.
- Enabling greater local-regional-national integration and comparison across regions.
- Open – Ensure that everyone has access to data on lake and watershed health.
- Understandable & user-friendly – People need information on lake resources that is engaging, useful and links how decisions consider scientific data.
- Ecoservices – Broader ecoservices approaches move beyond bio-physical variables to consider additional aspects (e.g. social, economic, cultural).
- Increased collaboration, communication & coordination – Encourage collaboration between government, academia, NGOs and other groups by sharing data, information and technologies to support healthy lakes.
- Partner engagement – Aligned with provincial, territorial and federal partners.
- Analysis – Signal trends and provide interactive maps and graphics to visualize these trends.
- Forecasting – Analyze future scenarios by modelling climate change and changes in land use as development intensity increases.
- Extend sampling coverage to historically underrepresented regions.
- Water literacy – Increase awareness and knowledge by providing interpreted data products that can support diverse activities and organizations from provincial water monitoring programs to community stewardship groups.

The Web Portal is housed at the Université de Sherbrooke

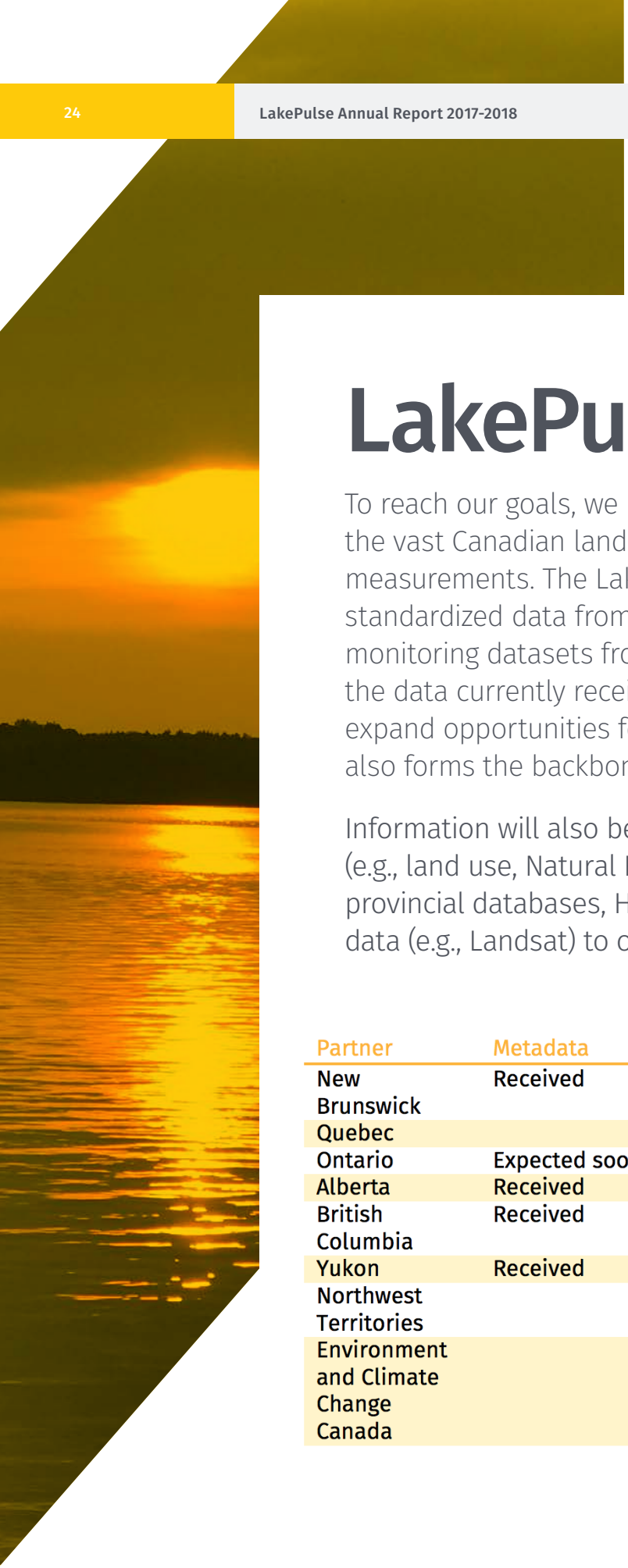
Development of the LakePulse Web Portal is coordinated and managed by Yannick Huot (LakePulse Director) with the Administrative & Specialist teams at the Université de Sherbrooke. They work closely to apply their specialized skills, and they are on track with the development of the web interface, GIS analyses and database.

The scientific and technical challenges to create the LakePulse Web Portal exceed the capabilities - and timelines - of most scientific projects. LakePulse brings together the capabilities needed to surmount the technical and communication issues and the scientific expertise to interpret and summarize our key findings. As a research Network, LakePulse has the expertise to analyze, interpret and report lake health data.

By working with our technical specialists, we integrate water knowledge in a structured framework, and make that knowledge accessible via our Web Portal for applied decision making. LakePulse fills a unique role by increasing accessibility to useful and reliable lake data that is evaluated and interpreted by experts, thus allowing academic researchers to serve the needs of governments, policy makers, stakeholders and various communities.

We expect the LakePulse Web Portal to support improved lake stewardship while also producing new scientific knowledge to support the most appropriate management policies. Our government partners and outreach activities help us to ensure that we align our outcomes to inform and engage with policy.

In LakePulse's second year, the basic framework of the Web Portal was put in place. A workshop is planned for our 3rd Annual Network Meeting in November 2018 to discuss progress on the LakePulse Web Portal, which will be of particular interest to our government partners, lake associations and NGOs. All researchers and HQP will be provided with the opportunity to use a preliminary version of the Web Portal and to provide their most significant results for inclusion in our Stewardship Tools.



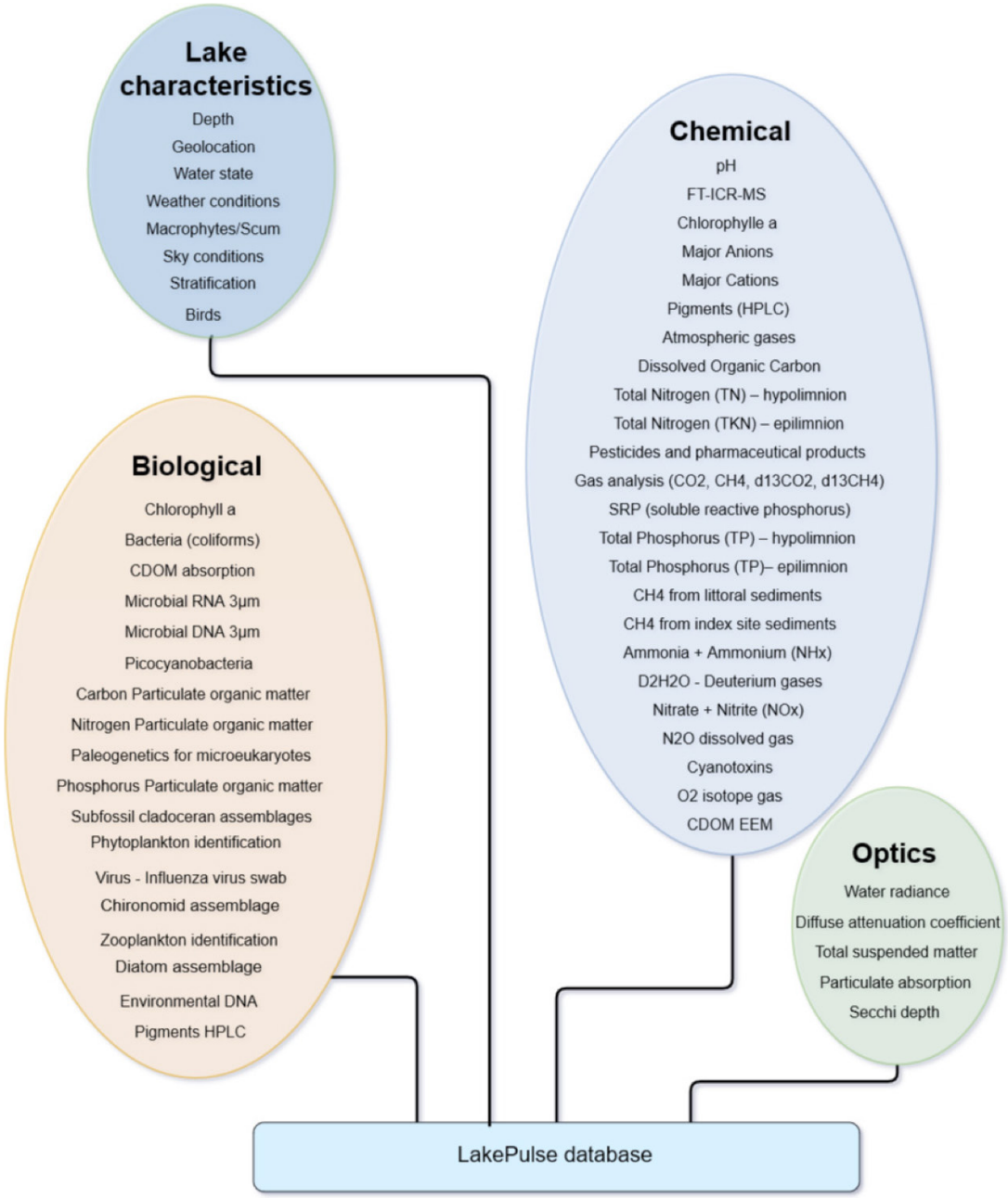
LakePulse database

To reach our goals, we require a consistent dataset that covers the vast Canadian landscape and includes state-of-the-art measurements. The LakePulse database is being populated with standardized data from the LakePulse Survey and historical monitoring datasets from our partners (see the table below for the data currently received). Integrating various datasets will expand opportunities for analysis and comparison. The database also forms the backbone of our Web Portal.

Information will also be extracted from large spatial databases (e.g., land use, Natural Resources Canada's GeoGratis database, provincial databases, Hydrolakes), and we will process satellite data (e.g., Landsat) to obtain further information about lakes.

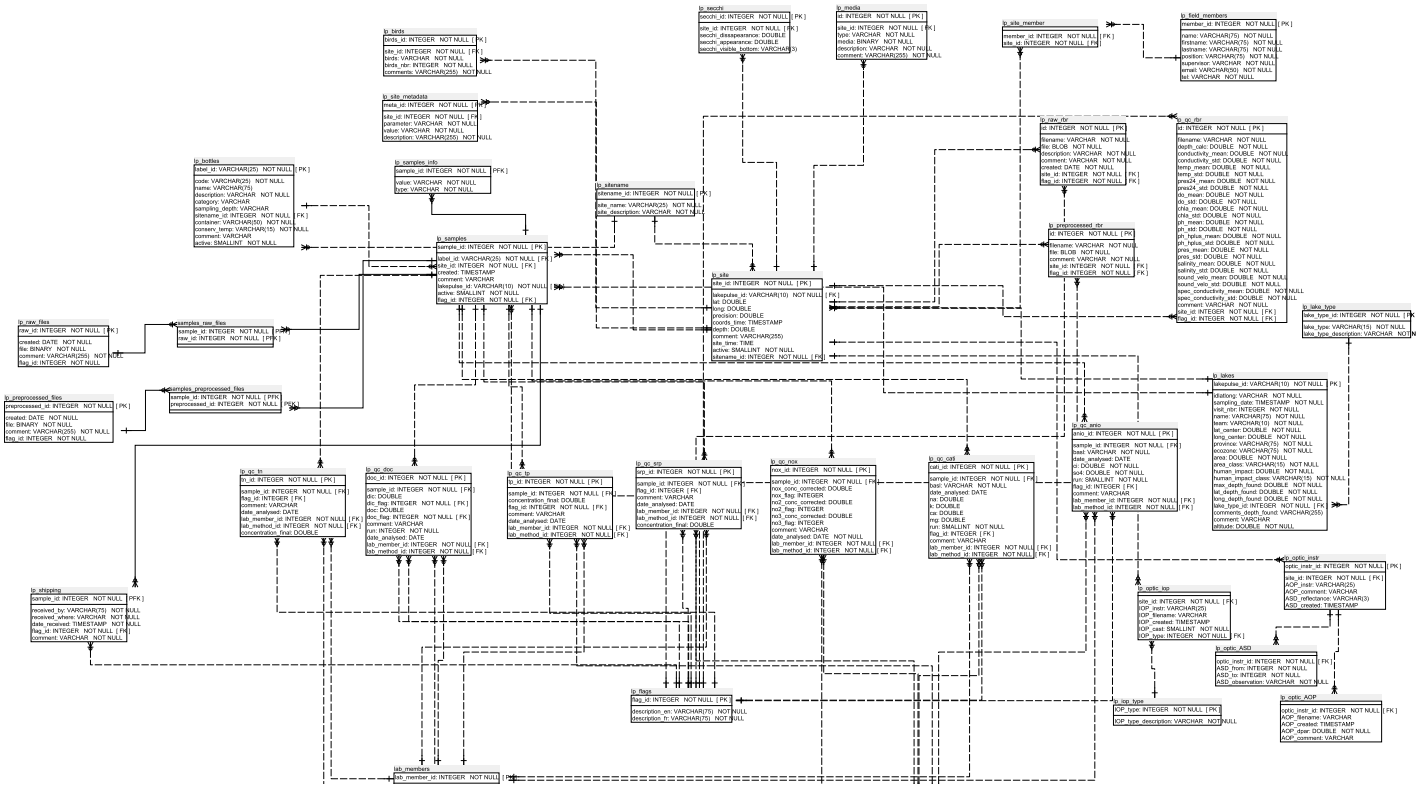
Partner	Metadata	Data	Comments
New Brunswick	Received		Example dataset provided to help prepare database.
Quebec			Data being prepared for the Network.
Ontario	Expected soon		
Alberta	Received	Received	
British Columbia	Received	Received	Publicly available data. Other data will follow.
Yukon	Received	Received	
Northwest Territories			Dataset is being compiled but limited lake data exists.
Environment and Climate Change Canada			ECCC is waiting for specific requirements to send optical data.

The LakePulse database will support national and continental-scale analyses of lake health indicators, now and into the future. The figure below illustrates the part of our database associated with the variables sampled during the LakePulse Survey.



