Kenauk Institute – 2019 Annual Report

1000 Chemin Kenauk
Montebello, QC, J0V 1L0
www.kenaukinstitute.org

Liane Nowell
December 31, 2019

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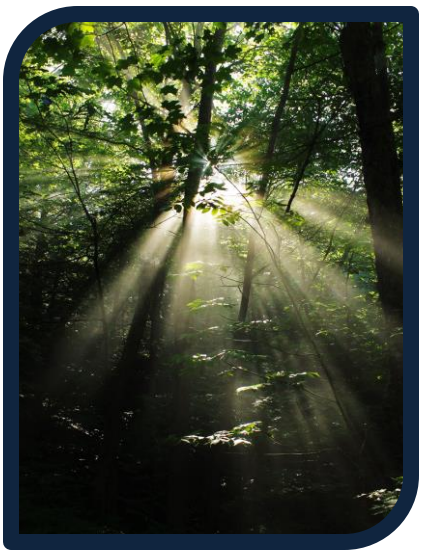
Executive Summary



The mission of The Kenauk Institute is to support, coordinate and supervise scientific research, involve local schools in environmental education, and connect Kenauk with the broader community. The vision is to establish a baseline inventory of biodiversity and monitor the property with a 100 year time horizon. With time, Kenauk will become a laboratory for monitoring climate change and human impacts.

Kenauk has proven to be an ideal location for a research institute because of its extensive size, its uniqueness as a pristine watershed and as a wildlife corridor. The abundance and diversity of flora and fauna in combination with the properties unique history provides endless possibilities for research and education.

Throughout 2019, The Kenauk Institute has seen a lot of progress which includes 21 successful research projects and 14 inspiring educational programs.

The foundations of our long term monitoring mission are firmly in place with our own weather station and 150 permanent sample plots established throughout the property. Inventories of the property continue to surprise us with over 73 rare and endangered species being validated so far which is a testament to Kenauk's uniqueness. The historical and environmental significance of Papineau Lake as a pristine watershed and conservation priority also continues. We look forward to: future successful partnerships, the results from our new projects and more innovative projects from incredible interns.

The Kenauk Institute's educational programs included the Outward Bound / YMCA group, involvement in the Canadian Conservation Corps programs, a field trip from the Saint-Michel elementary school, the ISFORT M.Sc. program, as well as our internship programs. We were also happy to include a grade 7 program from Bishops College School (BCS), and a new program from the Sunshine Montessori School. We look forward to many of these programs returning as well as future collaborations.

In 2020 we will be launching a capital campaign. The goal is to raise enough money to build a main research center and create an endowment fund to sustain long term research and educational programs. The research center would act as the main building for all research activities as well as increase our researcher accommodations and expand our capacity for hosting educational programs.

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Executive Director

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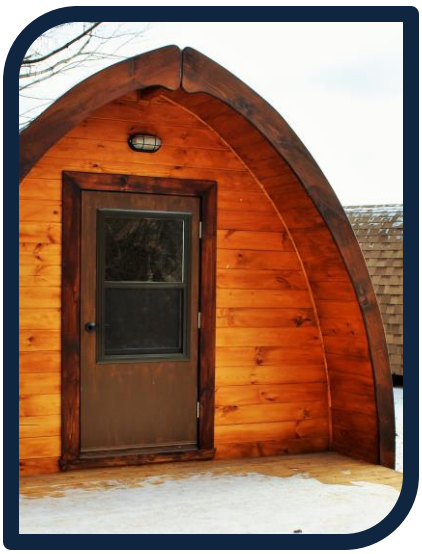
Facilities



Pods

Seven pods are installed at Whitefish Lake and act as our researcher accommodations. These pods include both professor and student accommodations. The guide shack (an existing and nearby building) includes the washroom and kitchen facilities.

Nature House

The recent addition of the Nature House, also located at Whitefish Lake, has expanded our facilities. With 5 bedrooms and 10 beds we have more space for intern and researcher accommodations. It will also act as the Kenauk Institute office and includes a meeting space. We would like to recognize the directors who contributed to this purchase and for their continued support in all of the Kenauk Institute's endeavors.

Kenauk Nature Partnership

The Kenauk Institute is also fortunate to have the existing Kenauk Nature outfitting facilities at our disposal. Chalets are available for rent by educational programs as well as potential in-kind contributions for researchers. Kenauk Nature has also generously provided in-kind contributions for some industrial research project grants including the use of fishing boats and the marina, storage space, mapping data, equipment and assistance from knowledgeable personnel.

2019 Educational Programs

1. Outward Bound and YMCA C-Vert Programs (x2)

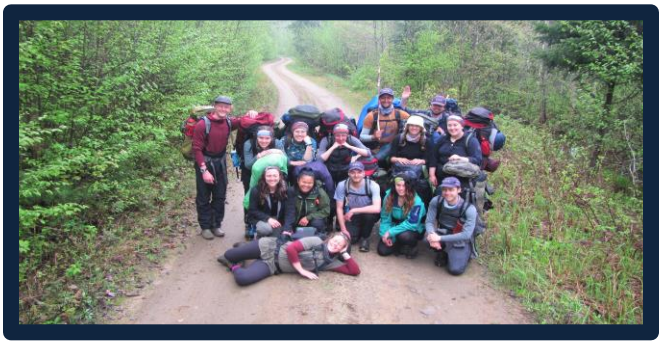
This program is an enrichment opportunity for youth who participate in the YMCA's C-Vert program; an environmental engagement program that aims to transform young people into active eco-citizens. The experience removes them from their usual urban environment and thrusts them into an exciting and adventurous challenge. Participants gain new practical skills and abilities (autonomy, responsibility), while developing self-esteem, resilience, leadership and perseverance. Each program includes a 10 day hiking expedition, a canoe and portage portion, solos as well as a research/service day.

2. The Canadian Conservation Corps (CCC)

CCC is a program that provides Canadian youth with opportunities to connect to conservation through three stages: 1) wilderness journeys, 2) science field work internships and 3) urban education outreach. Their mission is to advance conservation ethic as a unifying, optimistic, Canadian value. The vision is to produce professionals deeply connected to conservation ethics. The Kenauk Institute was involved in two of the CCC stages; hosting a wilderness journey and science field work internships.

3. École Saint-Michel – Montebello Elementary School

Saint-Michel is the local elementary school for which the Kenauk Institute provides free annual field trips for the grade 5 and 6 class. This is an opportunity for young students to get out of the classroom and into the outdoors. By combining biology, wilderness survival, time outside and play we hope to fuel a curiosity and passion for the environment while giving students valuable knowledge and skills.



4. Sunshine Montessori School (SMS) Program

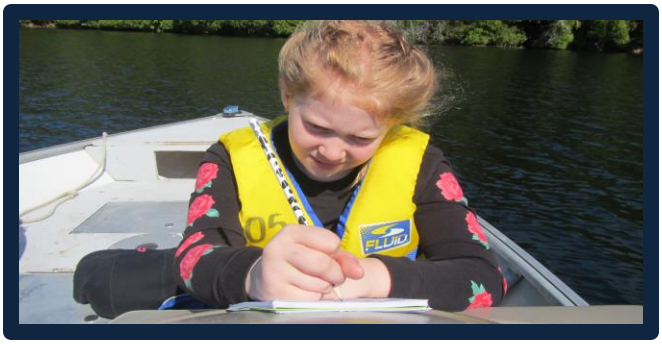
The Sunshine Montessori School Program is an opportunity for the entire grade 7 class to end the school year by getting outside of the classroom and experience the outdoors. This program includes team building, guided canoeing/kayaking, and a tour of the fish hatchery, with lessons on sustainable food, fish anatomy and local flora and fauna. Students were also paired with our graduate researchers and spent the day helping collect data to get real hands on experience in biology and a taste of the scientific process. Also included was a cultural day with tours of local historical sites.

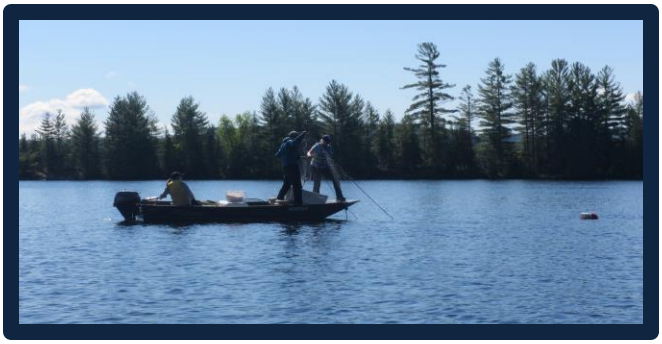
5. ISFORT M.Sc. Program

The ISFORT M.Sc. program is a professional masters degree in the sustainable management of forest ecosystems offered jointly by UQAM, UQO and UQAT. It's specialized for people who are interested in studying the relationships and interactions between humans and forests. Topics include flora, fauna, ecological functions, ecosystem services and the cultural value of forests. The Kenauk forestry company, Kenauk Canada ULC, provides valuable on-site data to support the program. This program is two weeks long and repeated annually.

6. Bishop's College School (BCS) Grade 7 Program

The BCS grade 7 program is an opportunity for students to start the school year by getting to know each other outside of the classroom. This program includes team building, canoeing/kayaking, wilderness survival activities and many lessons on the local flora and fauna. It is an opportunity for students to get a taste of the scientific process and learn about real career opportunities in biology and the sciences. Students are encouraged to continue using the knowledge gained during this program to contribute to research projects conducted at BCS throughout their high school experience.





7. University Field Trips (x4)

The Kenauk Institute regularly hosts field trips from nearby Universities including Carleton University and the University of Quebec in Outaouais (UQO). These field trips come to get lessons on eco-tourism, conservation management and sustainable forestry. We also provide guest lectures for University classes that detail our research projects and conservation intiatives.

