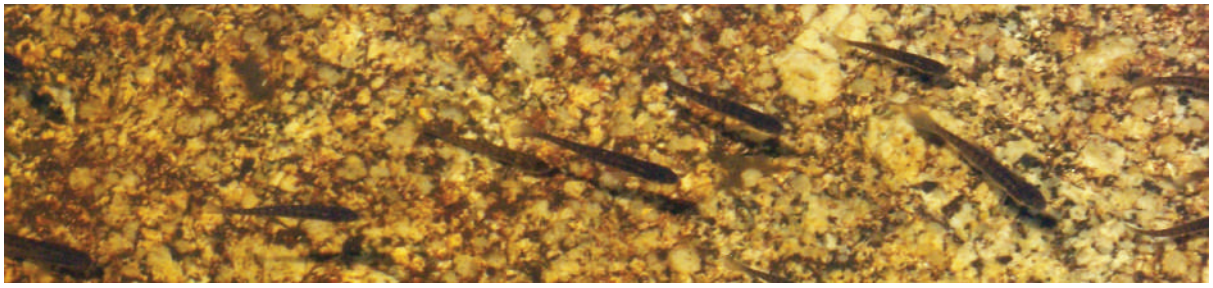
Annual Report of Research and Monitoring in the Greater Kejimkujik Ecosystem 2008



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Mersey Tobeatic Research Institute

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Cover photos from top left:
- Coast of Pieces Island by A. Belliveau, MTRI
- Flying squirrel at Donnellan Lake by A. Lavers, MTRI
- Kyle Rowter standing by an newly installed sign warning of invasive fish species, A. Lavers, MTRI
- Wetlands at Big Dam Lake by A. Belliveau, MTRI
- Minnows in Sixth Lake by A. Belliveau, MTRI

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Annual Report of Research and Monitoring in the Greater Kejimkujik Ecosystem 2008

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FRESHWATER5

WETLANDS

HUMAN DIMENSIONS

INTRODUCTION

This is the fourth Annual Report of Research and Monitoring in the Greater Kejimkujik Ecosystem. As with previous editions, this one was inspired by a very similar series piloted by the Parks Canada Western Arctic Field Unit. This report serves as a compilation of the research and monitoring projects that were conducted in the Kejimkujik area. The summaries are all written by the researchers who are listed as contacts for each project but the report as a whole is a collaborative effort between Kejimkujik National Park and National Historic Site of Canada (Kejimkujik) and the Mersey Tobeatic Research Institute (MTRI). A committee comprised of Amanda Lavers and Crystal Doggett (MTRI), Sally O'Grady, Darien Ure, and Chris McCarthy (Parks Canada) collected, edited, and prepared the publication. Many thanks to all the researchers who took the time to submit the research and monitoring project summaries this year.

This report was produced in summer 2009 and is a compilation of the research and monitoring projects that were conducted in the Kejimkujik area in 2008 by Parks Canada, MTRI, and their partners. The purpose of the report is to make information about these projects available to the public, government agencies, researchers and other stakeholders.

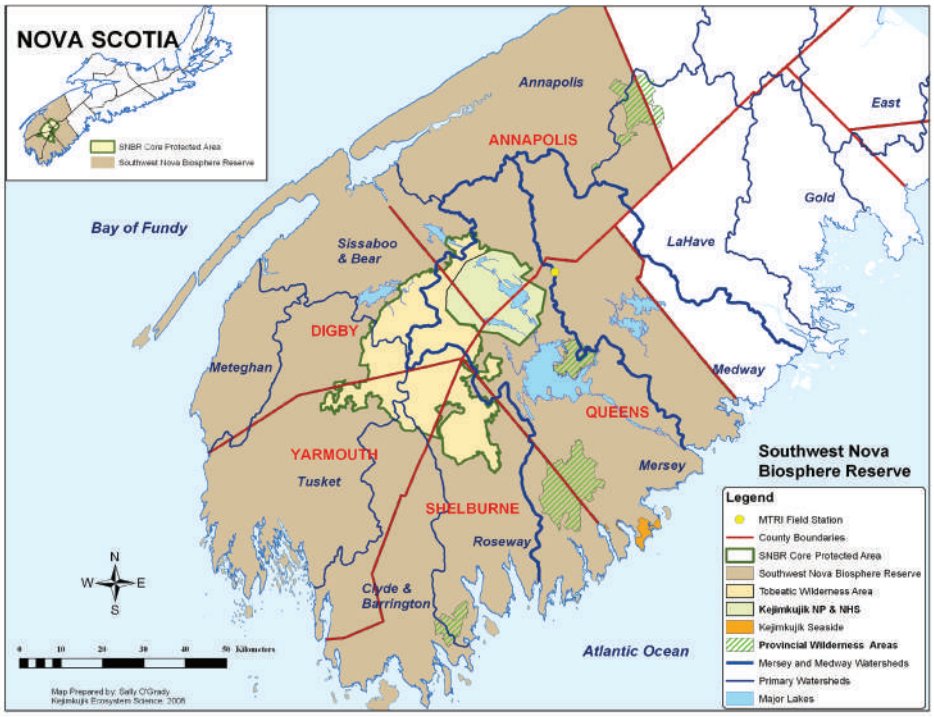
Research and monitoring projects provide the information necessary to make wise management and conservation decisions. The projects in this report are organized in four chapters corresponding to Kejimkujik's Indicator Ecosystems: Coastal, Forest, Wetland, and Freshwater, with an additional chapter highlighting research about the Human Dimensions of sustainable resource use. Projects are categorized as either monitoring or research projects.