Technical details: The LakePulse Database resides on a Linux operating system (Red Hat v7 64-bit) virtual server at the Université de Sherbrooke. The server is configured with an SSL certificate to enable further protection of the data by encrypting/decrypting all in-transit data and providing a secure transit channel for web sessions. The PostgreSQL v10/ PostGIS 2.4 database was selected for its versatility, its support of spatial object types and spatial functions, its ability to work effectively in very low-resource environments and its shared environments with a variety of other applications.

Webserver Apache v2.4.6 /Tomcat v7.5 was installed and will be used with the SSL certificate for data protection and encryption. Apache Tomcat is the most widely used open source web application server due to its stability, high flexibility and added layer of security. Apache Tomcat is also used in variety of mapping applications. The Apache Server is configured to run PHP, which is a scripting language for the development of the LakePulse Web Portal. The schematic below provides an overall impression of key relationships that are being developed to create the LakePulse database.

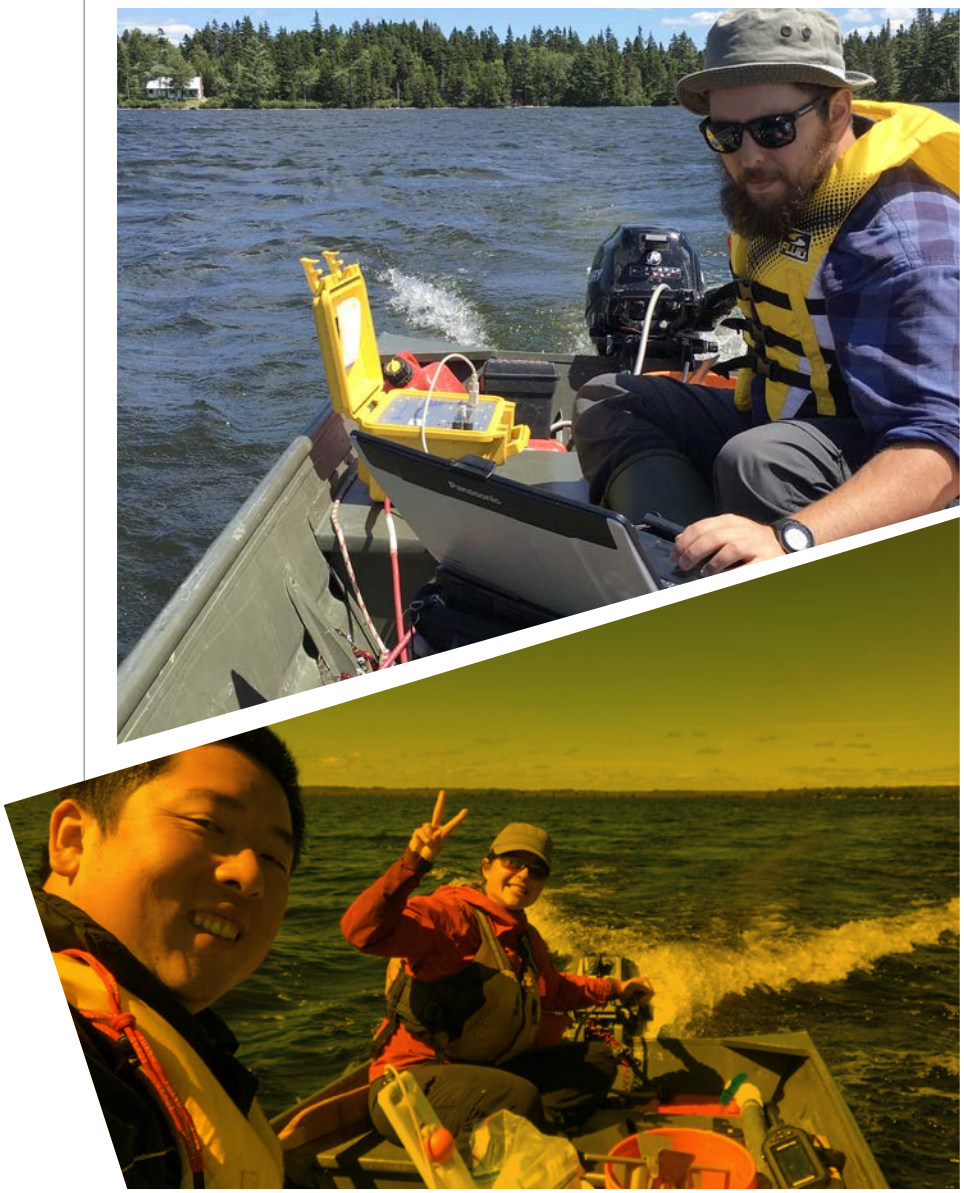


The LakePulse database is partially based on the design of the CHUASI ODM database (CHUASI - the Consortium of Universities for the Advancement of Hydrologic Science, Inc.). Part of the terminology was adopted to reflect LakePulse specifications.

We had several objectives for the early stage of development of the LakePulse database:

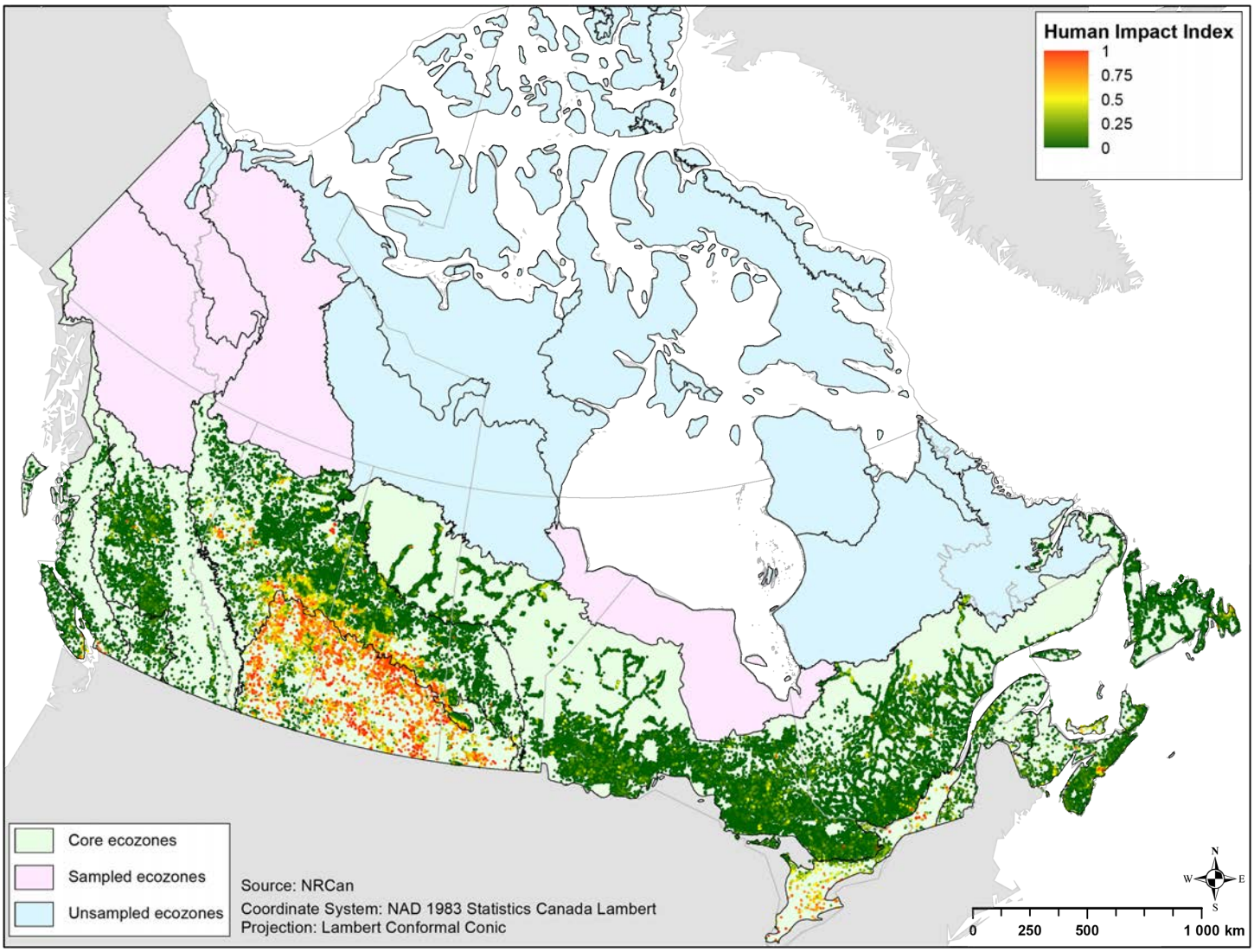
1. Eliminate data redundancy: identical data should not be stored in more than one place. Duplicate data could lead to inconsistencies.
2. Ensure data integrity and accuracy.
3. Normalise quality control data.

In LakePulse's second year, the database for the LakePulse Survey was fully set up: it includes capabilities for storing raw data, processed data and quality controlled data; and it includes the capacity to store metadata for all the steps of data collection and processing as well as quality control flags. Over the coming year, this database will be linked to other databases (e.g., geomatics, partner datasets) that are being developed.



Canadian Watershed Analysis

At our host institution, the Université de Sherbrooke, we have delineated 78,483 lake watersheds across Southern Canada, which we have characterized by land use and a human impact index. This new dataset will be further extended to more lakes.



Human impact in 78,483 lake watersheds in Canada

The index ranges from 0 (for the least impacted watersheds) to 1 (for the most impacted watersheds). In the map above, each point represents a lake and is coloured according to the human impact in its watershed.

LakePulse's human impact index is a simple measure that reflects the potential impact on lake health of agriculture, urbanization, forestry and industrial activities in lake watersheds. This index was designed to support the lake selection process for the LakePulse Survey.

LakePulse Watershed Analysis

This dataset will be a key tool to examine links between water quality indicators and watershed characteristics and will be used extensively by LakePulse researchers.

Regional comparisons

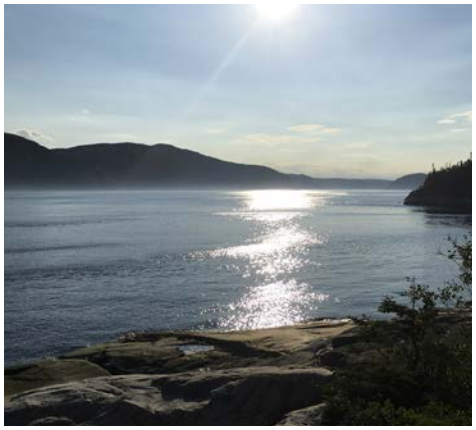
How does watershed and lake health vary across Canada ?

Links to lake health

How are lake and water quality observations linked to watershed characteristics?

A national perspective

What are the overall trends and how will they be affected by climate change, land use and pollution?



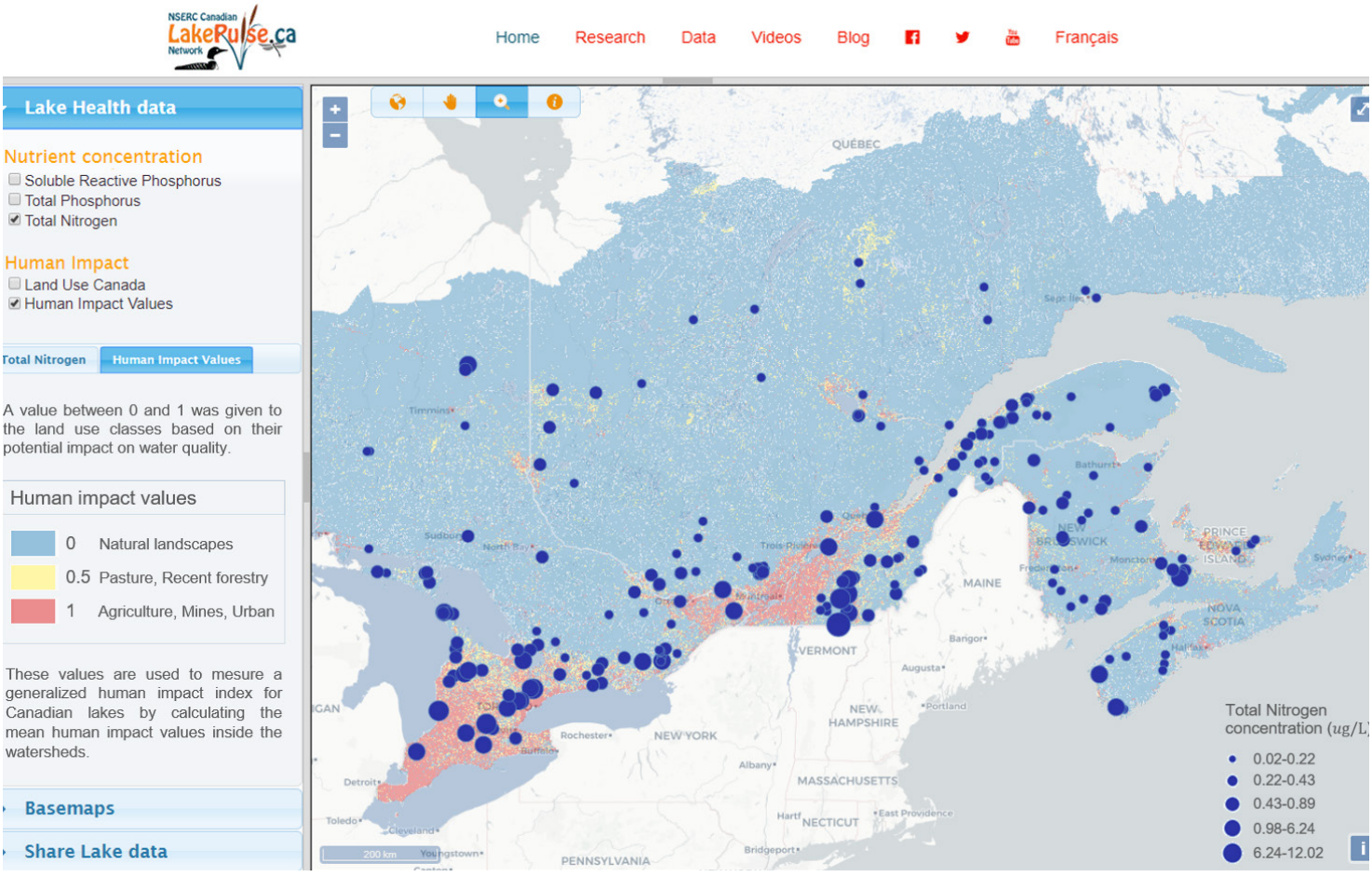
Lake health forecasts

How will lake health be impacted by changes in watersheds?