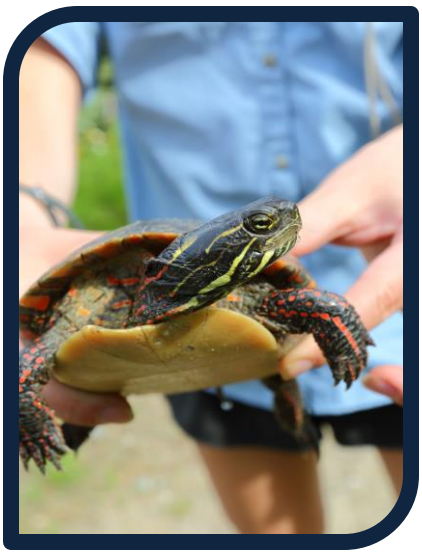
8. Kenauk Institute Internship Program

The Kenauk Institute has committed to providing undergraduate internships and a graduate senior internship for students studying biology in university. Interns are expected to juggle a variety of responsibilities that include contributing to multiple research projects, helping organize day-to-day operations, contributing to our educational programs as well as managing their own individual research project. The field experience gained during this internship is invaluable and will help individuals narrow down their research interests, as well as help them pursue their academic and career goals. Professional development sessions are held throughout the internship.

9. Kenauk Institute Junior Internship Program

The junior internship program targets senior female high school students with a keen interest and passion for the biological sciences. It is an opportunity for students to experience real hands-on data collection, learn about the scientific process, meet other young professionals studying biology, and learn about the various fields related to ecology and conservation biology. Students can use the data they collect for an independent research project or thesis, in accordance with their schools curriculum. They are also encouraged to continue their research back at their home schools.

2019 Research Projects



1. NCC Biodiversity Inventory Project (#2015-1.1)

University / Organization: The Nature Conservancy of Canada

Researchers: Marie-Andrée Tougas-Tellier, Joel Bonin and countless NCC volunteers

Description: In 2014, the Nature Conservancy of Canada (NCC) began a series of inventories on the property of Kenauk. This work aims to document the rich biodiversity of this vast and iconic property, to exemplify its value and manage it accordingly (ex. identification of areas with high conservation potential, forest corridors, etc.). Research conducted in collaboration with biological specialists have confirmed the exceptional ecological richness of this site. The initial results of this inventory and a review of the scientific literature have allowed NCC to produce a species database including a list of concrete recommendations for land stewardship and the management of its natural resources. This document will serve as a framework for planning target species management and conservation action plans for Kenauk.

NCC is also prioritizing the preservation of Kenauk's ecological features to ensure its dynamic role within the landscape-scale ecosystem. Kenauks' conservation planning will therefore include a larger scale objective to protect the Kinonge watershed (Figure 1) and the wildlife corridor to the North (Figure 2). The continuous forest cover to the North of Kenauk provides suitable conditions for wildlife movement and migration. Continuous forest is important for large mammals, forest interior birds, indigenous plants and amphibians with limited dispersal capacity. The objective is to maintain landscape connectivity for free dispersal of those groups.

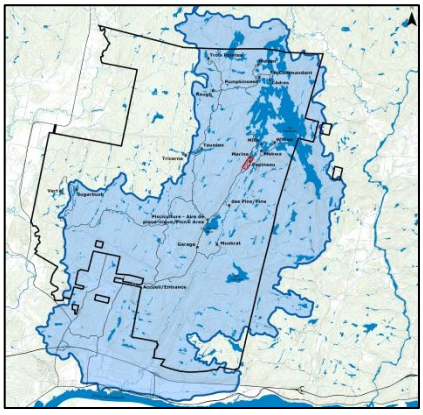


Figure 1. Kinonge watershed.

Results Summary:

- So far the presence of over 73 species at risk have been validated, including amphibians, vascular plants, arthropods, mammals, birds, fish and reptiles.
- Kenauk is home to the four-toed salamander, the walking fern and the largest black maple stand listed in Quebec.
- Old forest fragments that foster several bird species such as the Canada warbler and the wood thrush were also identified.
- Channel darters and pearlshell mussels were also found, indicator species for the quality of the riparian environment.

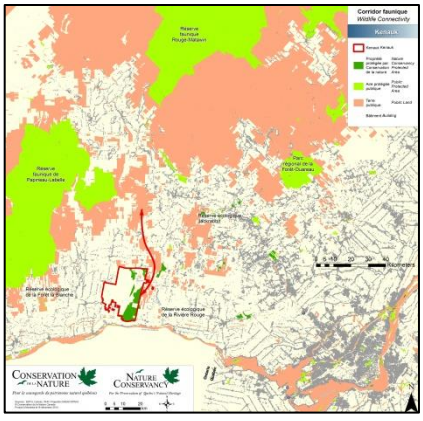
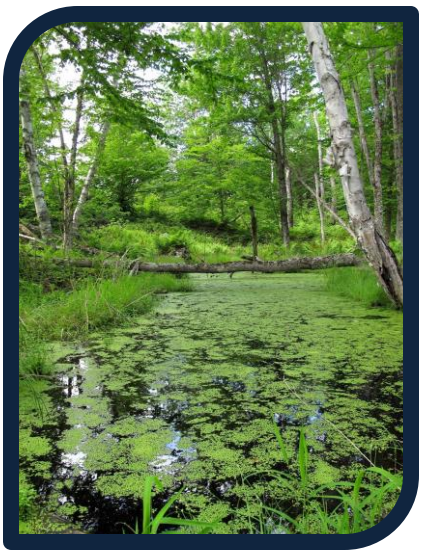


Figure 2. The wildlife corridor.

Status: This inventory will continue in 2020. Extensive species lists have been created which will facilitate long term monitoring, conservation and future research.

2. Vernal Pool Hydrology and Herpetology Project (#2016-1.2)



Title: Effects of even-aged vs uneven-aged silviculture and landscape quality on the hydrology and biodiversity of vernal pools.

University / Organization: Université du Québec à Montréal (UQAM) and Université du Québec en Outaouais (UQO)

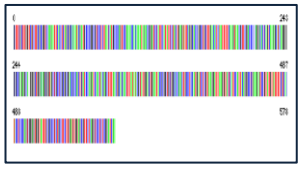
Researchers: Prof. Marie Larocque and student Marjolaine Roux (UQAM) (sub-project 1), Prof. Philippe Nolet and Prof. Yann Surget Groba (UQO) (sub-project 2)

Description: Vernal pools are geographically and hydrologically isolated wetlands commonly found in temperate forests of northeastern North America. They fill at their maximum in the spring following snowmelt and become completely dry during the summer; this hydroperiod affects faunal composition and reproduction. Vernal pools consist of very rich ecosystems and are essential to the life cycle of many organisms. Despite their ecological importance, there is still very little known about these habitats. In order to accomplish this project, it has been divided into multiple sub-projects: 1) gain a better understanding of the water budget of forest vernal pools, as well as the links between their hydroperiod and pool morphology, in order to identify the hydrological processes that regulate them; 2) evaluate the impact of even-aged and uneven-aged silvicuture on vernal pool herpetofauna diversity, abundance and connectivity; and 3) provide recommendations to decrease the impact of silviculture on vernal pools and their associated herpetofauna. For sub-project 1, 41 vernal pools (16 in 2016, 14 in 2018, and 11 in 2019) were identified, characterized, and have been monitored for water levels. For sub-project 2 environmental DNA is being used to estimate herpetofauna diversity.

Results Summary (sub-project 1):

- Hydroperiods are highly variable depending on meteorological conditions in late winter, spring and early summer. There is groundwater input in the spring and autumn. In the summer, pool water infiltrates the water table.
- The water budget varies seasonally but is mainly influenced by precipitation, evapotranspiration, and infiltration.
- Because vernal pools are not hydrologically isolated from the local water network, conservation of the ecosystem within the immediate watershed of vernal pools is essential to preserve their integrity.

Figure 3. Example of DNA sequence to identify vernal pool species.



Status: Hydrological monitoring and data analysis for this project will continue through 2020.

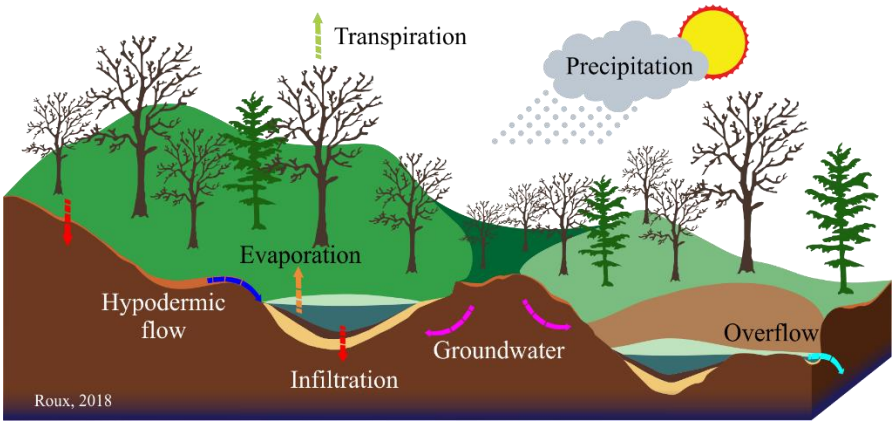


Figure 4. Conceptual vernal pool hydrological model (Roux, 2018).

3. Tree Growth and Productivity Project (#2016-1.3)

Title: Effects of even-aged vs uneven-aged silviculture on tree growth and forest productivity.

University / Organization: Université de Québec à Montréal (UQAM), Université de Québec en Outaouais (UQO) and Centre d'Enseignement et de Recherche en Foresterie (CERFO)

Researchers: Philippe Nolet (UQO), Guy Lessard (CERFO), Dr. Christian Messier (UQO/UQAM)

Description: The aim of this project includes assessing the effects of even vs. uneven forestry approaches compared to unmanaged stands on: 1) forest productivity and regeneration; 2) floristic and soil biodiversity; 3) verify whether forest productivity and regeneration (Obj. 1) is related to floristic and soil biodiversity (Obj. 2); and 4) identify the advantages of each approach in terms of forest resilience to global change. This project will contribute to the permanent sample plot network at Kenauk. Each plot will provide detailed information on the various parameters identified in Objectives 1 and 2. Specifically, forest productivity will be assessed through growth ring analyses and resilience through an evaluation of functional diversity and tolerance to drought (the most important risk related to climate change) of seedlings found in the sample plots.