Stewardship Tools & Web Atlas

As part of our Web Portal, the LakePulse Stewardship Tools are being designed to support policy, planning and management decisions, and they will integrate data and information needed by decision-makers. There is an urgent demand for environmental stewardship tools that can also improve communicating information to politician's, policy makers, governments, First Nations, businesses, the non-profit sector and citizens.

In 2018, the first version of the LakePulse Web Atlas was produced with OpenLayers (version 4.6.5) web mapping interface software and the JQuery (version 1.10.2) library. GeoServer (version 2.13.0) map server software was used to broadcast Web Map Service layers. The LakePulse Web Atlas is currently deployed locally on a test environment and will eventually be migrated to a virtual server where it will be connected directly to the LakePulse database to reflect changes in real time. The figures below and on the next page show basic mapping tools for a preliminary version of the LakePulse Web Atlas.

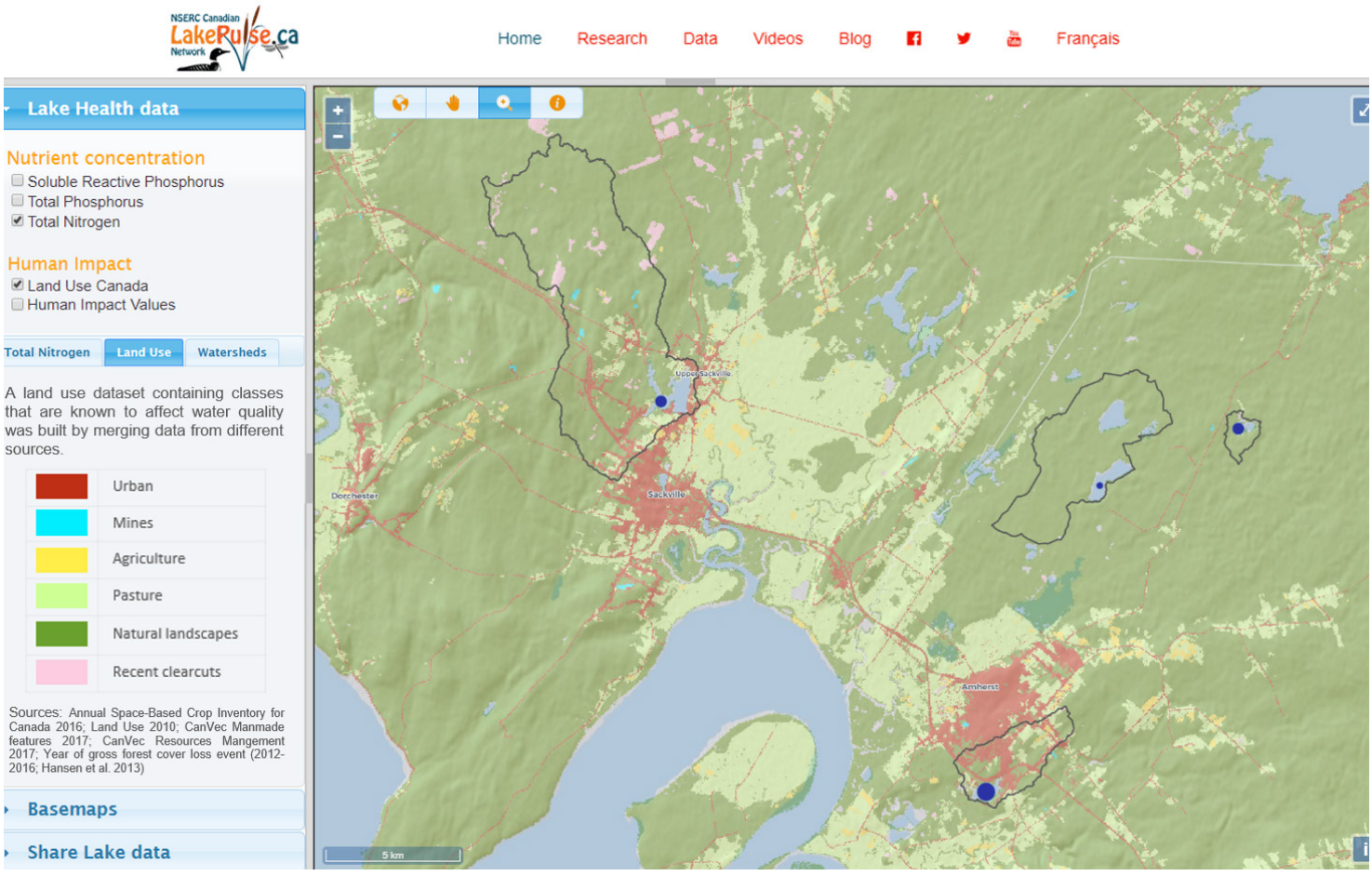


Addressing water information gaps

LakePulse addresses gaps between science and science policy by providing environmental data that is accessible and understandable. Pressures on Canada's freshwater resources are increasing and there is a pressing need to share knowledge to increase awareness and collaboration and to support informed management at all levels.

LakePulse was designed to provide deliverables needed by our government partners as they must provide adequate stewardship of lakes while facing increasing pressure from multiple stressors, but with limited resources for monitoring, analysis and interpretation.

We are making rapid progress with our web interface and national watershed analysis, and we are planning to consult with our partners and other groups on a beta-version of our Stewardship Tools for lakes that we are preparing to share at our Annual Network Meeting in November 2018, and throughout 2019.



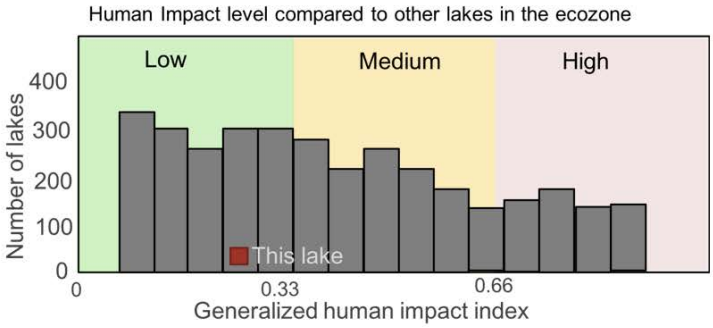
Practical Stewardship Tools for decision making

In LakePulse's second year, we continue to have many groups who contact us expressing their interest in our data products on lake and watershed health, such as lake associations, First Nations, provincial governments, community groups and individuals. In particular, groups would like to use information from the LakePulse Survey in their reports to monitor lake health and water quality, including for drinking water sources.

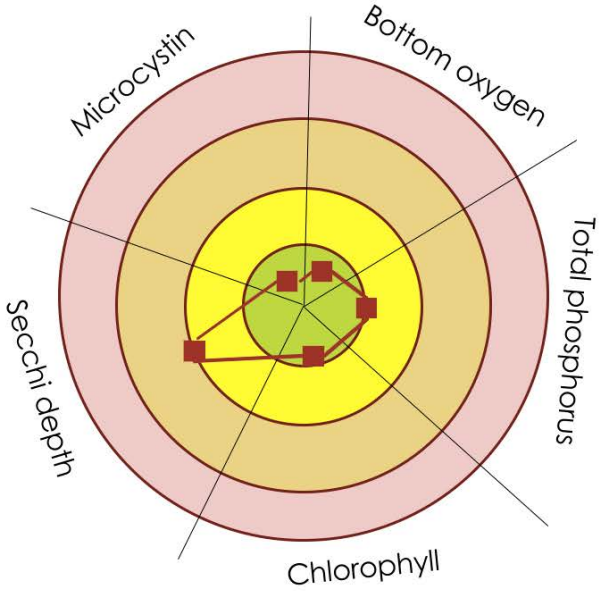
The interest and involvement of community groups, watershed organizations, lake associations, and other groups in our lake Stewardship Tools will help us to make key links between policy, research and monitoring. LakePulse aims to provide accessible and useful data to meet the practical needs of various groups and to contribute to policy discussions on protecting inland waters. We will do this by providing balanced and objective information to assist in understanding problems, alternatives, and solutions. The image below shows an example of a design for the interface we are planning for our automated lake health reports.

Elkwood Lake is a medium-sized, relatively deep lake in the Mixedwood Plains ecozone. Smaller and shallower lakes tend to be more susceptible to eutrophication. Elkwood Lake is, therefore, somewhat more resilient to changes.

The Mixedwood Plains ecozone is one of the most impacted ecozones in Canada. The graph below shows the distribution of human impacts in the ecozone.



Of the 5 variables used for our assessment of health (see health circle on the right), 4 in the index are in the 'very good' category while 1 is in the 'fair' category. We therefore consider this lake to be in very good health.



LakePulse health circle for Elkwood Lake

Environmental science literacy & public engagement

A common issue in policy discussions is the importance of informed stakeholders, and LakePulse can make a significant contribution by providing critical data on lake health. We are developing Stewardship Tools that are needed by individuals, groups and communities to support active involvement in lake health issues, at all levels of government. For example, our Stewardship Tools can be used at the community level to support and empower lake and watershed associations.

LakePulse aims to encourage and enable public engagement in lake health issues, which is important for increasing public interest in evidence-based decision making and freshwater policy implementation. Access to science, facts and evidence are critical to create a common ground of shared knowledge.

One of the central goals of the LakePulse Web Portal is to support education and engagement by presenting useful and understandable data at a time when freshwater issues are becoming increasingly complex in the context of a changing climate and more intense development. LakePulse seeks to increase accessibility to information and expertise.

The use of non-technical, plain language will help to communicate information to increase understanding of lake health issues. Better understanding can allow more meaningful participation and policy engagement.

Whether for collecting data, analyzing results, encouraging monitoring programs or making policy reforms, a better explanation of the role and nature of environmental science can contribute to better-informed discussions and more collaborative outcomes. Building public understanding and engagement in environmental management issues requires providing access to useful environmental information and supporting science literacy.

Engagement with Policy

The critical links between lake health data and policy span the federal, territorial, provincial, Indigenous and municipal levels of government as well as different community groups and non-governmental organizations. Freshwater management is challenging in Canada because various types of information need to be collected and evaluated but no government has full authority to regulate all aspects: each level of government can only regulate matters within its jurisdiction.

The need for data accessibility - provided in an understandable, unbiased way - for all stakeholders is at the root of evidence-based environmental assessment, policy making, management and monitoring. There is an urgent need for useful, accessible lake health information across multiple jurisdictions.

LakePulse has two major activities for policy engagement:

1. **Providing clear, well explained information on lake health to everyone - from the public to policy makers at all government levels - via our Web Portal, especially with expert-interpreted data and easy-to-understand health indexes.**

2. **Explaining the potential policy implications of our findings through policy briefs.**

These contributions will allow LakePulse to engage effectively to encourage evidence-based policies in Canada by filling a gap identified by many groups:

- In the Water Action Plan of the Canadian Council of Ministers of the Environment (CCME), the water priorities include improving the management of water quality and quantity for the benefit of human and ecosystem health. The CCME stresses the importance of developing **indexes and monitoring and reporting tools that can inform Canadian Water Quality Guidelines**.

- In its recommendations for the 2018 federal budget, the Green Budget Coalition suggested the development of **environmental data and science systems as a budget priority** (proposing $150M be invested over 5 years) to support environmental assessment and regulatory reforms.

- A recent survey of 146 lake associations across Canada initiated by Living Lakes Canada, the Gordon Foundation and WWF-Canada, identified **data management, communication, reporting, and interjurisdictional coordination** amongst their 5 most pressing needs to support community-based monitoring on which provinces are increasingly relying for their monitoring (e.g., Lake Partner Program in Ontario, Réseau Volontaire des lacs in Québec).

- The expert panel charged with reviewing the federal environmental assessment process (one of the three key federal laws on the protection of freshwaters in Canada) stressed the need to **improve access to unbiased, accurate, accessible and complete environmental information**.

- Across Canada, there are several groups that focus on freshwater governance issues, such as watershed-based planning and ecosystem-based legal reforms (e.g., Water Sustainability Project at the University of Victoria, the Council of Canadians, the Forum for Leadership on Water, West Coast Environmental Law, the Delta Dialogue Network at the University of Saskatchewan). These groups often include experts in water law, governance, policy and ethics with a focus on ecological function, healthy watersheds and stewardship. **An observation often repeated by these groups is that in order to advance legal and policy changes based on the principles of sustainability and ecological governance, a critical component is open accessibility to useful water data and information.**

Canada currently lacks adequate data on lake health and water monitoring as well as mapping tools needed for effective cumulative effects management and climate change risk mitigation

LakePulse was designed to address such problems of data accessibility with the goal of making credible, unbiased data and information available across jurisdictional boundaries via a multi-user Web Portal to share scientific information and fill important water information gaps while building collaborations with all levels of government, academia, NGOs and other groups.

LakePulse will provide access to environmental information interpreted by experts and in lay terms that is understandable by citizens. Through our Stewardship Tools integrated in the LakePulse Web Portal, we will present lake and watershed health issues for engagement, education and management decisions. These tools will likely spur further monitoring efforts and policy building efforts as various groups identify key information required for their stewardship efforts.

Building a model framework for storing and sharing water data

There is intense interest in improving access to environmental data but limited examples of operational frameworks. We hope that LakePulse can provide leadership and guidance for various groups interested in the development of interactive, geospatial databases for disseminating environmental data and information.

In order to do so, we decided to fast track the development of our Web Portal. This will allow more time for feedback and engagement from partners and citizens. For our Web Portal, we already have a web-ready system running internally (roughly two years ahead of our planned milestone) with basic functionalities (see the Stewardship Tools & Web Atlas section on pages 30-32).

LakePulse is developing transferable knowledge on how to develop a coordinated, collaborative, cost-effective and open data platform for lake and watershed data. The LakePulse platform will provide a model for other environmental databases, which is an area of intense and growing interest among governments (at all levels), water stewardship groups, industry and academia.

A unique and complementary role for the LakePulse Web Portal

Providing access to science-based data – such as maps of water quality and lake health indicators as well as regional comparative analyses – is a powerful tool that can influence policy and debate. These deliverables can have far reaching impacts on lake health issues that are of growing public concern. We are designing our Web Portal to go beyond maps, however, by providing interpreted data and interactive tools to communicate information to Canadians in an engaging and interactive style. As such, to reach our end-users, our Web Portal will be complementary to efforts occurring at different levels. At the local scale or lake level, it will support monitoring efforts by providing baseline data and information and the ability to conduct comparative analyses. This will support the many associations and consulting companies monitoring lake health across the country. At the national scale, it will be complementary to - and could in the future be integrated into - the Federal Geospatial Platform (FGP) that aims to openly distribute federal data from various departments and agencies. The interpreted data and interactive tools we will provide to explore lakes will provide additional - and fundamentally different - information that will not be available in the FGP.

In 2015, Canada signed on to the United Nations 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs), a set of 17 ambitious goals that address social and environmental issues from poverty to climate change. Statistics Canada has a key role in developing the UN SDG indicators in Canada. For Canada's SDGs to be reached concerning water quality and restoring and protecting freshwater ecosystems, there are concerns regarding the limited and sparse data. To meet the data challenges of the SDGs, LakePulse can help to provide information that is critical for the development of relevant national indicators and to establish national priorities. LakePulse is participating in consultations on proposed indicators and discussions of Canada's data holdings, and has been invited to give a presentation in June 2018 in Ottawa. A LakePulse researcher also gave an invited presentation at the launch of the Sustainable Development Solutions Network (SDSN) of Canada at the University of Waterloo in May 2018, and was a member of an expert panel.

By incorporating expert analysis, standardized protocols, national and international coordination, and expertise in data management and communicating/reporting for lake health issues, LakePulse is uniquely positioned to demonstrate an operational framework for managing open environmental data across Canada and a Web Portal to access useful and interpreted data. The LakePulse vision is to support positive engagement and informed management by fostering a common ground of shared knowledge. We are committed to consult with all levels of government and local end-users throughout the development of our Web Portal to ensure that it is optimized for their needs because this will maximize the potential for practical applications and engagement with policy.

Policy briefs as a way to provide 'policy ready' information

LakePulse plans to produce many publications in scientific journals, but generally they do not reach policy makers. While our Web Portal will provide understandable and interpreted data to fill broad information gaps, we will also produce concise policy briefs on targeted issues arising from our research. This will increase our ability to engage with policy by focusing on key findings with potential policy implications.

The science of LakePulse is focused on understanding lake health across Canada. The project leaders in our Network provide progress reports every 6 months. Beginning in our third year, the project reports will also require project leaders to identify current or expected findings that may have policy implications and the potential for producing policy briefs. Once the findings are available, Catherine Brown (LakePulse Manager) will then work with the project leaders and interested partners to prepare policy briefs.

LakePulse's goals for policy engagement can support key national policy priorities:

- Environmental impact assessment reforms
- Canada's biodiversity and protected areas targets
- Fish and other wildlife habitat protection and restoration
- Freshwater protection
- Reduction of environmental risks through assessment and regulation of toxic substances

Our policy briefs will also be useful for informing decision-making for territorial, provincial, municipal and Indigenous governments.

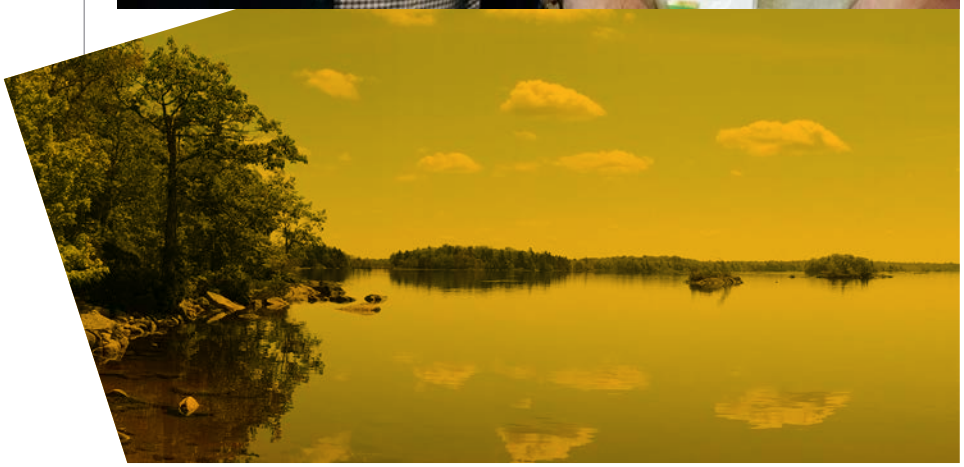
Collaboration and community building at the science-policy interface

LakePulse is expecting to make valuable contributions over the next three years and is already interacting with many people and groups who are active and concerned about lake health policy issues. This year, LakePulse continued to engage with important contacts who have extensive experience with work at the science-policy interface. For example, Jim Rusak is an Ontario Ministry of the Environment and Climate Change (MOECC) scientist involved in the Lake Partner Program (LPP) who is a Network collaborator and serves as a member of our Scientific Committee. The LPP is a concrete example of how data influences policy. The MOECC uses data collected by citizens to inform a provincial report card, with the data being used for local land-use planning and climate change initiatives. LakePulse is developing automated lake health reports available via our Web Portal based on our extensive lake sampling through the LakePulse Survey. Our reports will be complementary to the long-term monitoring by lake associations that is encouraged by the LPP.

We will continue to engage with umbrella organizations working at the policy interface who represent hundreds of lake associations such as FOCA and the British Columbia Lake Stewardship Society as well as NGOs such as Living Lakes Canada. Many of these groups are particularly interested in learning about our data management capabilities and Web Portal, and they are interested in disseminating our findings to their extensive communities and networks. This year, we also had the opportunity to develop relationships with First Nations communities who will allow us to sample lakes that are of particular importance for their communities.

Amina Pollard, the Coordinator of the Environmental Protection Agency's National Lakes Assessment (NLA), is an international member of our Scientific Committee. As an invited speaker at our Annual Network Meeting in 2017, she highlighted the online dashboard for their dataset. She is also working on ways for lake associations to compare local lake data to the vast NLA dataset. LakePulse is consulting with Amina as we develop our Web Portal for the LakePulse datasets.

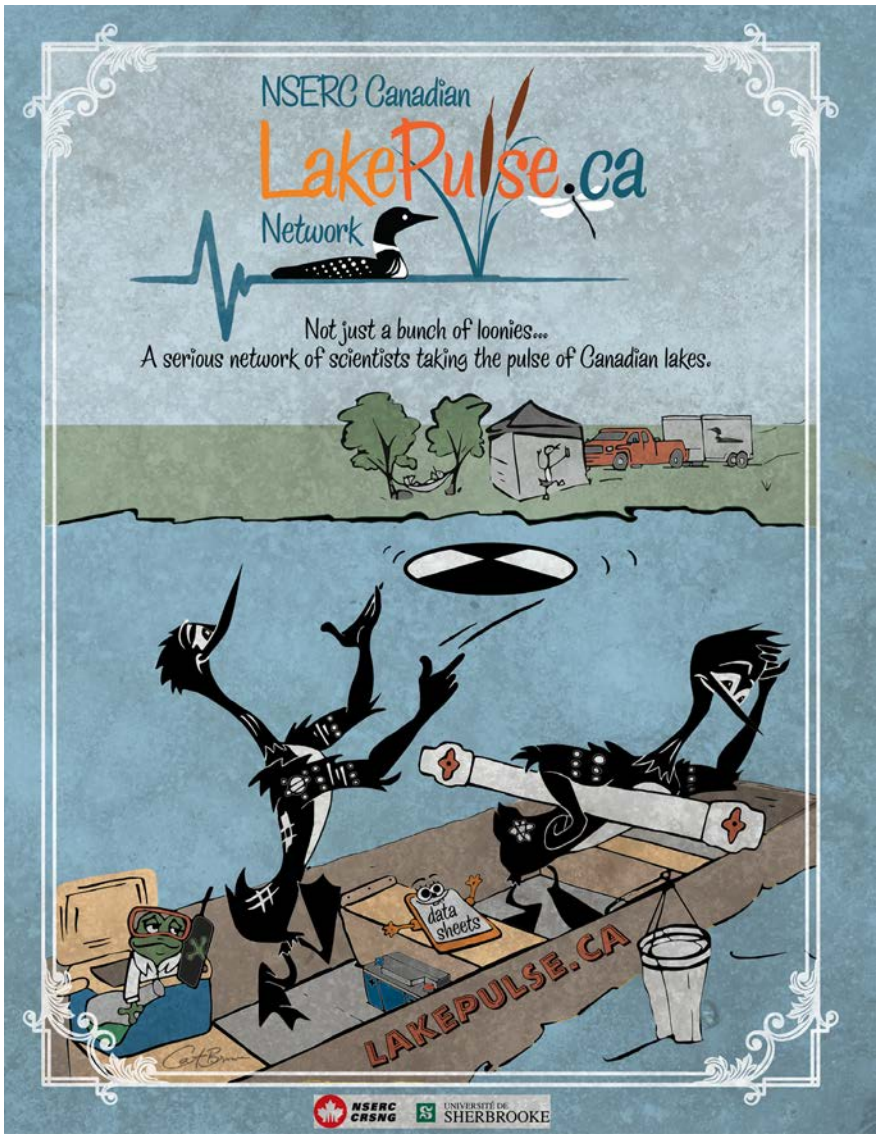
At our Second Annual Network Meeting in November 2017, one of our invited speakers was Terry Rees, the Executive Director of the Federation of Ontario Cottagers' Associations (FOCA), which represents hundreds of lake associations in Ontario. The LakePulse Director and Manager attended FOCA's Annual General Meeting in March 2018, which was also attended by a representative of the LPP. These relationships are particularly important for promoting our data products and communicating with key end-users who will use our Stewardship Tools to influence policy that affects lake health.



Communications & Outreach

Our Administrative & Specialist teams are on track with the communications and outreach milestones. Our Network Specialists are in constant communication with LakePulse researchers and HQP regarding field work, data, and geomatics information. The Administrative team has advanced broader communication with the public, lake associations, NGOs, and First Nations communities. We have also improved the communication between the Scientific Committee and project leaders through a more structured approach and more involvement from the theme leaders. We will continue to work closely with our partners and various organizations to identify how to best integrate scientific and technological advances into lake management, especially via our Web Portal and Stewardship Tools.

Over 300 handouts that explain in plain language the goals of the LakePulse Survey and our sampling activities were distributed by our field teams in 2017. Our field teams are encouraged to interact with the public and have become true ambassadors of LakePulse. They interact with curious citizens who stop by their laboratory-in-a-tent at lakes across Canada. Numerous lake associations, including those who met the field teams in 2017, have contacted LakePulse to request results from the LakePulse Survey for their lake associations, especially for their annual meetings. In response to this interest, we developed a questionnaire for our LakePulse Stewardship Tools. We presented our questionnaire at the Annual General Meeting of the Federation of Ontario Cottagers' Associations in March 2018. The field teams will also distribute the questionnaire to >200 lakeside communities & lake associations. It is also available on our website (lakepulse.ca/survey).

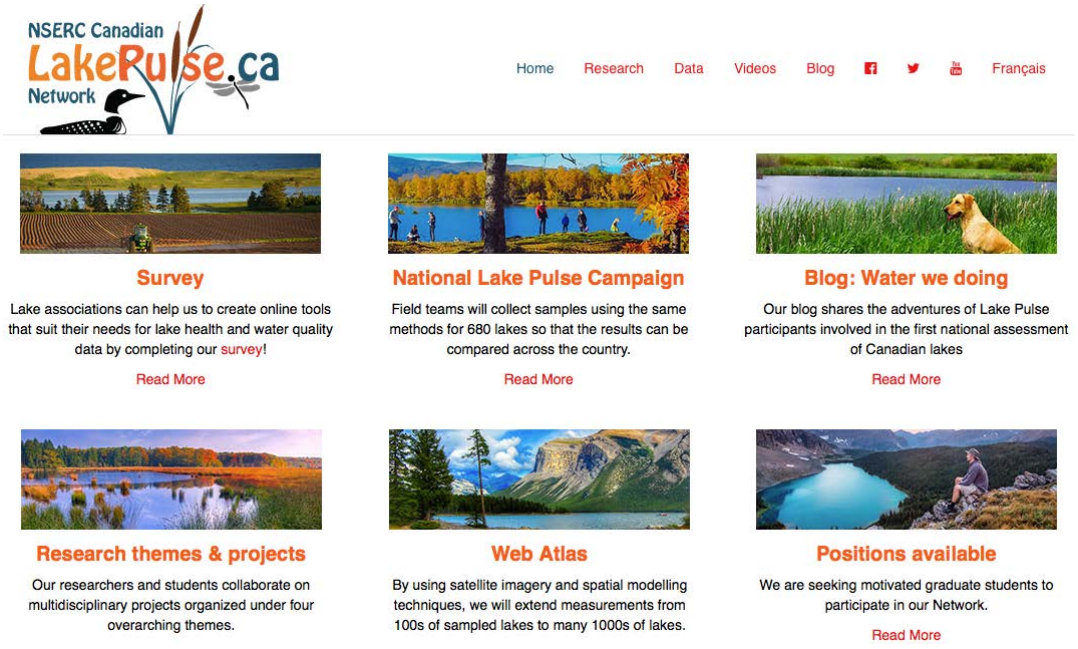


Central to our communications approach is our website (www.LakePulse.ca) where information is centralized and available in both official languages. It is being developed in distinct phases, and the first phase is soon coming to an end in 2018. The first goal of our communications strategy was to raise awareness of LakePulse and to explain our unique and complementary role. We have been using various approaches such as social media (Twitter and Facebook), YouTube videos, and our blog on our website with a subscription option.

The second phase is currently being developed with the goal of highlighting the researchers, HQP and research results. Information on the LakePulse Survey in 2018 has recently been added in addition to web pages for our HQP. The third phase will be the addition of our Web Portal for some of our key deliverables. We are now working on a 'beta' version of our Web Portal to support our outreach efforts and to foster feedback from within and outside the Network, which will contribute to the usefulness of our tools.

Outreach is vital in order for our deliverables to effectively engage with policy. For this reason, communicating and sharing our activities and outputs with diverse groups is an integral aspect of LakePulse. Many of our outputs, such as our interactive Web Atlas and Stewardship Tools are intended for a broad range of end-users.