Results Summary:

- 150 plots (in 50 sites) were sampled for tree, shrub and plant diversity, structure and composition. The 50 sites were distributed amongst old growth, even and uneven forests.
- Trees: Differences in tree species dispersion, abundance and composition, but not richness, was found between all forest types.
- Plants: Many important plant species are affected by forestry; some do not recover (30+) years after forestry. Species richness and abundance is highest in old growth forests.

Figure 5. A) Even-aged forestry; strip or clear cutting. B) Uneven-aged forestry; selective cutting.

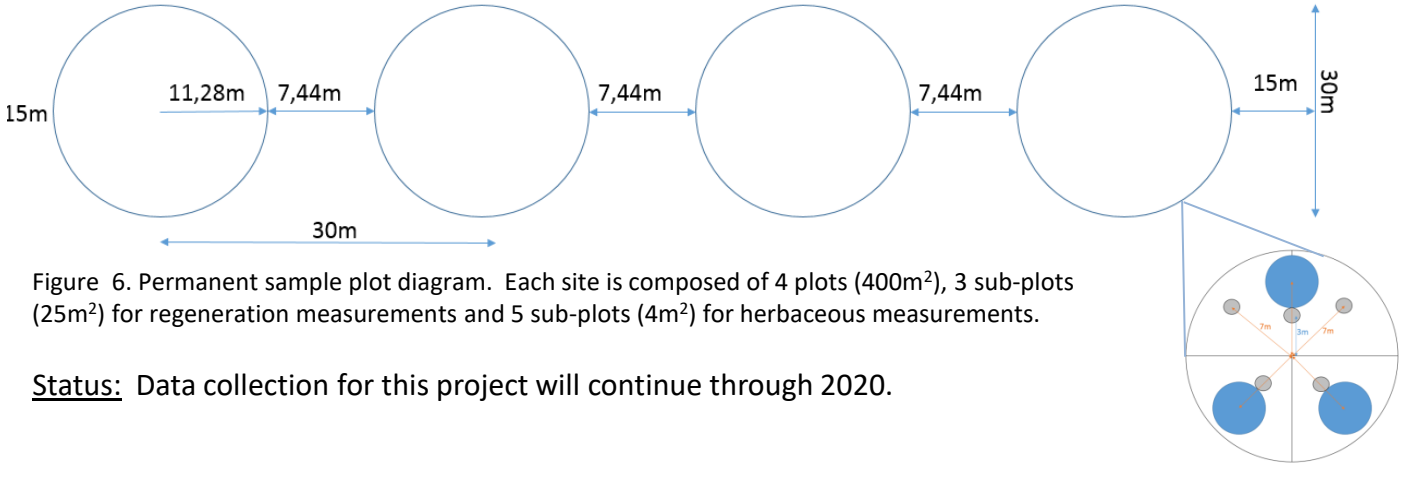


Figure 6. Permanent sample plot diagram. Each site is composed of 4 plots (400m^2), 3 sub-plots (25m^2) for regeneration measurements and 5 sub-plots (4m^2) for herbaceous measurements.

Status: Data collection for this project will continue through 2020.

4. Forest Resilience Project (#2016-1.4)

Title: Determine the best management strategies that increase the overall resilience of forests to invasive pests, disease and climate change.

University / Organization: Université de Québec à Montréal (UQAM), Université de Québec en Outaouais (UQO) and Centre d'Enseignement et de Recherche en Foresterie de Sainte-Foy (CERFO)

Researchers: Dr. Christian Messier (UQO/UQAM), Dr. Frédérick Doyon, Philippe Nolet and Rebeca Cordero Montoya (UQO), Guy Lessard (CERFO)

Description: Forests are increasingly being managed for a multitude of ecosystem services occurring at both the stand and landscape scales. However, these services are being threatened by rapidly changing biotic and abiotic factors such as invasive diseases, insects and climate change. For example, in the last 40 years the Kenauk forests have been invaded by dutch elm, beech bark and ash-borers which are decimating important tree species. Many more insects and diseases, already found in the north-eastern US, are also likely to move into Kenauk in the next 40 years. This is occurring simultaneously with rapidly changing climates and increasing human demands. To respond to these challenges, forest managers are required to develop new management strategies aimed at maintaining or increasing the overall resilience of the forest to sustain their vital ecosystem services. This project will use simulation models to evaluate the best management strategies to ensure forests will continue to provide ecosystem services. Part of this objective will be accomplished by comparing tree mortality patterns between even and uneven aged forest stands using novel ground-based mobile LiDAR technology. It is hypothesized that stand dynamics will influence tree vulnerability to stressors.

Results Summary:

- In total 42 sites were scanned using ground-based mobile LiDAR (sites = 0.4-0.8 hectares). So far, the data from 22 sites have been extracted.
- Preliminary conclusions: For similar size classes, tree mortality is higher in Uneven-Aged Stands (UEAS) than in Even-Aged Stands (EAS). Current competition does not explain this higher mortality so it seems that trees growing in UEAS are more vulnerable to stressors than the ones in EAS.

Status: Data analysis for this project will continue through 2020.

Management	Alive	Dead
EAS 30	3,984	70
UEAS 30	2,345	112
UEAS 15	2,792	164
Total	**9,121**	**346**

Figure 7. Inventory of 22 sites including Even-Aged Stands (EAS) and Uneven-Aged Stands (UEAS) that are 15 or 30 years old. Data extracted from mobile LiDAR.

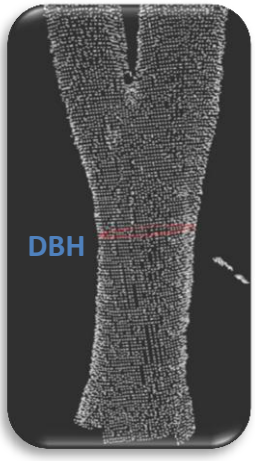


Figure 8. Tree size is measured using Diameter Breast Height (DBH) which is standardized across all forestry.

5. Integrated Forestry Planning Project (#2017-1.1)

Title: Validation of an annual forest planning approach which integrates LiDAR.

University / Organization: Centre d'Enseignement et de Recherche en Foresterie de Sainte-Foy (CERFO), Kenauk Canada ULC and Les Conseillers Forestiers de L'Outaouais (LCFO)

Researchers: Guy Lessard, Gilles Joanisse, Philippe Bournival, Donald Blouin (CERFO), Pascal Audet (LCFO)

Description: This project will include the validation of an annual forest planning approach which incorporates airborne LiDAR technology. The goal is to keep forestry companies competitive using evidence-based planning while adhering to all certification and accountability requirements as well as prioritizing forest ecosystem services and regeneration. This project will compare forestry methods to promote the restoration of desired species in a profitable context. Three types of irregular progressive cuts will be studied for feasibility, conformity, resilience, sustainability, short term effects on tree type, composition, spacing and cover, effects on regeneration (notably for hardwoods), impacts on biodiversity, fauna, productivity and related costs (Figure 9).

Results Summary:
The three types of irregular progressive cuts compared in this project are (Figure 10):

- By microstand with positive (remained) tree marking
- By microstand without tree marking (operators choice)
- By permanent cover with negative tree marking

Status: Data analysis for this project will continue through 2020.

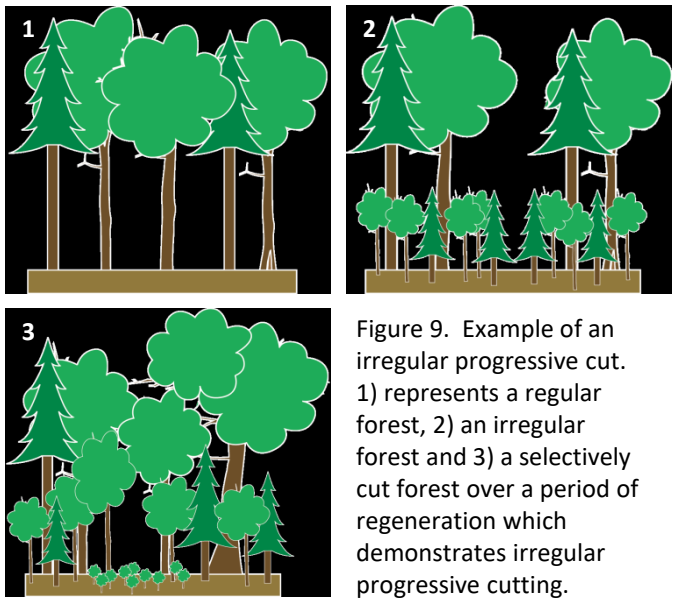


Figure 9. Example of an irregular progressive cut. 1) represents a regular forest, 2) an irregular forest and 3) a selectively cut forest over a period of regeneration which demonstrates irregular progressive cutting.

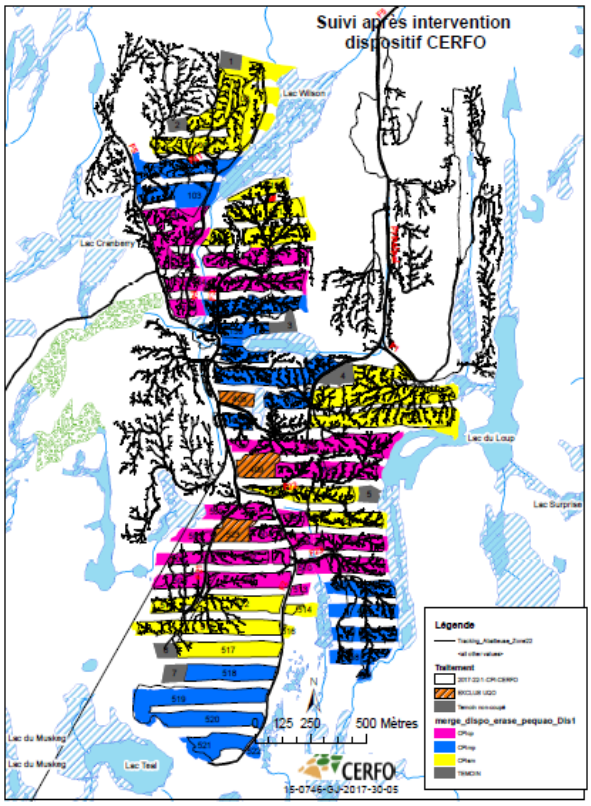
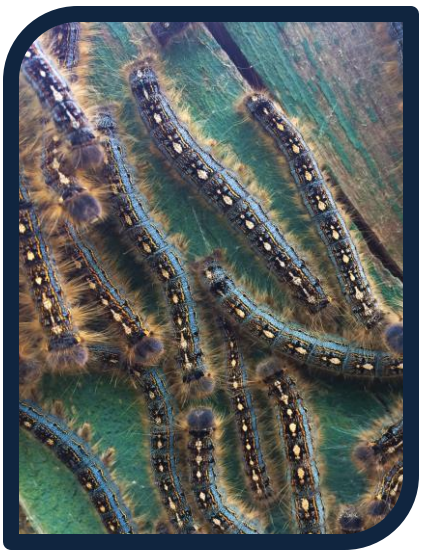


Figure 10. The three types of irregular progressive cuts.