Effective knowledge transfer involves ongoing discussions, developing relationships and understanding different perspectives. We are exceeding our original plans for outreach and seeking feedback from diverse groups, and this will be useful to improve our Web Portal and to address the fast-growing demand for well-organized, science-based data products to support decision makers and to support citizen involvement in environmental issues.



Administrative & Specialist Teams

The LakePulse Administrative & Specialist teams work under the supervision of the Director, Yannick Huot. Each team member brings specific strengths to this collaborative and high-performing group. Their teamwork, specialized skills and shared vision are central to the success of LakePulse.

They efficiently coordinate their work and have made excellent progress on many activities:

- Developing and managing key Network deliverables (e.g., LakePulse Survey, Web Portal, Database, Watershed Analysis, Stewardship Tools and Web Atlas).
- Ensuring that LakePulse activities are aligned to engage with policy issues, and making key links between policy, research and monitoring.
- Communicating progress to diverse audiences.
- Engaging with lake associations, First Nations, NGOs and watershed organizations.
- The Administrative Team works with governments, NGOs and diverse groups to align LakePulse expertise and deliverables with the need for lake and watershed health indicators as well as monitoring protocols and tools for analyzing environmental data.

Administrative Team: They are responsible for day-to-day administrative, organizational & financial matters, running of the Network, and organizing meetings. The Administrative team includes Yannick Huot (Director), Catherine Brown (Manager) and Université de Sherbrooke personnel.

Specialist Team: This group includes the Director and Manager and a group of research professionals who work on many activities for the benefit of the whole Network. Our Network specialists include a Database Specialist, a Field Coordinator and two part-time GIS Specialists.

The LakePulse core team is hosted at the Université de Sherbrooke

Brief biographies are provided in Appendix L

Director – Dr. Yannick Huot
Manager & Communications/Outreach/Policy – Dr. Catherine Brown
Database Specialist – Jelena Juric
Field Coordinator – Marie-Pierre Varin
GIS Specialists – Maxime Fradette & Geneviève Potvin (part-time)


Marie-Pierre
Varin


Geneviève Potvin


Yannick Huot


Catherine
Brown


OTTAWA
OUTAOUAIS


Jelena
Juric


Maxime
Fradette
SEQUOIA NATIONAL PARK
FORESTER PASS
ELEVATION 13,200 FT.

Management & Governance

The LakePulse Board of Directors has the overall responsability for management, direction and financial accountability and is accountable to NSERC. As such, all important decisions must be approved by the Board.

The Network Director, together with the Scientific Committee, coordinates the Network's research. He reports to the Board on all Network activities. The Director also supervises the Manager and Specialist team.

The Scientific Committee assists the Network Director in managing the scientific research program.

The Network Manager is in charge of day-to-day financial management and direction of Network operations, preparing reports, communications, public outreach and policy engagement.

An online reporting system is used to track the progress of research projects and their metrics. The project reports are reviewed at 6-month intervals by the Scientific Committee and Board:

- **Fall review:** This is a more formal review that occurs before the Annual Network Meetings. The Scientific Committee recommends to the Board whether the reports should be approved.
- **Spring review:** This is a shorter review that allows the Scientific Committee to identify if any issues have arisen that need to be resolved.

Annual face-to-face meetings in 2017

Each year, a face-to-face Board meeting is held the day following the Annual Network Meeting. This allows Board Members to attend the 2-day annual meeting. The Scientific Committee meets the day before the Annual Network Meeting, which members are expected to attend.

Board of Directors

Rick Butts (Chair, retired Director General, Agriculture and Agri-Food Canada)

Voting members
Vincent Aimez (VP Partnerships and Know. Transfer, UdeS)
Nicole Armstrong (Director, Manitoba Sustainable Development)
Kevin Cash (DG, Environment & Climate Change Canada)
Bill Donahue (Executive Director, Environmental Monitoring and Science Division , Alberta Environment and Parks)
John Downing (Director of Minnesota Sea Grant, Chair of SC)
Yannick Huot (Network Director, Université de Sherbrooke)
Roxanne Maranger (Professor, Université de Montréal)
Verena Tunnicliffe (Professor, University of Victoria)

Non-voting members
Samir Boughaba (Manager, NSERC)
Catherine Brown (Network Manager, Université de Sherbrooke)

Scientific Committee

John Downing (Chair, University of Minnesota)

Voting members
Beatrix Beisner (UQAM, Theme 2 leader)
Caren Binding (Environment & Climate Change Canada)
Paul del Giorgio (UQAM, Theme 1 leader)
Irene Gregory-Eaves (McGill, Theme 1 leader)
Marie-Josée Fortin (UofT, Theme 3 leader)
Daniel Hering (Universität Duisburg-Essen)
Yannick Huot (UdeS, interim Theme 4 leader)
Amina Pollard (US EPA)
James Rusak (MOECC)
Non-voting members
Catherine Brown (UdeS)

Administrative Centre

Yannick Huot (Network Director)
Catherine Brown (Network Manager)

Student Committee

Lisa Lahens (UdeS)
Cindy Paquette (UQAM)

Theme 1

Paul del Giorgio & Irene Gregory-Eaves (Theme leaders)
Yves Prairie (UQAM, Project 1.1 & 1.3 leader)
Paul del Giorgio (UQAM, Project 1.2 leader)
Helen Baulch (USask, Project 1.4 leader)
Hubert Cabana (UdeS, Project 2 leader)
John Smol (Queen's U., Project 3 leader)
Dave Walsh (Concordia, Project 4 leader)

Theme 2

Beatrix Beisner (Theme leader)
Andrew Lang (U. Memorial, Project 5 leader)
Yannick Huot (UdeS, Project 6.1 leader)
Dave Walsh (Concordia University, Project 6.2 leader)
Irene Gregory-Eaves (McGill University, Project 6.3 leader)

Theme 3

Marie-Josée Fortin (Theme leader)
Simon Bélanger (UQAC, Project 7 leader)
Marie-Josée Fortin (UofT, Project 8 leader)

Theme 4

Yannick Huot (interim Theme leader)
Roxanne Maranger (UdeM, Project 9 leader)
Rolf Vinebrooke (UofA, Project 10.1 leader)
Yannick Huot (UofA, interim Project leader 10.2 & 10.3)

Financial Summary 2017-2018

Much of the year-1 budget (Table 1, p. 48) was dedicated to materials and equipment for the LakePulse Survey and for salaries for the research professionals (RPs) and Network Manager. We provided a similar table in the Annual Report for year 1 (2016-2017) that was based on data available on May 11, 2017, for the Board meeting on May 24, 2017. Many of the largest expenses for the LakePulse Survey were thus not included in the table in the Annual Report for year 1 because they were spent in the last month of year 1 (for LakePulse, the financial year ends on June 30).

Table 1 (p. 48) presents all the expenses accrued in year 1. Not shown in this table (see accompanying footnote) is that there was $442 410 committed in orders for materials and instruments for the LakePulse Survey at the end of year 1, but these orders had not been received. As a result, $278 316 remained from the year-1 budget starting in year 2. These expenses are reported in year 2.

Table 2 (p. 49) presents the budget for year 2. This table was prepared with data available on April 11, 2018, for the Annual Report for year 2 (2017-2018), which was sent to NSERC on May 4, 2018. Overall, our spending is in line with the budgeted amounts. The differences are explained in the comments column of Table 2. The “Theme” sections show some differences for the budgeted amounts but they are not of concern as they arise from different start dates for the HQP; they will balance over the five years of the Network. There are two line items in the “Common Network Resources” section that we are keeping a close eye on: The “Materials and supplies” line may eventually show a surplus; and the “Field work” line (see year-3 forecast in Table 4, p. 51) may show a deficit over the five years. However, at this point, it is difficult to produce a better forecast than what is presented here.

Table 3 (p. 50) provides an overview of the year-1 and year-2 budgets. In particular, this table highlights that while much of the remaining funds from these years are expected to be used in the future, some savings were made in year 1 and year 2 that can be reassigned to other budget items. After the original Network proposal was submitted, postdoctoral fellows have unionized across the country, which has raised their salaries. We are therefore reassigning parts of our savings from year 1 and year 2 to increasing the postdoctoral fellowships (overall $61 423 is currently planned toward this, including $10 000 expected savings from the year-3 budget on the cost of our Annual Network Meeting). It would otherwise be very difficult to hire the number of post-docs planned originally as researchers would have to find very significant amounts of complementary funds.

We are also keeping funds saved from various past salaries (due to late start dates or sick leave, for example) for increasing the hours or extending the contracts of our Network Specialists. They are key to the Network's success and we will need as much time from them as possible in the future.

Finally, in theme 1 there is a recurrent saving (over 3 years) that comes from a change from the original proposal as a research professional is only required part-time instead of full-time. As previously approved by the Board of Directors, these funds are used to compensate for the higher than expected salary of the Network Manager, based on the proposal.

Table 4 (p. 51) shows the year-3 forecast for our budget. One point to note for the "Field work" line is that if the cost per lake is the same as last year it will exceed the planned budget (which was already slightly exceeded in year 2). However, the cost per lake is affected by many factors. For the LakePulse Survey in 2018, the travel, lodging and shipping costs are expected to be higher than in 2017, but there were some non-recurrent expenses included in the year-1 costs per lake that will be saved this year. As a result, we have kept the same estimate from the LakePulse Survey in 2017 of the per lake costs for our best estimate in 2018. An update on this item will be provided at the Board meeting in November 2018.

Tables 5, 6 and 7 (p. 52 to 54) show the Université de Sherbrooke's cash contributions. There is not much to add to these tables as the funds are generally used as originally planned in the proposal.

Table 8 (p. 55) shows that the contribution from Ouranos for year 2 is expected to be spent by the end of year 2, pending the approval by MITACS of the scholarship.

Table 1: Budget Overview for Year 1 (1 July 2016 - 30 June 2017)

NSERC contribution

Activity	Description	Budgeted	Spent	Difference	Comments on difference
Network administration	Conferences	26 118	10 622.02	15 495.98	Fewer participants from away and more local participants than expected participated in the AGM. Costs per participant were generally lower than expected. Some participants did not ask for reimbursements. No travel to EPA as this was unnecessary with Amina Pollard on our Scientific Committee.
Network administration	Technical/professional assistants (Brown)	52 481	50 099.97	2 381.03	Annual salary of Network Manager is higher than budgeted, but she was hired later than planned.
International strategy	Conferences	5 824	2 487.40	3 336.6	Only one participant instead of 2 traveled to the EPA training due to our Field Coordinator's (Varin) sick leave.
Common Network Resources	Materials and supplies	328 816	52 711.68	276 104.32	The budgeted amounts included orders for materials for Yr2 & Yr3 which were not spent in Yr1.
Common Network Resources	Equipment or facility - Purchase or rental	386 540	7 089.23	379 450.77	Two orders are being prepared. Some funds will be reallocated to "Operation and maintenance costs" instead of "purchase and rental".
Common Network Resources	Students	6 643	12 350.74	-5 707.74	Undergraduate interns started in Yr1 instead of Yr2.
Common Network Resources	Technical/professional assistants (3 RPs)	106 409	68 687.42	37 721.58	RPs started late and savings occurred due to Varin's sick leave.
Theme 1	Materials and supplies	5 000	0	5 000	Due to late student start, no funds were transferred in Yr1 for students.
Theme 1	Students	30 367	1953.31	28 413.69	Due to late student start, only about a month of salary was paid.
Theme 1	Technical/professional assistants	0	53 342.00[1]	-53 342	Transfer for RP starting in Yr2 sent at the end of Yr1 to allow start.
Theme 2	Materials and supplies	2 500	0	2 500	Due to late student start, no funds were transferred in Yr1 for students.
Theme 2	Students	15 184	3495.50	11 688.5	Due to late student start, no funds were transferred in Yr1 for students.
Theme 3	Materials and supplies	3 750	1 250[1]	2 500	Due to late student start, funds for only 1 student were used in Yr1 for students.
Theme 3	Postdoctoral fellows	15 184	0.00	15 184	Postdoc did not start in Yr1 as planned.
Theme 3	Students	15 184	15 184.00[1]	0	
	Totals	**1 000 000**	**279 273.27**	**720726.73[2]**	

1. Funds transfer to other universities from Université de Sherbrooke. We consider here the funds transferred to other universities as an expense to the budget. This is consistent with the expectation that all funds will be spent by the universities where the transfer is sent. Since other universities report after the annual report is due, this is our best estimates of the expenses. In these three cases, we are certain that these funds were spent by the end of Yr2.
2. At the end of Yr1, there was $442 410.40 that was committed but not paid, such that there was $278 316.33 available.

Table 2: Budget Overview for Year 2 (1 July 2017 - 30 June 2018)

NSERC contribution

Activity	Description	Budgeted	Spent by 04/11	Committed by 04/11 (forecast to 06/30)	Difference	Comments on difference
Network administration	Conferences	50 157	16 857.12	(6 344)	26 955.88	Annual, Board and SC meetings cost $9787.88 less than expected. Students haven't started traveling to partners labs ($17 168K saved for following years). Forecast for the field campaign training workshop as budgeted.
Network administration	Technical/professional assistants - Brown	65 811	63 400.93	19 352	-16 941.93	Salary is higher than estimated in proposal.
International strategy	Conferences	50 686	0	0	50 686	Student visits to international labs have not started (~$40K budgeted). Participation to IOCCG course will be in Yr3.
Common Network Resources	Materials and supplies	251 487	109 084	70 728 + (25 000)	46 675	Fewer lakes than planned in Yr1; not all analyses of samples are completed.
Common Network Resources	Equipment or facility Purchase or rental	0	341 405.47	7 550.14	-348 955.61	These purchases were planned in the Yr1 budget but were paid in Yr2.
Common Network Resources	Students	33 671	42 929.99	1 618.98 + (3 000)	-13 877.97	More students than expected participated in the field campaign.
Common Network Resources	Technical/professional assistants - 3 RPs	115 203	98 444.80	14 806.19 + (8 000)	-6 047.99	A few external RPs participated in the field campaign.
Common Network Resources	Dissemination	1 250	0	0	1 250	
Common Network Resources	Field work	192 024	160 117.65	(50 000)	-18 093.65	Fewer lakes than planned in Yr2; there will be more than planned in Yr3; cost per lake in Yr2 was $884.90. Includes some Yr3 campaign costs expended in year 2.
Theme 1	Materials and supplies	1 250	4 758.63	(1 250)	-4 758.63	
Theme 1	Students	75 918	44 171.14	6 183.96 + (14 434)	11 128.9	Delayed student start date.
Theme 1	Technical/professional assistants	151 957	60 917.92	2 000	89 039.08	Used Yr1 funds to pay for Yr2; one RP has a lower salary than budgeted.
Theme 2	Materials and supplies	2 500	3750	0	-1 250	Delayed student start date.
Theme 2	Students	60 734	36 367.13	832.52	23 534.35	MSc student recruited instead of PhD; delayed student start date.
Theme 3	Materials and supplies	1 250	1 335.31	0	-85.31	
Theme 3	Postdoctoral fellows	30 367	0	0	30 367	Delayed postdoc start date.
Theme 3	Students	30 551	3 785.54	3 494.34	23 271.12	
Theme 3	dissemination	1 250	0	0	1 250	Delayed postdoc start date.
Theme 4	Materials and supplies	1 250	0	0	1 250	
Theme 4	Students	7 684	0	(7 684)	0	Delayed student start date.
	Totals	**1 125 000**	**987 325.63**	**242 278.13**	**-104 603.76**	

Table 3: Budget Overview for End of Year 2 & Expected Available Funds

NSERC contribution

Activity	Description	Year 1 funds from Table 1	Year 2 funds from Table 2	Year 1 + Year 2 available funds	Funds saved from previous activities (can be reassigned)	Funds from Yr1 & Yr2 that will be used in future years on intended usage as activities were delayed or modified	Comments
Network administration	Conferences	15 495.98	26 955.88	42 451.86	28 083.86[1]	14 368.00	
Network administration	Technical/professional assistants - Brown	2 381.03	-16 941.93	-14 560.9	0	0	Expect deficit each year on this line.
International strategy	Conferences	3 336.6	50 686	54 022.6	3 336.6[1]	50 686	
Common Network Resources	Materials and supplies	276 104.32	46 675	322 779.32	20 000[1]	302 779.32	
Common Network Resources	Equipment or facility Purchase or rental	379 450.77	-348 955.61	30 495.16	0	30 495.16	
Common Network Resources	Students	-5 707.74	-13 877.97	-19 585.71	0	0	Expect to be balanced with Yr3 & Yr4 budget.
Common Network Resources	Technical/professional assistants - 3 RPs	37 721.58	-6 047.99	31 673.59	31 673.59[2]	0	
Common Network Resources	Dissemination	0	1 250	1 250	0	1 250	
Common Network Resources	Field work	0	-18 093.65	-18 093.65	0	0	
Theme 1	Materials and supplies	5 000	-4 758.63	241.37	0	241.37	
Theme 1	Students	28 413.69	11 128.9	39 542.59	0	39 542.59	
Theme 1	Technical/professional assistants	-53 342	89 039.08	35 697.08	35 697.08[3]	0	
Theme 2	Materials and supplies	2 500	-1 250	1 250	0	1 250	
Theme 2	Students	11 688.5	23 534.35	35 222.85	0	35 222.85	
Theme 3	Materials and supplies	2 500	-85.31	2 414.69	0	2 414.69	
Theme 3	Postdoctoral fellows	15 184	30 367	45 551	0	45 551	
Theme 3	Students	0	23 271.12	23 271.12	0	23 271.12	
Theme 3	dissemination	0	1 250	1 250	0	1 250	
Theme 4	Materials and supplies	0	1 250	1 250	0	1 250	
Theme 4	Students	0	0	0	0	0	
	Totals	**720 726.73**	**-104 603.76**	**616 122.97**	**118 791.13**	**549 572.10**	

1. Will be put toward increasing the post-doctoral scholarships
2. Will be kept for future years to increase professionals' hours or contract lengths
3. Will used to pay for the difference in the Network manager's salary compared to budgeted in proposal.

Table 4: Budget forecast for Year 3 (1 July 2018 - 30 June 2019)

NSERC contribution

Activity	Description	Budgeted	Forecast	Difference	Comments on difference
Network administration	Conferences	55 170	45 170	10 000	The difference is in line with the previous year's savings on the annual meeting.
Network administration	Technical/professional assistants - Brown	68 772	84 415	-15 643	Salary difference offset by Theme 1 RPs' lower costs.
International strategy	Conferences	75 750	75 750	0	
Common Network Resources	Materials and supplies	149 191	300 000	-150 809	
Common Network Resources	Equipment or facility Purchase or rental	0	20 000	-20 000	
Common Network Resources	Students	27 028	20 000	7 028	
Common Network Resources	Technical/professional assistants - 3 RPs	120 985	120 985	0	
Common Network Resources	Dissemination	0	0	0	
Common Network Resources	Field work	137 592	155 297	-17 705	This is the expected cost of 232 lakes at $884.90 per lake minus the $50K spent in Yr2 for Yr3 campaign.
Theme 1	Materials and supplies	6 250	6 250	0	
Theme 1	Students	121 469	121 469	0	All students are expected to be recruited.
Theme 1	Technical/professional assistants	156 472	125 000	31 472	
Theme 1	Dissemination	5 000	2 500	2 500	Delayed by late student start date.
Theme 2	Materials and supplies	2 500	2 500	0	All students are expected to be recruited.
Theme 2	Students	91 102	91 102	0	All students are expected to be recruited.
Theme 2	Dissemination	2 500	0	2 500	Delayed by late student start date.
Theme 3	Materials and supplies	0	0	0	
Theme 3	Postdoctoral fellows	15 184	15 184	0	
Theme 3	Students	30 551	30 551	0	All students are expected to be recruited.
Theme 3	dissemination	2 500	0	2 500	Delayed by late student start date.
Theme 4	Materials and supplies	3 750	3 750	0	All students are expected to be recruited.
Theme 4	Students	53 234	53 234	0	All students are expected to be recruited.
	Totals	**1 125 000**	**1 257 407**	**-148 157**	

Table 5: Budget Overview for Year 2 (2017-2018)
Université de Sherbrooke contribution

Description	Description	Year 2 Budgeted	Spent by 04/11	Committed by 04/11 (forecast to 06/30)	Difference	Comments on difference
Common Network Res.	Conferences	2 800.00	2 096.62	0	703.38	
Common Network Res.	Student	15 000	8 071.81	(3 125)	3803.19	
Common Network Res.	Technical/prof. assistants	50 000	42 041.23	7958.77	0	
Common Network Res.	Equipment	6 666	636.28	(6029.72)	0	
Theme 3	Students	15 000	0	0	15 000	**Student started later**
	Totals	**89 466**	**52 845.94**	**17 113.49**	**19 506.57**	

Table 6: Year 2 Expected Available Funds
Université de Sherbrooke contribution

Description	Description	Year 1 funds	Year 2 funds from Table 5	Year 1 + Year 2 available funds	Funds saved from previous activities (can be reassigned)	Funds from Yr1 & Yr2 that will be used in future years on intended usage as activities were delayed or modified	Comments
Common Network Res.	Conferences	171.91	703.38	875.29	875.29	0	Kept for future conference guests.
Common Network Res.	Student	0.00	3803.19	3 803.19	0.00	3 803.19	
Common Network Res.	Technical/prof. assistants	0.00	0	0	0.00	0.00	
Common Network Res.	Equipment	0.00	0	0	0.00	0.00	
Theme 3	Students	0.00	15 000	15 000	0.00	15 000	
	Totals	**171.91**	**19 506.57**	**19 678.48**	**875.29**	**18 803.19**	

Table 7: Year 3 Forecast
Université de Sherbrooke contribution

Description	Description	Budgeted	Forecast	Difference
Common Network Res.	Conferences	2 800	2 800	0
Common Network Res.	Student	15 000	15 000	0
Common Network Res.	Technical/prof. assistants	50 000	50 000	0
Common Network Res.	Equipment	6 667	6 667	0
Theme 3	Students	15 000	15 000	0
	Totals	**89 467**	**89 467**	**0**

Table 8: Budget Overview for Year 2 (2017-2018)

Ouranos contribution

Description	Description	Year 1 funds	Proposal Budget	Year 2 budget	Difference	Comments on difference
Theme 4	Students	0.00	7 500	(7500)	0.00	Will be spent by the end of year 2 pending MITACS scholarship approval (expected).
	Total		**7 500**	**(7 500)**	**0.00**	

Appendix A: Partners, supporting partners and proposed partners pending approval

Partner	Starting date – current status
Environment and Climate Change Canada	Founding Partner – current partner
Environment and Natural Resources (Government of Northwest Territories)	Founding Partner – current partner
Environmental Monitoring and Science Division (Government of Alberta)	Founding Partner – current partner
Environmental Protection Division (Ministry of Environment - Province of British Columbia)	Founding Partner – current partner
Ministère du Développement Durable, de l'Environnement et de la Lutte contre les Changements (Québec)	Founding Partner – current partner
Ontario Ministry of the Environment and Climate Change	Founding Partner – current partner
Ouranos Consortium	Founding Partner – current partner
Public Health Agency of Canada	Founding Partner – current partner
Department of Municipal Affairs and Environment (Government of Newfoundland and Labrador)	Founding partner changed status to "supporting organization"
New Brunswick Department of Environment and Local Government	Partner added in Year 1 – current partner
Yukon	Partner added in Year 1 – current partner
IISD-Experimental Lakes Area	Recommended by the Scientific Committee Pending approval by the Board

Appendix B: List of Partner Collaborators

Name	Affiliation	Position	Role
Caren Binding	Environment and Climate Change Canada	Scientist	Partner Scientist, SC Member
Stéphanie Brazeau	Public Health Agency of Canada	Scientist	Partner Scientist
Don Fox	State of the Environment (NB)	Scientist	Partner Scientist
Antoinette Ludwig	Public Health Agency of Canada	Scientist	Partner Scientist
Nicholas Ogden	Public Health Agency of Canada	Scientist	Partner Scientist
Louis Roy	Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques	Scientist	Partner Scientist
James Rusak	Ontario Ministry of Environment and Climate Change	Scientist	Partner Scientist, SC Member
Mike Sokal	Environmental Protection Division (B.C. Ministry of Environment)	Environmental Impact Assessment Biologist	Partner Scientist
Gila Somers	Northwest Territories Department of Environment and Natural Resources	Watershed Management Advisor	Partner Scientist
Ron Zurawell	Alberta's Environmental Monitoring and Science Division	Scientist	Partner Scientist

Appendix C: Partner Contributions

Partner	Expected contribution (Yr 2)	Received contribution (Yr2)	Comments
Environment and Climate Change Canada	$17 000 (staff time)	-$13 430 (staff time) + $5000 (instrument loans) -Kevin Cash sits on the BOD.	Caren Binding is participating in the SC and attends Annual Network Meetings. She is involved at all levels of science, including starting student co-supervision. -Undergraduate student intern at ECCC participated in the field with LakePulse (yr 2). -Provided optical instrument ac9, hyperpro & HS2.
Environment and Natural Resources (Government of Northwest Territories)	10 days of staff time ($3000)	-Estimate yet to be received. -Gila Somers sits on the conflict of interest committee.	Gila Somers is an active participant and participated in the Annual Network Meeting. Participation will greatly increase next year as we sample in the Northwest Territories.
Environmental Monitoring and Science Division (Government of Alberta)	$40 000	-Estimate yet to be received; will be lower than estimated as Division cannot commit as much personnel as expected to support field campaign. -Bill Donahue sits on the BOD.	Ron Zurawell and his team participated in the Annual Network Meeting and helped with data questions. He has spent many days working with the Specialist team on lake selection and preparing the data shared with the Network
Environmental Protection Division (Ministry of Environment - Province of British Columbia)	$1600	$1600	Mike Sokal has been closely involved working with the Specialist team on the lake selection and helped with orienting the LakePulse Survey in BC.
Ministère du Développement Durable, de l'Environnement et de la Lutte contre les Changements (Québec)	$33,200	$7000 (expected contribution going forward)	Louis Roy and his team have been extremely active within the Network spending considerable time and resources to help with lake selection and all aspects of preparation for the field campaign, as well as participation in the Annual Network Meeting, interaction with co-PIs, contributing additional TP sample analyses for the campaign.

Ontario Ministry of the Environment and Climate Change	$5500	$5500	Jim Rusak is very active in the Network and sits on the SC.
Ouranos Consortium	$7500 cash $9000 in kind	Expected $7500 cash before the end of year 2. $4000 in kind	Robert Siron participates actively in the Annual Network Meetings and Project 9. Initial interaction with the climate modeling groups. Ouranos will contribute in cash more than expected next year as they will provide a MITACS post-doc scholarship contribution instead of a doctoral scholarship.
Public Health Agency of Canada	$35,000	60 h (approximately $5000) -Providing instrument for field work.	Many meetings on recruitment of students. Co-supervising two students starting in fall 2017. Participation of 3 members in the Annual Network Meeting. Time commitment will increase rapidly with start of co-supervision
Department of Municipal Affairs and Environment (Government of Newfoundland and Labrador)	N/A	Many hours of personnel contribution	We have received support and help with lake selection, itineraries and logistics.