6. Forest Tent Caterpillar Project (#2018-1.1)



Title: Interaction between forest tent caterpillars and forest composition: Role of predation in outbreak dynamics and effects on litter, soil and tree regeneration.

University / Organization: Université de Québec en Abitibi-Témiscamingue (UQAT), Université de Québec à Montreal (UQAM), and Concordia University

Researchers: Dr. B. Lafleur (UQAT), Dr. E. Despland, Dr. J.P. Lessard and Anne-Sophie Caron (Concordia), Dr. T. Handa (UQAM)

Description: The forest tent caterpillar (FTC) (*Malacosoma disstria*) is a frequent and significant defoliator of hardwood forests across Canada. Historically, severe outbreaks have occurred at ~10 year intervals and lasted 1-3 years (Figure 11). They cause a reduction in tree growth, an increase in tree mortality, a decrease in forest productivity, accelerated forest succession and influence stand composition. With the potential for increases in the frequency and severity of outbreaks from climate change, more than ever we need to understand the factors that regulate the dynamics of FTC populations and the effects of FTC outbreaks on forest ecosystems. The objectives of this project are to: 1) measure the role of predation in controlling FTC population dynamics in both the forest canopy and understory and 2) characterize the effects of FTC outbreaks on soil ecology and forest regeneration. In the long term, this project will contribute to the development of silvicultural approaches that take into account the trophic effects of FTC outbreaks.

Results Summary:

- 1) No difference in FTC larval mortality between defoliated sites (from 2016-2017 FTC outbreak) and non-defoliated sites, 2) No difference between the canopy and the understory, 3) There is a difference in ant abundance and activity in non-defoliated sites, 4) No difference in ant community composition at the genus level, but species level identification is pending.

Status: Data analysis for this project will continue through 2020.

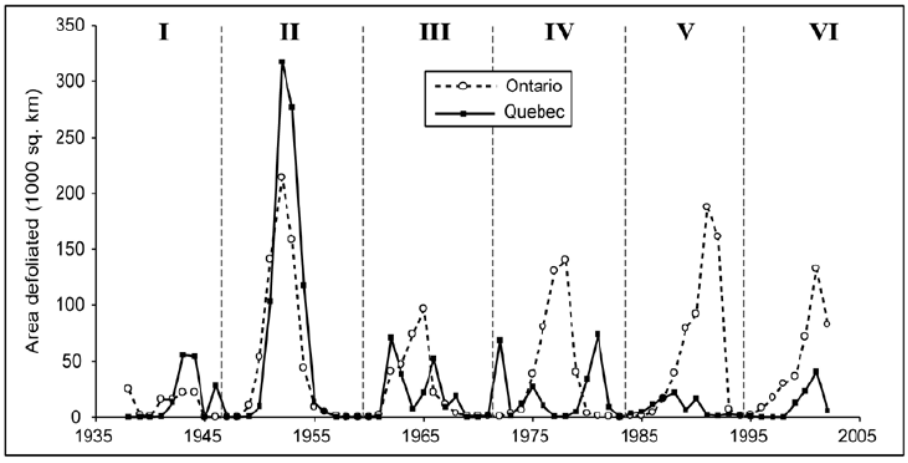


Figure 11. The distribution of FTC defoliation during six outbreak cycles in Ontario and Quebec (Cooke, Lorenzetti and Roland 2009).

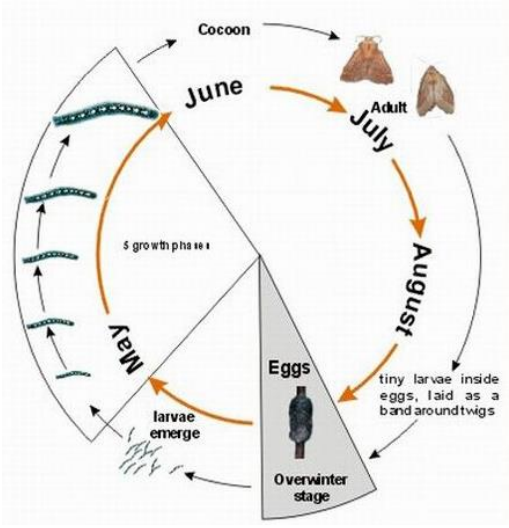
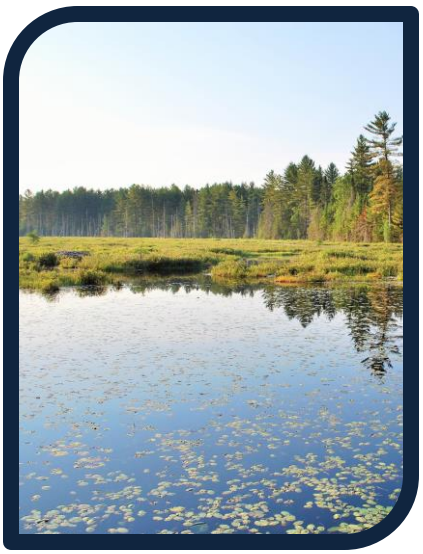


Figure 12. FTC life cycle.

7. Papineau Lake Hydrology Project (#2016-2.1)



Title: Dynamics and long-term resilience of a lake and its wetlands.

University / Organization: Université de Québec à Montréal (UQAM), Université de Québec à Trois Rivières (UQTR), Montreal Botanical Gardens (IRBV), The Nature Conservancy of Canada (NCC), The Ouranos Consortium

Researchers: Prof. Marie Larocque (UQAM), Prof. Raphaël Proulx (UQTR), Prof. Stéphanie Pellerin (IRBV), and countless students

Description: The goal of this project is to understand the hydrologic dynamics of Papineau Lake and how those dynamics are related to shoreline wetlands using three specific objectives. 1) Establish a monitoring network and hydrological alert system around Papineau Lake (Figure 13). Quantifying the lakes hydrodynamics will allow an estimation of how the lake will be affected in the long-term by land use changes and climate change. Probes that measure water levels and inflow/outflow volumes were installed throughout the lake for long term monitoring as well as a weather station. A hydrological model is also being developed to understand the processes regulating the lake's hydrology and the watershed but also to simulate the impacts of future scenarios, such as climate change. 2) Locate and characterize the lake's shoreline wetlands and identify the anthropogenic pressures they face. Indicator species, species at risk and insect bioacoustic signatures will be identified in these areas so as to designate them as protection zones. The natural and anthropogenic pressures these wetlands face will be identified, with a specific focus on shoreline thermal regimes and shoreline erosion by waves. 3) Create a list of recommendations to prevent / mitigate the negative effects of these pressures on the wetlands of Papineau Lake. An eco-nautical map of Papineau showing areas of specific concern will be created along with a set of regulations to help reinforce the conservation of the entire lake and watershed.

Results Summary:

- There are 4 concurrent graduate students working on 4 research aspects of this project.
- A wealth of information has been collected including lake volumes, the characterization of all its wetlands (there are over 100), weather station data, lake levels and inflows, surface runoff, groundwater levels, horizontal and vertical temperature profiles and more.
- Vascular vegetation was sampled in 38 wetlands; 9 of which were identified as unique, meaning they have a special and distinct species composition compared to the other sites. These unique wetlands (mostly peatlands) harbour many rare and disturbance-sensitive species.

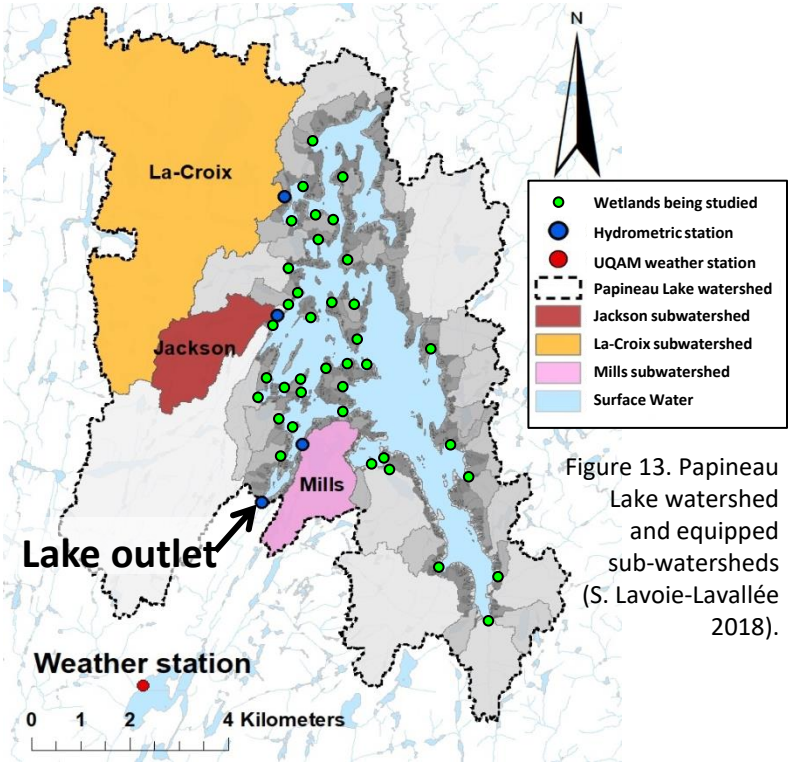


Figure 13. Papineau Lake watershed and equipped sub-watersheds (S. Lavoie-Lavallée 2018).