Appendix D: List of Co-PIs

Name	Affiliation	Position
Dermot Antoniades	Université Laval	Professor
Beatrix Beisner	Université du Québec à Montréal	Professor
Helen Baulch	University of Saskatchewan	Professor
Simon Bélanger	Université du Québec à Rimouski	Professor
Hubert Cabana	Université de Sherbrooke	Professor
Jeffrey Cardille	McGill University	Professor
Paul del Giorgio	Université du Québec à Montréal	Professor
Marie-Josée Fortin	University of Toronto	Professor
Irene Gregory-Eaves	McGill University	Professor
Yannick Huot	Université de Sherbrooke	Professor
Andrew Lang	Memorial University	Professor
Isabelle Laurion	INRS-ETE	Professor
Roxane Maranger	Université du Montréal	Professor
Yves Prairie	Université du Québec à Montréal	Professor
John Smol	Queens University	Professor
Rolf Vinebrooke	University of Alberta	Professor
David Walsh	Concordia University	Professor

Appendix E: LakePulse Research Projects

Theme# (leader)	Project# (leader) *Project title*	Evaluation by Scientific Committee in April 2018
1 (Gregory-Eaves and del Giorgio)	1.1 (Prairie) *Carbon gas fluxes, concentration and isotopic signature in Canadian lakes*	On track
1 (Gregory-Eaves and del Giorgio)	1.2 (del Giorgio) *Biogeochemical drivers of carbon sinks, greenhouse gas fluxes, and nutrient regeneration – Patterns in lake metabolism and organic C dynamics*	On track Protocol for oxygen measurements has been improved.
1 (Gregory-Eaves and del Giorgio)	1.3 (Prairie) *In-lake carbon modelling in Canadian lakes*	Recruitment of PhD3 is late. The SC recommends a hiring deadline of Sept. 30, 2018, so that the PhD project remains within the lifetime of the Network.
1 (Gregory-Eaves and del Giorgio)	1.4 (Baulch) *Sediment phosphorus characterization across Canadian lakes*	On track, but details on the analytical plan have been delayed and are expected in April 2018. Samples are being processed but some delays.
1 (Gregory-Eaves and del Giorgio)	1.5 (Cardille) *?* *(In March and April 2018, the project topic has been shifting.)*	2 HQP (PDF1 & PhD17) supervised by Cardille have similar projects (see Project 7 on next page)
1 (Gregory-Eaves and del Giorgio)	2 (Cabana) *Fate and behaviour of contaminants of emerging concern in Canadian lakes*	On track
1 (Gregory-Eaves and del Giorgio)	3 (Smol) *Changes in Canadian lakes over the Anthropocene; which lakes are susceptible to different stressors*	On track
1 (Gregory-Eaves and del Giorgio)	4 (Walsh) *Linking genetic and microscopic approaches to reconstruct historical conditions of lake ecosystems*	On track
2 (Beisner)	5 (Lang) *Microbial contamination in Canadian lakes – risks for human and animal health*	On track New protocols for field incubations because of perishable samples.

Appendix E: LakePulse Research Projects (continued)

2 (Beisner)	6.1 (Huot) *Understanding the information obtained from the "one-shot" large-scale sampling of lakes (LSSL) using the autonomous mooring data*	Project starts in 2019
2 (Beisner)	6.2 (Walsh) *Assessment of anthropogenic influences on the structure and function of plankton communities across the lakes of Canada*	On track; delays in processing the taxonomy samples should not impact HQP progress.
2 (Beisner)	6.3 (Gregory-Eaves) *Cyanobacteria distribution and dynamics*	On track
3 (Fortin)	7 (Bélanger) *Remote sensing as direct observation of lakes water quality and information on land use*	On track, except 2 HQP (PDF1 & PhD17) supervised by Cardille have similar projects (see Project 1.5)
3 (Fortin)	8 (Fortin) *Spatial modelling as a tool to integrate results*	On track; the project leader says that she only needs 1 of the 2 postdocs planned for this project
4 (Huot interim)	9 (Maranger) *What biophysical features package aquatic ecoservice bundles and how do these bundles change across Canada?*	On track
4 (Huot interim)	10.1 (Vinebrooke) *Forecasting the cumulative impacts of human and natural environmental change on the functioning of Canadian lake ecosystems*	Recruitment of PhD20 is late. The SC recommends a hiring deadline of Sept. 30, 2018, so that the PhD project remains within the lifetime of the Network.
4 (Huot interim)	10.2 Proposed integration and forecasting project (see "Proposal for reorganizing theme 4.pdf")	The Scientific Committee reviewed the "Proposal for reorganizing theme 4" and recommends the proposal for approval by the Board.
4 (Huot interim)	10.3 (Huot) Forecasting future states of lakes	On track
Network project	Network project (Huot) Enable national-scale citizen scientist monitoring of lake health via the "Lake Observer" app	On track The project was adjusted to avoid redundancy with existing mobile apps and to better suit the opportunities with the LakePulse Web Portal.

Appendix F: Highly Qualified Personnel (HQP) Status. Red the HQP was expected but not present. Green the HQP was expected to be and is present. Yellow, the HQP is expected to start but no HQP is identified. Gray the planned HQP study/work period. Green text, in a white square represents HQP who are present (or expected to be present) before he/she was expected to start.

Theme / project	HQP & RP	Supervisor (project collaborators)	Year six month intervals (start month·end month)									
			2016	2017		2018		2019		2020		2021
			07·12	01·06	07·12	01·06	07·12	01·06	07·12	01·06	07·12	01·06
N§	15 BSc	Sampling team leaders and RPs			5		5		5			
N§	RP1	Huot		Potvin/ Fradette								
N§	RP2	Huot		Juric								
N§	RP3	Huot		Varin								
N§	MSc1	Huot		Juric								
1 / 1	PhD1	Prairie (del Giorgio)			Kim							
1 / 1	PhD2	del Giorgio (Prairie, Solomon)			Shahabinia							
1 / 1	PhD3	Prairie or del Giorgio (Solomon)										
1 / 1	PhD4	Baulch (Maranger, Leavitt, Engstrom)		Mauro								
1 / 1	PDF1	Cardille (Solomon, del Giorgio, Fortin, Laurion)										
1 / 2	PhD5	Cabana (Barcelo)		Lahens								
1 / 2	PhD6	Walsh (Cabana, Lang) *proposed switch to PDF (Kraemer)					Kraemer					
J1 / 2	PhD7	Cabana (Barcelo, Bélanger)					Teyssseire					
1 / 2	RP4	Cabana			Dion-Fortier/ Barry							
1 / 3	RP5	Smol (G.-Eaves, Antoniades, Fortin)			Jeziorski							
1 / 3	RP6	G.-Eaves (Antoniades, Smol, Fortin)			Griffiths							
1 / 3	MSc2¶	Smol (G.-Eaves, Antoniades)						Simmatis				
1 / 3	MSc3¶	G.-Eaves (Antoniades, Smol) *(PhD)*						Baud				
1 / 3	MSc4¶	Antoniades (Smol, G.-Eaves)										
1 / 4	PhD8	Walsh (G.-Eaves) *proposed switch to MSc who is likely to change to PhD program					Garner					

Appendix F: Highly Qualified Personnel Status (continued)

2 / 5	PhD9	Lang (Ramey) *proposed switch to MSc who is likely to change to PhD program			Wight							
2 / 5	PhD10*	Lang (Ogden, Ludwig, Turgeon)		Oliva								
2 / 6	MSc5	Huot (Baulch, Solomon)										
2 / 6	PhD11	Beisner (G.-Eaves, Smol, Leavitt)		Paquette								
2 / 6	PhD12	G.-Eaves (Pick, Beisner, Smol, Leavitt, Antoniades, Taranu)					MacKeigan					
2 / 6	PhD13	Huot (Beisner, G.-Eaves, Cabana, Vinebrooke)					Cremella					
2 / 6	PhD14	Walsh (Beisner, Huot)				Onana						
2 / 6	PDF2	Beisner (Walsh, Huot)										
3 / 7	PhD15	Huot (Cardille, Bélanger, Hunter)				Potvin						
3 / 7	PhD16	Laurion (Bélanger)		Goubet								
3 / 7	PhD17	Cardille (Bélanger, Huot)										
3 / 7	PDF3	Belanger (Huot, Cardille, Antoine, Lubac)					Pan					
3 / 8	PDF4	Fortin (Lehner, Baulch)										
3 / 8	PDF5	Fortin (Cardille, del Giorgio)										
4 / 9	PhD18	Maranger (Baulch, Taranu) *proposed switch to PDF (Fortin St-Gelais)					Fortin St-Gelias					
4 / 9	PhD19	Maranger (Baulch)										
4 / 10	PhD20	Vinebrooke (Simpson, Leavitt) *proposed switch to PDF (Loewen)										
4 / 10	PhD21	*SC has proposed theme 4 reorganization to Board										
4 / 10	PDF6	*SC has proposed theme 4 reorganization to Board										
4 / 10	PDF7	Huot										

[§] Network HQP and RP - provide services to all participants

[¶] Fully supported by co-applicants of this project (outside Network's budget)

*Passage from MSc to PhD

[#]Public Health Agency of Canada scientists (Ludwig, Turgeon, Brazeau, Kotchi, Ogden)

◆Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC)

Appendix G: Proposed changes for Highly Qualified Personnel (HQP)

The Scientific Committee has recommended the following HQP changes for approval by the Board:

1. Theme 1, Project 2 (project leader: David Walsh): Switch funding for PhD6 to support a postdoc. The SC favourably reviewed the request because the proposed postdoc is an excellent fit for this project. She has already been a valued participant in the LakePulse Survey and a speaker at the Second Annual Network Meeting in 2017. She has been processing and analyzing lab samples, and helping to improve the field protocols. She can also play an important role in mentoring students and publishing results. There is no change in the funding amount provided by the Network, and the postdoc will complete the original PhD project that was planned.
2. Theme 1, Project 4 (project leader: David Walsh): Switch funding for PhD8 to a MSc who is likely to fast track to a PhD program. The MSc student is a super fit for this project (e.g., prior experience in this field, high academic standing, experience with field work). There is no increase in the funding amount provided by the Network. The student will participate on a field team in the LakePulse Survey in 2018.
3. Theme 4, Project 9 (project leader: Roxane Maranger): Switch funding for PhD18 to support a postdoc. The proposed postdoc would significantly enhance the project at no extra cost to the Network. The proposed postdoc is an excellent fit for this project, and he was a speaker at the Second Annual Network Meeting in 2017.
4. Theme 4, Project 10.1 (project leader: Rolf Vinebrooke): Switch funding for PhD20 to support a postdoc. The proposed postdoc would enhance the project as he has experience in the same type of analysis as planned. Recruitment is late because the proposed candidate currently has a short-term job contract. The Scientific Committee proposes a recruitment deadline of September 30, 2018. If the post-doc candidate is not available, a PhD candidate can be recruited but with the same recruitment deadline of September 30, 2018. This is to ensure that the HQP is aligned with the lifetime of the Network.

Appendix H: Metrics

In this section the **LakePulse HQP names are in bold font** while the LakePulse co-PIs are underlined.

Grants directly linked to LakePulse

In preparation

Smith S, Chokmani K, Campbell P, Cardille JA, McGeer J. (to be submitted Spring 2018). Risk Assessment of Metals Determined Using Remote Sensing of Dissolved Organic Carbon. Collaborative Research and Development Grant.

Applied for

Bélanger, S., Huot Y et al, (submitted January 2018) WaterSat Imaging Spectrometer Experiment (WISE) for optically shallow inland and coastal waters assessment. Submitted to Canadian Space Agency, Flights and Fieldwork for the Advancement of Science and Technology (FAST 2017).

This grant builds on the optical dataset collected in LakePulse to advance hyperspectral remote sensing.

Obtained

NSERC Research Tools and Instruments Grants Program, $137 737, Cabana H (lead), Segura PA (coPI), Gaudreau L (coPI), Beauregard P (coPI), and Heitz M (coPI).

This instrument allows automated extraction of organic compounds and was requested for the most part to process the large quantity of LakePulse samples to be processed for pesticides and pharmaceuticals.

FRQNT Team research project grant program, $162 000, Gregory-Eaves (lead), Antoniades (coPI), del Giorgio (coPI), Francus (coPI) and Smol (collaborator).

This grant was requested to process the full cores sampled during the LakePulse Survey. These cores were not originally planned, and further funds were required to process them.

Publications from Network activities

Submitted

Griffiths K, Winegardner AK, Beisner B, Gregory-Eaves I. (March 2018) Ecological indicators on subfossil analyses from an eastern transect of the US National Lake Assessment (NLA) lakes.

Although LakePulse data were not used, LakePulse is mentioned, and the dataset used may eventually be merged with the eastern LakePulse dataset that C. Paquette is developing.

Appendix H: Metrics (continued)

Presentations at conferences (includes those planned until the end of Year 2)

International

Griffiths K, Smol JP, Antoniades D, **Jeziorski A**, Gregory-Eaves I. "Inferring past environments across the Lake Pulse Network: Tracking diatom changes across four Canadian ecozones", International Paleolimnology Association 2018, 18-21 June, 2018, Stockholm, Sweden

Gregory-Eaves I, **Baud A**, **Garner R**, **Griffiths K**, **Jeziorski A**, **MacKeigan P**, **Paquette C**, **Simmatis B**, Amyot M, Antoniades D, Francus P, Beisner B, Huot Y, Poulain A, Walsh D and Smol JP. "Landscape Paleolimnological Insights from the Canadian Lake Pulse Network (lakepulse.ca)", International Paleolimnology Association 2018 meeting, 18-21 June 2018, Stockholm, Sweden

Kraemer SA, Barbosa da Costa N, Shapiro BJ, Walsh D. Land use structures lake bacterial communities across Eastern Canada, ASLO summer meeting, Victoria, BC, 10 – 15 June, 2018.

Maranger R, **Fortin St-Gelais N**, Lapierre J-F, Poisot T, Dubé P, Franssen J, Talbot J. Making ecosystem science matter: stakeholder-engaged research through co-design and integrated social-ecological synthesis, PECS II, 7 – 10 November, 2017 Oaxaca, Mexico

Fortin St-Gelais N, Goyette JO, Siron R, Lapierre JF, Maranger R. A novel approach to quantify the multiple dimensions of water quality and aquatic ecosystem services, 10-15 June, 2018, Victoria, BC.

MacKeigan P, Beisner B, Taranu Z, Pick F, Sauvé S and Gregory-Eaves I. Cyanobacteria Distribution and Dynamics from the Canadian Lake Pulse Network (lakepulse.ca), Interdisciplinary freshwater harmful algal blooms workshop, Toronto, 16 – 20 April 2018

National

Gregory-Eaves I, Invited as expert panel participant for the National Launch of the Sustainable Development Solutions Network (SDSN) Canada. May 7 & 8, 2018, University of Waterloo, Waterloo.

Regional

de Toledo, M, and Baulch HM. Phosphorus Concentration and Nutrient Availability in Canadian Lakes: The Role of Regional Geology, Geography, Land Use, and Lake Characteristics. School of Environment and Sustainability Symposium, 23 March 2018. Saskatoon, Saskatchewan.