Status: Data collection will continue in 2020.

8. Papineau Lake Telemetry Project (#2017-2.1)

Title: Towards sustainable recreational fisheries on Papineau Lake

University / Organization: Carleton University, University of Waterloo, University of Vermont, University of Illinois and the Fisheries Conservation Foundation (FCF)

Researchers: Dr. Steven Cooke and Benjamin Hlina (Carleton U), Dr. Ellen Marsden (U of Vermont), Dr. David Philipp (U of Illinois), Julie Claussen (FCF), Dr. Mike Power (U of Waterloo)

Description: The goal of this project is to understand the spatial ecology, population dynamics and fishery for lake trout, rainbow trout and black bass in Papineau Lake. This project will provide the data and tools to identify sustainable conservation strategies that will help ensure high quality fishing on Papineau Lake while protecting its natural assets for future generations. Five specific objectives will contribute to this goal. 1) Identify the life history characteristics for lake trout specific to different sub-populations and/or ecotypes. 2) Characterize how adult lake trout and bass use different habitats (ex. depth and thermal habitat) on a seasonal basis (ex. spawning and overwintering locations). 3) Identify the level of reproductive success for lake trout and bass. 4) Determine why most lake trout in Papineau Lake fail to attain body mass greater than ~2kg. 5) Document the level of angler effort/harvest and their preferences and opinions for different management strategies.

Results Summary:

- Tags have been implanted in 66 lake trout and 56 bass.
- 4 spawning sites have been identified in the lake.
- Small and large lake trout have been identified. Large lake trout seem to be solely cannibalistic while smaller lake trout feed on zooplankton and aquatic insects.
- Results will be shared with community members to promote sustainable recreational fisheries management.

Status: Data collection will continue through 2020.

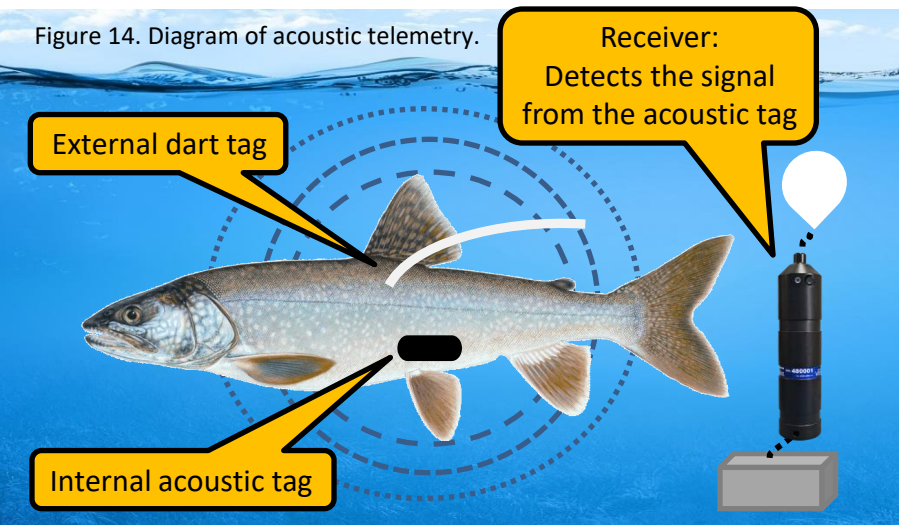


Figure 14. Diagram of acoustic telemetry.

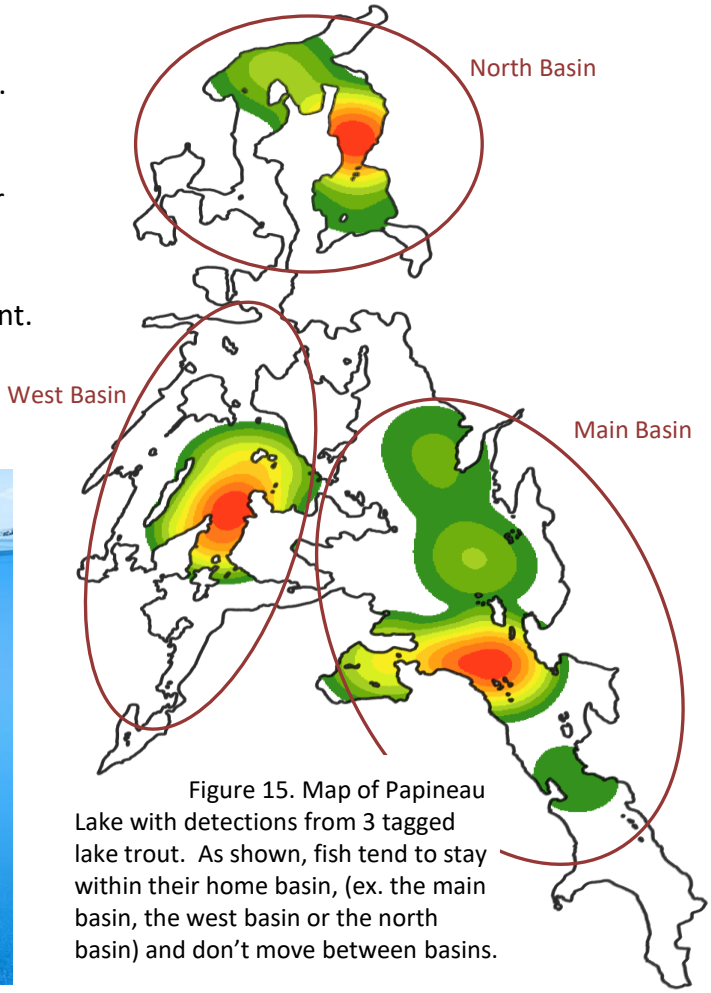
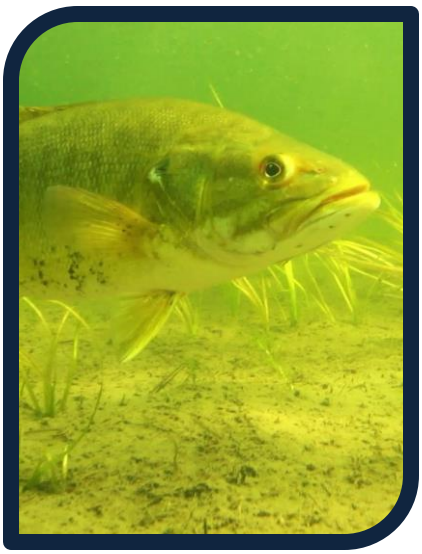


Figure 15. Map of Papineau Lake with detections from 3 tagged lake trout. As shown, fish tend to stay within their home basin, (ex. the main basin, the west basin or the north basin) and don't move between basins.

9. Bass Accelerometer Project (#2019-3.1)



Title: Evaluating the efficacy of recovery treatments following simulated tournament handling in smallmouth bass (*Micropterus dolomieu*).

University / Organization: Carleton University

Researchers: Peter Holder (PhD Student), Dr. Jake Brownscombe (Dalhousie/Carleton), Dr. Andy Danylchuk (Umass Amherst), Dr. Steven Cooke (Carleton)

Description: Catch-and-release angling (C&R) is an emerging conservation technique that focuses on returning fish to their environment following capture. These fish are assumed to return to their normal behaviour, however, we know this is not the case. Following a fisheries interaction, fish may experience physiological stress and become impaired. This impairment can manifest as compromised decision making, inability to avoid predation or inability to seek refuge. In extreme cases, fish may also perish, though the exact physiological cause remains unknown. During large fishing tournaments, fish can be held captive for long periods of time, leading to increased stress and an increased chance of impairment. This study aims to identify 1) the level of impairment smallmouth bass experience follow an angling event, 2) the level of impairment smallmouth bass experience following exposure to factors that increase stress (ie. air exposure and/or fish handling), 3) how these factors modulate their post-release swimming performance and 4) identify if specific treatments minimize impairment following capture. The two treatment conditions we are investigating are 1) holding a fish in captivity with fresh circulating water or 2) holding fish in a customized chamber that provides a steady flow of fresh water pointed towards their head and over their gills. In order to assess swimming performance, we employ the use of a novel technology: tri-axial accelerometers. These devices measure changes in gravitational force in three axes. By temporarily fixing these to the fish, we can now track metrics like tail beat magnitude and tail beat frequency to compare swimming performance profiles across an array of treatment conditions. Our hope is to investigate the effect of tournament-like conditions on swimming performance in smallmouth bass. We intend to use our results to identify the best practices for handling fish to minimize impairment and thus, minimize mortality.

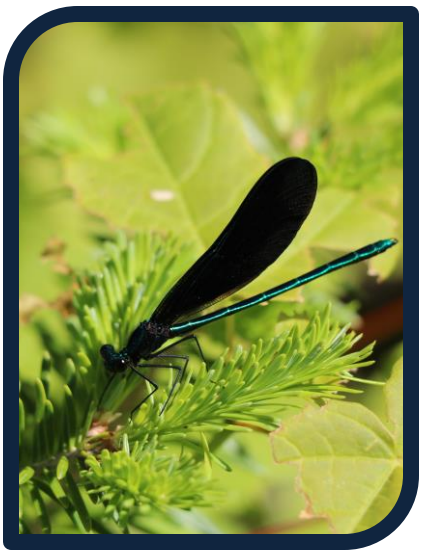
Results Summary:

- This project included 6 treatment groups with 10 fish in each for a total of 60 fish being temporarily fixed with accelerometers.

Status: Data is being analysed, results are anticipated by Spring 2020.

Figure 16. A smallmouth bass being released after a catch and release treatment with an accelerometer temporarily strapped to it's body.

10. Dragonfly Project (#2018-2.1)



Title: Evolutionary and ecological determinants of immune response in North American Odonates.

University / Organization: Concordia University

Researchers: Maggie Blondeau, Serena Sinno, Dr. Jean-Philippe Lessard (Concordia)

Description: Parasites play key ecological roles within communities, potentially by either increasing or decreasing host reproductive rates, altering host behaviour, and/or redirecting the flow of energy throughout ecosystems by withdrawing nourishment from hosts, which can ultimately alter ecosystem functions. A prior study conducted by Daniella Loscerbo (unpublished) describes how certain taxa of dragonflies and damselflies (order Odonata) were more likely to be parasitized by water mites. Water mites are small arthropods that will insert their feeding tube into the body of the odonate in order to withdraw hemolymph; a fluid rich in nutrients. However, dragonflies and damselflies are capable of mounting an immune response wherein the feeding tube of the mite is coated with melanin produced by the odonate, effectively preventing the mite from parasitizing the individual. We are able to measure the strength of that immune response by quantifying the darkness of the melanin layer produced when a mite proboscis proxy is inserted into an individual for a number of hours. When removed, the darker the layer of melanin on the insert, the stronger the defense. This project aims to determine whether the differential parasitism rate in North American dragonflies and damselflies can be explained by variation in odonate immune response along a latitudinal and environmental gradient. If an individual mounts a stronger immune response, it should have fewer live mites bound to it. We expect immune response to be conserved phylogenetically, with individuals from genus' Aeshna, Hagenius, Gomphus, Somatochlora, Dorocordulia, Epitheca, Enallagma and Cordulia having a stronger immune response than individuals from genus' Ladona, Celithemis, Sympetrum, Leucorrhinia, and Lestes. This is expected because the former group were found in Loscerbo's study to have less than expected mite parasitism, whereas the latter had more than expected.

Results Summary:

- In 2019, eight lakes were sampled at Kenauk, the most southern site in the latitudinal gradient, with approximately 400 individuals sampled from at least 18 species.

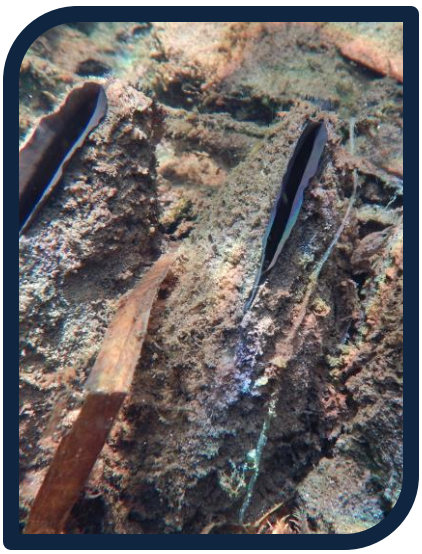
Status: Data collection for this project will continue through 2020.

A

B

Figure 17. A) An donate with mites. B) Post treatment, the mite proboscis proxy insert with a layer of melanin.

11. Mussel Inventory Project (#2018-3.1)



Title: A survey of native freshwater mussels (superfamily: Unionacea) and fishes (family: Cyprinidae, Salmonidae) at Kenauk

University / Organization: Canadian Museum of Nature (CMN), Technische Universität München (TUM), Ministère des Forêts de la Faune et des Parcs du Québec (MFFP)

Researchers: André Martel, Noel Alfonso, Jacqueline Madill (CMN), Jürgen Geist, Sofie Hemprich (TUM), Annie Paquet, Guillaume Canac-Marquis (MFFP)

Description: Freshwater mussels play vital ecological roles in river and lake ecosystems, including nutrient cycling, water filtration, substrate oxygenation and providing habitat. Freshwater mussels and fishes are linked in two significant ways: fish are an essential link in mussel life history and both groups face significant conservation pressures. Freshwater mussels are amongst the most threatened faunal groups globally, with nearly 30% of Canada's species considered at risk. The main causes of the decline for both groups include habitat loss, fragmentation and degradation, overexploitation, non-native species, and climate change. This project will survey Kenauk for mussel and fish species with an emphasis on the Eastern pearlshell recently discovered in the Kinonge Main and the Kinonge West Branch Rivers. We will also aim to determine whether brook trout are the host fish used for metamorphosis and dispersal.

Results Summary:

- Major discoveries about Eastern Pearlshell mussels at Kenauk to date
  - Genetic analysis: a distinct population in North America
  - Distribution: this is the western-most population in Canada for this species
  - Host fish for reproduction: presumed to be Brook Trout
  - Kinonge River West Branch: Ideal habitat for both the Pearlshell and Brook Trout, with cool waters and protective forest canopy
- Fish inventories were carried out in the two rivers to better understand the links between freshwater mussels and fishes at Kenauk. Approximately seven new fish species were inventoried.

Status: Data collection for this project will continue in 2020.

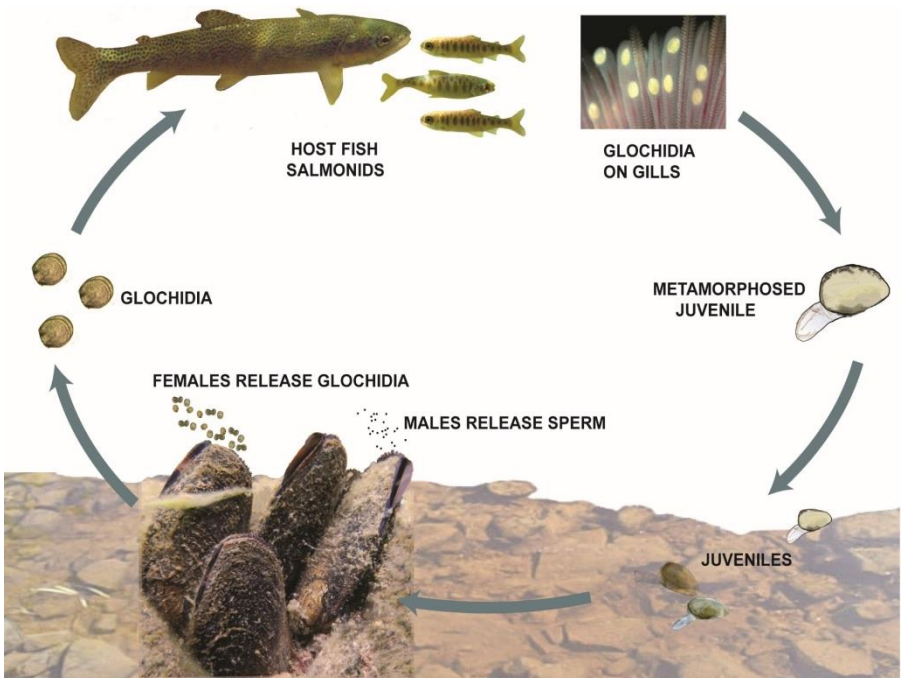


Figure 18. The life cycle of Pearlshell Mussels (Freshwater Mollusc Conservation Society). They can grow to 10-13cm in length and live an average of 93 years, although the oldest Pearlshell mussel was found to be 280 years old.

12. Canada Warbler and Forestry Project (#2018-4.1)

Title: Modelling habitat quality for the Canada Warbler using LiDAR technology on the forest shrub layer.

University / Organization: Dendroica Environnement et Faune, Centre d'Enseignement et de Recherche en Foresterie de Sainte-Foy (CERFO), Nature Conservancy of Canada (NCC)

Researchers: Carl Savignac (Dendroica), Mathieu Varin (CERFO), Marie-Andrée Tougas-Tellier and Catherine Colette (NCC), and many volunteers from the Club des Ornithologues des Outaouais

Description: The Canada Warbler (CW), an endangered species in Canada, nests on the ground in riparian forests and swamps where the shrub layer is dense. The primary objective of this project is to create and validate the first habitat quality index model for this species by incorporating accurate measurements of shrub layer density and height from airborne LiDAR technology. The second objective is to compare Canada Warbler habitat use with the structure and composition of riparian forest nesting bird communities between three riparian forest treatments: 1) unmanaged (≥ 30 years), 2) young partial cuts (2-10 years) and 3) older partial cuts (11-20 years). In 2018, 94 listening stations in 3 treatments were visited twice to identify all breeding birds. Nine vegetation parameters were also measured at 44 listening stations (22 with the presence of CW, 22 without). Preliminary results suggest that the species is relatively abundant in the riparian forests of Kenauk, and possibly most common in older partial cut forests.

13. Tick Inventory Project (#2019-2.1)

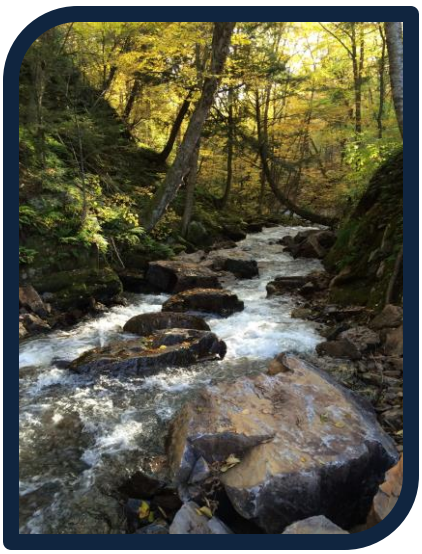
Title: Education about the prevention and risks of Lyme disease as well as inventorying ticks (*Ixodes scapularis*) in Canadian parks.

University / Organization: Institut National de Santé Publique du Québec (INSPQ), Public Health Agency of Canada, The Kenauk Institute

Description: The overall objective of this project is to inform people on Lyme disease, including prevention measures, and to sample *Ixodes scapularis* ticks in the environment safely and independently. We collected ticks from a previously non-sampled area on the property of Kenauk to document local risk and contribute to the National Lyme Disease Surveillance Program. The Kenauk Institute performed 6 surveys on the property, in the most popular areas and along all of the hiking trails. All together we found 10 black legged ticks (the only species that could potentially carry Lyme disease). These ticks were sent for Lyme disease analysis so results are pending.

Status: Data collection for both projects will continue through 2020.

14. Papineau Lake Weir Monitoring Project (#2015-2.1)



University / Organization: The Kenauk Institute

Description: In 2015 the Papineau lake dam was converted into a weir to improve fish access and aquatic habitats. A weir is a low dam structure used to locally modify the hydraulic characteristics of rivers. They can be used to increase the availability of quality habitats for fish reproduction, foraging, and spawning by facilitating fish passage while still maintaining water levels. This weir will improve the physical and chemical condition of the river for fish spawning and circulation in terms of ideal flow rates, water depths, oxygenation and habitat diversity. The goals of this project include monitoring: 1) fish movement between the Kinonge River and Papineau Lake, 2) spawning grounds, 3) the number of fish that return to Papineau Lake and 4) fish circulation and sustainability. In order to monitor the success of the weir in maintaining water levels; a probe has been installed above the weir that measures water depth hourly throughout the year. Comparisons between water level fluctuations before and after the weir installation will allow Kenauk to monitor the success of the weir as well as contribute to the overall monitoring of the Kinonge watershed.