Goubet S, Laurion I, Chokmani K. Hyperspectral imagery for the detection of algal blooms on lakes. GRIL Symposium, GRIL annual meeting, 22-24 March, 2018, St-Hippolyte, QC

Huot Y. The NSERC Canadian Lake Pulse Network. GRIL annual meeting, March 22-24, 2018, St-Hippolyte, QC

Fortin St-Gelais N, Goyette JO, Lapierre JF, Maranger R. What does water quality mean to you?, GRIL annual meeting, March 22-24, 2018, St-Hippolyte, QC

Appendix H: Metrics (continued)

Posters at conferences

International

Goubet S, Laurion I, Chokmani K. Development of optical tools to quantify algal biomass and identify dominant taxa. 9th US Symposium on Harmful Algae, 11-17 November, 2017, Baltimore, USA

Regional

Lahens L et al. Preliminary study of the occurrence of trace organic contaminants in Canadian lakes. Poster presentation. 32e congrès de l'Est du Canada. Association canadienne sur la qualité des eaux. May 4 2018, Sherbrooke, QC.

Lahens L et al. Preliminary study of the occurrence of trace organic contaminants in Canadian lakes. Poster presentation. 22e Colloque annuel du SETAC Chapitre Saint-Laurent. 14 – 15 June 2018, Québec, QC.

Huot, Y. The NSERC Canadian Lake Pulse Network, 32e congrès de l'Est du Canada. Association canadienne sur la qualité des eaux. 4 May, 2018, Sherbrooke, QC.
Invited plenary speaker

Baud A, Griffiths K, MacKeigan P, Paquette C, Smol JP, Antoniades D, Francus P, Beisner B and Gregory-Eaves I. "A changing Canada – the paleo-perspective from the Lake Pulse Network (lakepulse.ca)" GRIL annual meeting, March 22-24, 2018, St-Hippolyte, QC

Garner R, Gregory-Eaves I, Walsh D. Comparative paleogenetics of modern and preindustrial Canadian lake ecosystems, GRIL annual meeting, March 22-24, 2018, St-Hippolyte, QC

Special sessions at meetings

International

Gregory-Eaves I, **Griffiths K** and Jenny J will co-chair a special session entitled: "Landscape paleolimnology: a powerful approach for examining pressing environmental problems facing lakes at regional and global scales" at the joint meeting of the International Paleolimnology Association and the International Association of Limnogeology (IPA-IAL) 18-21 June 18, Stockholm University, Sweden.

Workshops at meetings

Regional

Walsh D, Mcmahon T. "DNA-based approaches in paleolimnology: what new questions can we address", GRIL annual meeting, March 22-24, 2018, St-Hippolyte, QC

Astorg L, Guernon S, **Paquette C.** Everything you don't know about plankton. ÉcoLac-GRIL Student Autumn Workshop

Appendix H: Metrics (continued)

Scholarships obtained

Mauro de Toledo, NSERC CREATE in Water Security Scholarship
Alexandre Baud, NSERC CREATE EcoLac Scholarship
Rebecca Garner NSERC CREATE EcoLac Scholarship, NSERC MSc Scholarship
Jordan Wight, Memorial University School of Graduate Studies Baseline Funding
Cindy Paquette, GRIL (FRQNT) partial scholarship program
Cindy Paquette, UQAM Faculty of Science Scholarship
Vera Onana, NSERC CREATE EcoLac Scholarship
Paul MacKeigan, NSERC CREATE EcoLac Scholarship, FRQNT Scholarship

HQP awards and honours

Geneviève Potvin, Selected as one of 20 international students for the 2018 IOCCG Summer lecture series.
Geneviève Potvin, NSERC "Science Action" video competition in 2018, Selected by the public among the top 25 videos, over 1200 views on NSERC YouTube channel.

Prize/award for LakePulse researchers

John Smol was presented on 28 April 2018 with the 2018 Lee Larch Award (CAUT Distinguished Academic Award), by the Canadian Association of University Teachers (CAUT), their highest honour, recognizing excellence in the three domains of academic life: teaching, research, and service.

HQP visits to collaborators

Alexandre Baud and **Rebecca Garner** visited Pierre Francus' lab on March 27-29th to scan ELA freeze cores on CT-SCAN and ITRAX. Alex will then spend two weeks this spring working intensively with Pierre Francus on the ITRAX and CT-SCAN analyses from these and the P4 cores.
Paul MacKeigan and Rene Gregory-Eaves visited Sauvé lab in Feb 2018 to discuss cyanotoxin analyses and see lab set up.
Paul MacKeigan will meet with Frances Pick at an upcoming meeting at the Interdisciplinary freshwater harmful algal blooms workshop in Toronto April 16-20th, 2018.

Appendix I: LakePulse Milestones Yr1 - Yr3

Progress on milestones planned for year 1 to the beginning of year 3 in the proposal. In green, milestones that are on track or were achieved on or near the expected date. In yellow, milestones that will be or were achieved behind schedule, but with no expected impact on the Network. In red (there are none), milestones that are behind schedule with either potential or certain impacts on the Network.

Milestone	Date planned	Progress
Advertise, interview and hire the Network Manager	Aug. 28, 2016	Catherine Brown was hired on Nov. 1, 2016.
Advertise and hold first AGM	Sept. 23, 2016	First AGM was held on Nov. 21 and 22, 2017
BOD meeting	Sept. 23, 2016	Oct. 31, 2016 (videoconference) Dec. 12, 2016 (face-to-face) Jan. 17, 2017 (videoconference)
Recruit Network RPs to work on database and prepare first field campaign	Nov. 20, 2016	Three RPs were hired between Jan. and Feb. 2017
Recruit students involved in first field campaign	May 12, 2017	Some students were not recruited and replaced with interns and research professionals.
Basic database is running and ready to receive data	Feb. 28, 2017	We have a database in place to receive data. It is currently being populated with Yr1 data. This was about a year late, with little or no consequences on Network progress. The work priorities of our Database Specialist had been shifted to better suit the needs for the first season of the LakePulse Survey.
Geomatics analysis for lake sampling in 2017: delineate watersheds; create an index of human impacts; determine lake sizes; accessibility; etc.	Sept. 30, 2017	An initial analysis was completed in April 2017. This analysis was done rapidly to allow lake selection; it will be refined with new techniques and data as they become available.

LakePulse Milestones Yr1 - Yr3 (continued)

Train sampling teams for first field campaign	June 16, 2017	Carried out during the first week of July 2017. This was logistically a better approach.
Yr2 large sampling effort	August 31, 2017	Accomplished as planned.
Processing samples from the Yr2 sampling effort	January 1, 2018	Ongoing, we expect to have most data, except for taxonomy, done by the end of June 2018. A push will be necessary for the taxonomic samples to avoid delays to student projects (currently, the expected date to complete processing is fall 2018).
Geomatics analysis for Yr3 & Yr4 lakes available in database	September 17, 2018	This is ongoing: all Yr3 lakes are done; Yr4 lakes are ongoing.
Yr2 data products are available in the Network	June 29, 2018	Expected to be reached for most samples, except taxonomy (see above).
IOCCG training class	June 29, 2018	We will not hold this class as the organizers preferred to keep the class at its original location. One of our students, Geneviève Potvin, was selected as a participant.
Yr2 annual and board member meeting	October 27, 2017	The meeting was held a few weeks later to help with attendance.
Training sampling teams Yr2	June 23, 2018	Planned for the following week.
Yr3 sampling effort	August 31, 2018	Expected on time; 232 lakes planned instead of 182.

Appendix J: Scientific Committee Members

Name	Affiliation	Position	Representation on SC
Beatrix Beisner	Université du Québec à Montréal	Professor	Theme 2 Leader
Caren Binding	Environment and Climate Change Canada	Scientist	Federal Partners
Paul del Giorgio	Université du Québec à Montréal	Professor	Theme 1 co-Leader
John Downing *(Chair of the Scientific Committee)*	University of Minnesota Duluth	Professor / Director of Minnesota Sea Grant Program	External / Independent
Marie-Josée Fortin	University of Toronto	Professor	Theme 3 Leader
Irene Gregory-Eaves	McGill University	Professor	Theme 1 co-Leader
Daniel Hering	Universität Duisburg-Essen	Professor / Dean of the Faculty of Biology	External International Advisor / Independent
Yannick Huot	Université de Sherbrooke	Professor	Network Director
Amina Pollard	U.S. Environmental Protection Agency	Scientist	External International Advisor / Collaborator
James Rusak	Ontario Ministry of the Environment and Climate Change	Scientist	Provincial Partners
Non-voting member			
Catherine Brown	Université de Sherbrooke	Manager	Network Manager

Appendix K: Board of Directors

Name	Affiliation	Position	Representation on BOD
Vincent Aimez	Université de Sherbrooke	Vice-President Partnerships and Knowledge Transfer	Host university
Nicole Armstrong	Water Science and Watershed Management Branch Department of Sustainable Development Government of Manitoba	Director	Provincial Partner
Richard Butts *(Chair of the Board)*	Cross Sectoral Strategic Direction /Agriculture Agri-Food Canada	Director General (retired)	External/Independent
Kevin Cash	Water Science and Technology/Science and Technology Branch Environment and Climate Change Canada	Director General	Federal Partner
Bill Donahue	EMSD /Alberta Environment and Parks	Executive Director, Science Branch	Provincial Partner
John Downing	University of Minnesota Duluth	Professor / Director of Minnesota Sea Grant Program	Chair of the Scientific Committee
Yannick Huot	Université de Sherbrooke	Professor	Network Director
Roxanne Maranger	Université de Montréal	Professor	Network co-PI
Verena Tunnicliffe	University of Victoria	Professor	External/Independent
	Non-voting members		
Samir Boughaba	NSERC	Program Officer	NSERC
Catherine Brown	Université de Sherbrooke	Manager	Network Manager

Appendix L: Administrative & Specialist Teams' Biographies

Dr. Yannick Huot, Director

Dr. Yannick Huot is the Director of LakePulse. Dr. Huot received his BSc in Physics from Laval University in 1997 and his PhD in Oceanography from Dalhousie University in 2004. His subsequent postdoctoral research appointment was with Dr. Marcel Babin at the Villefranche Oceanographic Laboratory in France (2004-2008). In 2008, he took a position in the Department of Applied Geomatics at the Université de Sherbrooke as a professor where he is the Canada Research Chair in Earth Observation and Phytoplankton Ecophysiology. Dr. Huot's research spans oceanography and limnology and focuses on several topics such as primary production, photophysiology, optical oceanography, sun-induced fluorescence, and remote sensing. He has also developed an advanced profiling platform for autonomous observations of lakes (profileur.usherbrooke.ca), with capabilities such as under-ice observations and imaging of in situ phytoplankton cells. From 2015 to 2016, Dr. Huot accepted a nine-month invited fellowship at Curtin University (Perth, Australia) where he collaborated with Dr. David Antoine to study anomalies in remotely sensed ocean colour and the remotely sensed partitioning of the Indian Ocean. Yannick is an associate editor of Inland Waters (Journal of the International Society of Limnology). Dr. Huot believes that a collaborative and multidisciplinary approach is critical to address urgent societal problems, which led him to develop LakePulse.

Dr. Catherine Brown, Manager and Communications/Outreach/Policy engagement

Dr. Catherine Brown is the LakePulse Manager and is also responsible for our communications/outreach activities and developing policy engagement opportunities. Dr. Brown was involved in the LakePulse initiative since the pre-proposal stage and served as an editor for the full proposal. Prior to her position with the Network, she worked as a research professional with the Centre for Remote Sensing Research and Applications and as an instructor for graduate courses in science communication and grant writing at the Université de Sherbrooke. She has a keen interest in science literacy, public engagement and science policy issues. Since 2005, she has worked to develop web-based communications for various institutions and research groups, in France and Canada, as well as writing, editing and translating scientific documents. In addition to her PhD in oceanography, Catherine has a bachelor of education degree in science. In her spare time, Catherine enjoys illustration and some of her cartoon characters visit the LakePulse world.

Jelena Juric, Database Specialist - Jelena received undergraduate training in informatics at the Université de Sherbrooke. She has over 16 years of experience working in the information technology and Geographic Information Systems (GIS) sectors. Jelena is developing the LakePulse database for storing data, metadata and quality control flags from the LakePulse Survey dataset, and she will also integrate datasets from our partners. Jelena is also a part-time Masters student in the Network contributing to the development of the LakePulse Web Portal and Stewardship Tools, which aim to provide automated lake health reports for tens of thousands of lakes across Canada. Jelena also helps to train and coordinate the Field Coordination team at the Université de Sherbrooke that receives all samples from the five field teams throughout the field season and that maintains daily contact with the field teams for logistical support. Jelena also developed an electronic log sheet system for data collection in the field using tablets.

Marie-Pierre Varin, Field Coordinator - Marie-Pierre received undergraduate training in environmental science followed by graduate training in limnology at the University of Ottawa. Marie-Pierre helps to coordinate the LakePulse Survey to sample 680 lakes across Canada over 3 years. Her tasks include purchasing and maintaining the equipment and instruments needed for lake sampling. She assists in planning the logistics for the field seasons in collaboration with the LakePulse Specialists, as well as the management of samples and training field participants. Marie-Pierre is also organizing the LakePulse Field Manual (154 pages), which will provide standardized protocols for lake sampling that are field tested on 680 lakes by 5 field teams during the LakePulse Survey. Marie-Pierre serves as a field team leader for the LakePulse Survey.

Maxime Fradette, GIS Specialist - Maxime received undergraduate training in physics followed by graduate training in geomatics at the Université de Sherbrooke. He carries out geomatics analyses and data processing for LakePulse, such as for the LakePulse Survey and the pan-Canadian watershed analysis. For the LakePulse Survey in 2018, this requires planning the logistics of five field teams sampling over 230 lakes from British Columbia to Newfoundland. Maxime is also a field team leader for the LakePulse Survey.

Geneviève Potvin, GIS Specialist - Geneviève transitioned to a part-time role as a GIS Specialist for LakePulse after beginning her doctoral studies within the Network in optics and remote sensing in 2018. She received undergraduate training in ecology followed by graduate training in biology and geomatics. She initially worked on geomatics analyses for LakePulse, such as for the LakePulse Survey and the pan-Canadian watershed analysis. For the watershed analyses, over 75,000 lake watersheds were delineated and a human impact index was developed. Beginning in 2018, she is focussing on the development of the LakePulse Web Atlas, which will present the vast datasets gathered by LakePulse in a user-friendly manner for a broad range of end users. Geneviève previously worked as a research assistant at the Université de Québec à Montréal. She is also a field team leader for the LakePulse Survey.

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