Results Summary:

	2016	2017	2018
Temperature Range (°C)	1.2 – 26.8	1.3 – 23.8	1.5 – 27.7
Variation in Depth (m)	1.03	0.47	1.40

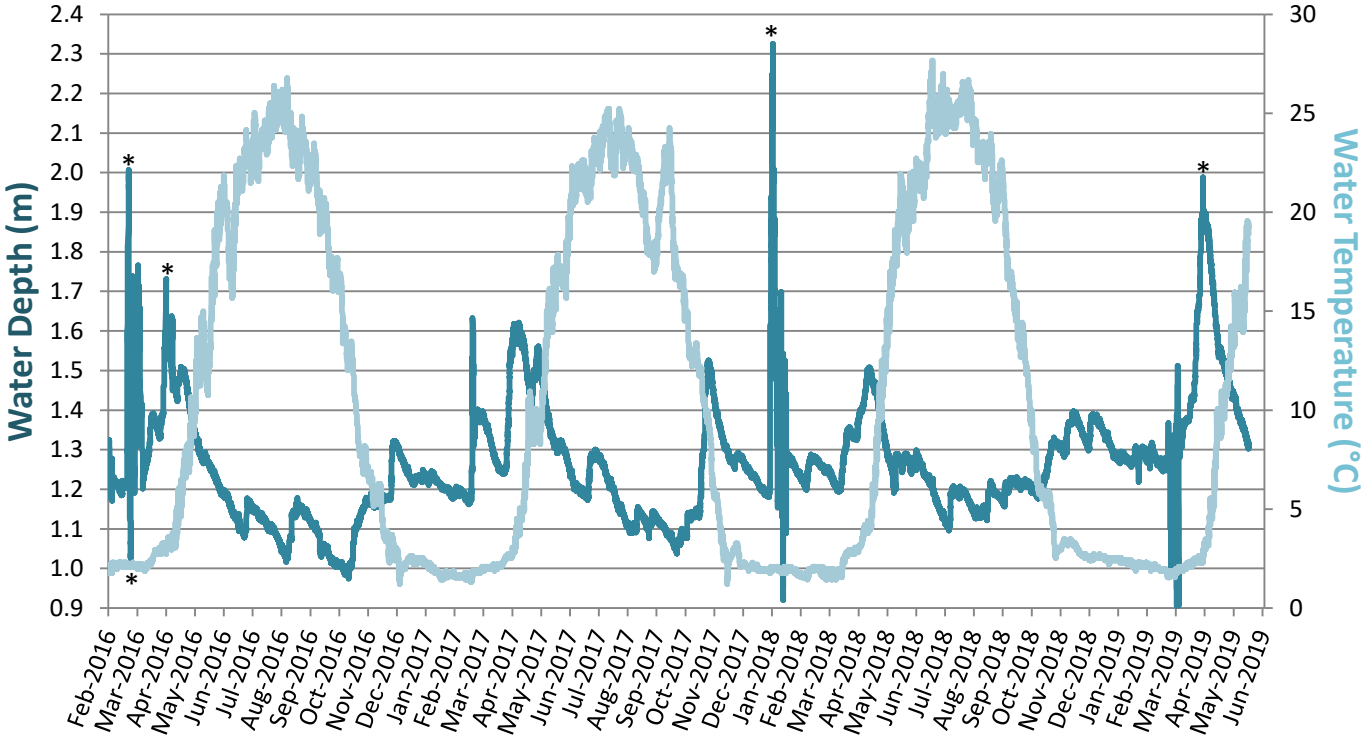
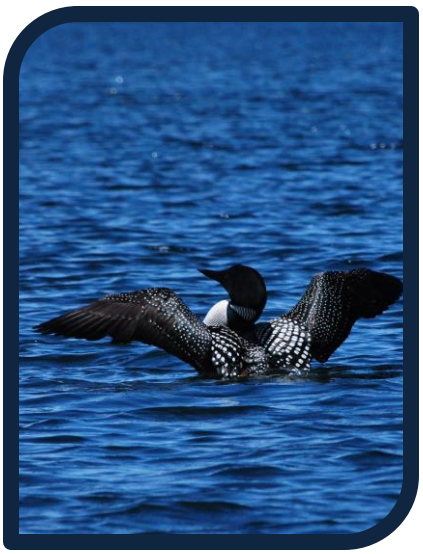


Figure 19. Water depth and temperature above the weir. *Note that water depth was compensated for barometric pressure; however extreme storm events can still affect the data, marked spikes are therefore exaggerated.

Status: Data collection for this project will continue through 2020.

15. Papineau Lake Water Quality Monitoring Project (#2015-3.1)



University / Organization: The Kenauk Institute

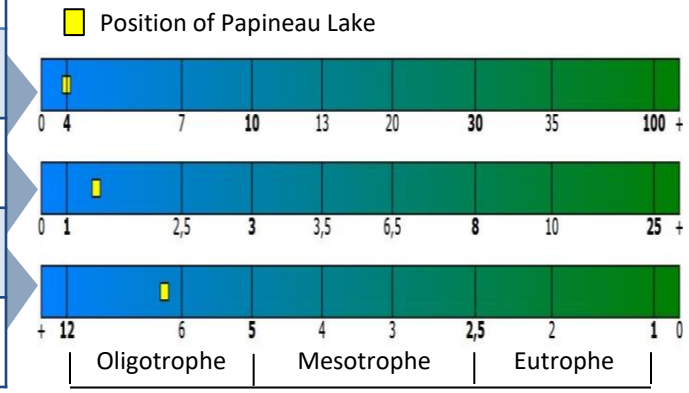
Description: Papineau Lake is a registered lake in the Volunteer Lake Monitoring Program (VLMP) of the Government of Quebec. The Kenauk Institute will periodically take water samples throughout each summer with the goal to establish a long term monitoring protocol for water quality with annual comparisons.

Results Summary:

- Based on multiple factors including the high water transparency, Papineau Lake is classified oligotrophic; it has few to no signs of eutrophication and warrants protection. Preventative measures are needed to limit anthropogenic nutrient input.

Figure 20. Water quality parameters of Papineau Lake (annual averages) and it's corresponding trophic classification.

	2014	2015	2016	2017	2018	2019
Total Phosphorus (µg/L)	6.00	5.18	3.50	3.05	4.15	4.40
Chlorophyll a (µg/L)	1.30	0.87	1.45	1.20	1.45	2.10
Secchi (m)	6.13	6.20	6.30	6.90	6.55	7.15
Organic Dissolved Carbon (mg/l)			3.65	3.30	2.95	3.45



16. Papineau Lake Loon Nesting Project (#2015-4.1)

University / Organization: The Kenauk Institute

Description: While loon populations are currently stable, a number of threats loom, including human encroachment and pollution. Loons select nest sites in quiet, protected areas along shorelines and often reuse the same nesting site annually which makes them particularly sensitive to boat traffic. By mapping nesting loons, we hope to monitor and protect their population.

Results Summary:

- See figure 22.

Status: Data collection will continue in 2020.

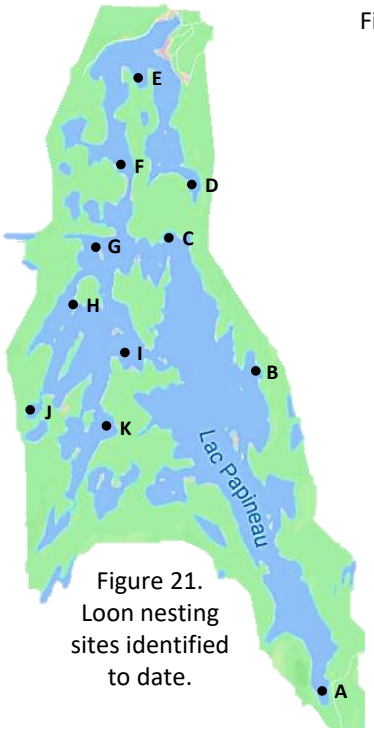
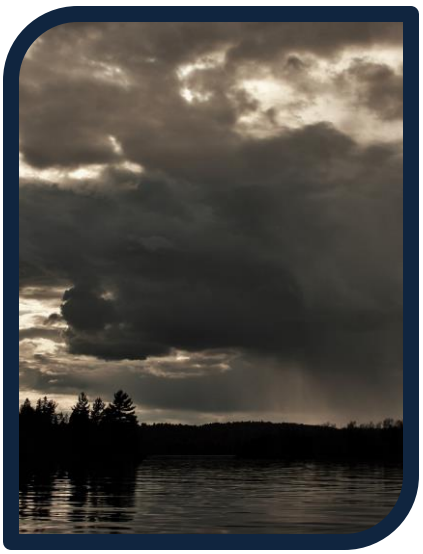


Figure 21. Loon nesting sites identified to date.

Figure 22. Loon observations 2019.

Nest ID	Loon Pair	# of Chicks
A	Unconfirmed	
B	√	1
C	√	1
D	Unconfirmed	
E	Unconfirmed	
F	Unconfirmed	
G	√	1
H	√	1
I	√	1
J	√	Eggs
K	√	1

17. Weather Station Data (#2016-3.1)

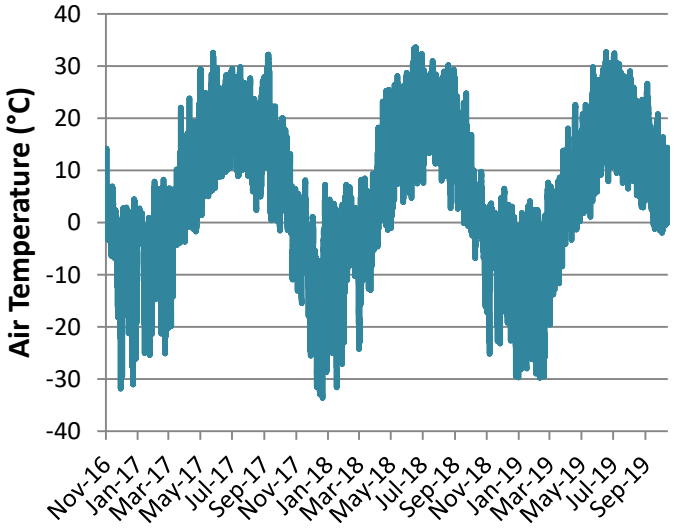


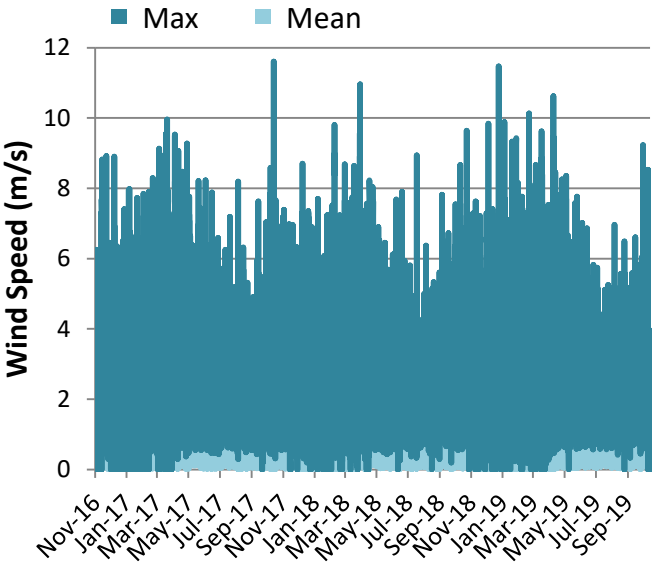
University / Organization: Université de Québec à Montréal (UQAM), The Kenauk Institute

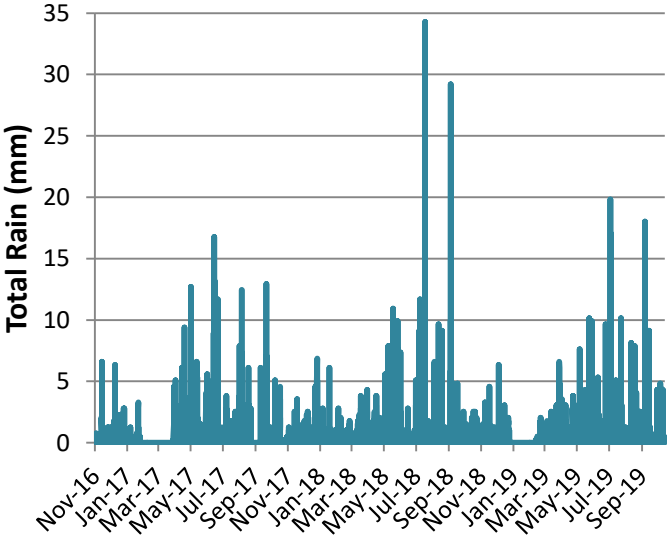
Description: In partnership with UQAM, Kenauk now has a weather station installed at Whitefish Lake. This weather station collects hourly data on temperature, relative humidity, net radiation, wind speed and direction, barometric pressure, rain and snow. Having property-specific data on weather factors benefits all the research projects associated with the Kenauk Institute and supports our long term monitoring mandate.

Results Summary:

- See graphs below for data collected by the weather station.





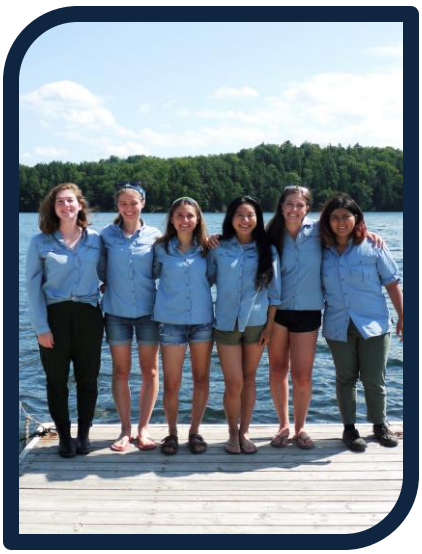


	2017	2018	2019
Max Temp (°C)	32.6	33.6	32.7
Mean Temp (°C)	5.80	7.71	6.22
Min Temp (°C)	-31.5	-33.6	-29.7
Max Wind Speed (m/s)	11.6	11.0	11.5
Max Rain / Day (mm)	47.5	67.1	29.2
Total Rain / Year (m)	0.90	1.13	0.80
Max Snow Depth (m)	0.68	0.75	0.90

Figure 23. Various weather parameters as measured by the weather station.

Kenauk Institute Intern Projects

18. Assessing the fish community in the Kinonge River system. (#2019-1.1)
– Jessica Reid, Dr. Steve Cooke (Carleton University), Dr. André Martel (Canadian Museum of Nature)



Over the past several decades, major biodiversity losses in freshwater ecosystems are of growing concern. The Kenauk Institute provides a unique opportunity to survey the abundance and diversity of freshwater ichthyofauna within a protected watershed. The aim of this study was to survey the diverse fish community in the Kinonge and Kinonge West rivers using a wide variety of sampling gear including GoPros, electrofishing, and minnow traps. Preliminary results reveal temperature-influenced relationships between systems, as the Kinonge is dominated by warm-water species and cold-water species find refuge in the Kinonge West during the summer. This information will be used to inform partnered studies focused on a rare species, the freshwater pearl mussel (*Margaritifera margaritifera*), whose life history is dependent on the surrounding fish community.

19. Bat-UAV interactions and the possibility of using UAVs to survey bats. (#2018-7.1)
– Gabrielle Ednie, Amélie Fontaine, Dr. Kyle Elliott (McGill University)

While Chiropterans (bats) are part of the second most diverse order of mammals in the world, they are also severely understudied despite many species being at risk of extinction. This is partly due to the inefficiency of traditional population survey technics which typically include passive or active acoustic surveys. It is increasingly important to gather data on chiropterans but to do so, new survey techniques must be developed. Over the past decade, unmanned aerial vehicle (UAV) technology has become increasingly compact, efficient, and affordable. As a result, it is quickly being integrated into scientific research. Furthermore, as bats are aerial species and frequently fly above tree canopies, UAVs could be ideal to perform population surveys. However, many studies have found that some animals have negative reactions to UAVs. The objective of this project was to evaluate how chiropterans behave around active UAVs equipped with an acoustic detector. Results of the study could indicate whether UAVs could be used to perform accurate population surveys of bats across the entire Kenauk property.





Kenauk Institute Intern Projects

20. The Relationship between wetland typology and fish communities on Papineau Lake. (#2016-2.1) – Tania Couture (McGill University)

Wetland habitats are among the most productive ecosystems in the world and provide a plethora of ecosystem services. One such service is they provide important habitat for fish and can act as nurseries, spawning, and feeding grounds for many species such as trout, striped bass, pike, and sunfish. The aim of this project was to measure different biotic and abiotic features of distinct wetland types. The wetland types that we observed were swamps, bogs, and marshes, which can have individual characteristics such as pH and vegetation cover. Our aim was to collect data on these habitat characteristics and compare them to fish abundance and diversity that we sampled at each location. Recognizing important habitat characteristics can help us understand what contributes to fish abundance, community structure, and species presence.

21. Increase of Gypsy Moth (*Lymantria dispar*) reproductive fitness after a forest tent caterpillar (*Malacosoma disstria*) outbreak. (#2018-1.1) – Pamela Yataco, Anne-Sophie Caron (PhD), Dr. Emma Despland (Concordia University)

The most recent forest tent caterpillar (FTC) outbreak in Kenauk occurred from 2016 to 2017. The goal of this project was to understand the effect that this could have on 1) the survival and 2) reproductive capacity of other caterpillars. Parasitoids and pathogens that cause forest tent caterpillar populations to crash may also infect other caterpillars such as gypsy moths (*Lymantria dispar*). This cross-infection may lead to an increase in mortality at sites that were previously infested by the FTC. Sources of pupal mortality in the forest defoliated by the FTC were compared with those in an untouched part of the forest and those on open-area trees around the Whitefish Lake meadow. Surprisingly, the results did not show higher gypsy moth pupal mortality in the areas affected by the outbreak: if anything, survival was lower in the undamaged forest than in either the defoliated forest or the heavily human impacted area around Whitefish. These findings point to the importance of healthy forest ecosystems to support natural biocontrol agents that can keep populations of pest insects down.

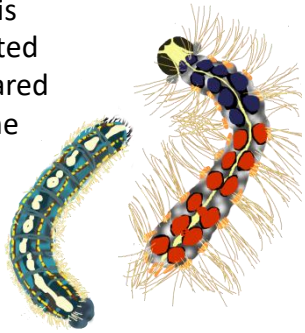


Figure 24. Illustrations of the forest tent caterpillar (left) and gypsy moth (right) by Pamella Yataco.





Research and Educational Partnerships

CERFO

Forêts, Faune et Parcs Québec

Carleton University

Université Concordia University

Fisheries Conservation Foundation

canadian museum of nature nature musée canadien de la nature

McGill

Université de Montréal

The University of Vermont

University of Guelph

Nature Conservancy Canada

ISFORT

UQÀM

Centre d'études nordiques
CEN Centre for Northern Studies

Sustainable Forestry Initiative

Illinois
University of Illinois at Urbana-Champaign

Ouranos

Université du Québec à Trois-Rivières
UQTR

University of Waterloo

Kenauk Nature

Université Laval

UQAT
Université du Québec en Abitibi-Témiscamingue

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World Fish Migration Day

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Donors and Grantors

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- Nature Conservancy of Canada (NCC)
- Natural Sciences and Engineering Research Council of Canada (NSERC)
- Passeport Innovation from the Ministère de l'Économie, de la Science et de l'Innovation, Government of Quebec
- Department of Fisheries and Oceans from the Government of Canada
- Sustainable Forestry Initiative
- Ducks Unlimited Canada