The research and monitoring projects detailed in this report are important tools for attaining sustainable management of our natural resources and maintaining ecological integrity of our protected areas. The monitoring projects are conducted to keep track of how the ecological systems around us are changing over time and examine the effectiveness of management actions. The research projects provide a better understanding of the ecology of the area and how it is affected by natural and human-related influences. Overall, they indicate an impressive amount of work that is being undertaken in Kejimkujik and the surrounding area.

Kejimkujik represents the Atlantic Upland Natural Region in Parks Canada's network of protected areas. Kejimkujik consists of 381 km^2 inland and 22 km^2 on the coast and, in combination with the Tobeatic, is the core area of the Southwest Nova Biosphere Reserve. Since its establishment, Kejimkujik has been an important centre of science for southwest Nova Scotia. In collaboration with partners, research and monitoring in the park and surrounding landscape has informed decision-makers on a number of management issues at local, regional and national scales. Kejimkujik was declared the first Ecological Monitoring and Assessment Network site in Canada (1993) and was the first in Canada to install a Smithsonian Institution Monitoring and Assessment of Biodiversity plot (1994). Kejimkujik also serves as one of five core Canadian Acid Precipitation Monitoring Network sites that monitor the long-range transport of air pollutants and is a long-term climate monitoring station for Environment Canada. In 1995, Kejimkujik was designated a national historic site (the only national park in Canada with this dual designation) highlighting the cultural significance of the area and the importance of aboriginal peoples to understanding and presenting commemorative integrity. Kejimkujik is identified by the Parks Canada Agency as a species at risk priority site where stewardship and recovery are paramount. More information about Kejimkujik can be found at www.pc.gc.ca/pn-np/ns/kejimkujik or at the Friends of Keji Cooperative Association website (www.friendsofkeji.ns.ca).

The Mersey Tobeatic Research Institute (MTRI) is a non-profit co-operative with a mission to advance collaborative research, monitoring, and management that promotes sustainable use of resources and biodiversity conservation in the Southwest Nova Biosphere Reserve. MTRI maintains a field station that provides office workspace, accommodation for researchers, space for public presentations and a site for learning. MTRI provides expertise in the community and coordinates research and monitoring projects to address the goal of sustainable resource management. MTRI also provides an important link from research to the public through an active outreach and education program. More information about the co-operative is available at www.merseytobeatic.ca.

The Southwest Nova Biosphere Reserve (SNBR) comprises a large portion of terrestrial and coastal southwestern Nova Scotia (see map below). The United Nations Educational, Scientific and Cultural Organization (UNESCO) internationally recognizes a biosphere reserve as an area in the world that is deemed to demonstrate a "balanced relationship between humans and the biosphere." Biosphere reserves around the world fulfill the following three functions: conservation, sustainable development, and capacity building. Collaborative efforts among people in the designated area promote the sustainability of local economies and communities, as well as the conservation of the ecosystems. A biosphere reserve is also a mechanism used for regional planning and multi-sector collaboration. It offers an opportunity for the community to envision sustainability for the region and to work towards achieving it. In 1999, a group of volunteers from Queens and Annapolis counties in Nova Scotia developed a proposal for the establishment of a UNESCO Biosphere Reserve incorporating Kejimkujik and the Tobeatic as the core protected area. This group of volunteers later became incorporated as the Southwest Nova Biosphere Reserve Association (SNBRA). In September 2001, the nomination document received approval and the region of southwest Nova Scotia was designated a biosphere reserve by UNESCO.



S. O'Grady, Parks Canada

Kejimkujik and Tobeatic comprise the core area of the Southwest Nova Biosphere Reserve.

Photos on page 9 by A. Belliveau, MTRI
Clockwise from top left:

- Saulnierville by A. Belliveau, MTRI
- Tusket Islands by A. Belliveau, MTRI
- Feather at Delaps Cove by A. Belliveau, MTRI
- Annapolis Royal by A. Belliveau, MTRI
- Plover on the beach by D. Clapp
- Saulnierville shore by A. Belliveau, MTRI

COASTAL

Rationale

The Piping plover is a small shorebird that has been listed as an Endangered species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) since 1985. Presently, the Piping plover nests on the white sandy beaches of southwest Nova Scotia, including St. Catherine's River Beach at the Kejimkujik Seaside. In recent years, the number of nesting pairs of Piping plover in the province has decreased significantly due to: habitat disturbance, loss and fragmentation, predation and development of over-wintering grounds. The Piping plover is often referred to as a *management dependent species*, as sustained management actions are needed to maintain and increase population levels. Park staff have monitored plover adults and chicks within the park since 1985 to assess Piping plover population levels at the Kejimkujik Seaside (and southwest Nova) and to implement a suite of management strategies focused on protecting and sustaining plover numbers.

H. Reed, Parks Canada

Piping plover on Summerville beach

Monitoring

PIPING PLOVER MONITORING PROGRAM

OBJECTIVES

- To monitor the status of Piping plover populations, breeding pairs and chick fledgling success.
- To protect Piping plover nests from predation via exclosure use.
- To examine predation and abandonment of nests through experimental deployment of a digital video recorder.
- To restore, maintain and monitor suitable nesting habitat for Piping plover in Kejimkujik.

H. Reed, Parks Canada

A Piping plover nest at the Kejimkujik Seaside

METHODS

- Park staff monitored St. Catherine's River Beach frequently during Piping plover nesting season. This was done at a distance with binoculars and spotting scopes. Other birds and animals, including predators, were also noted.
- Nest, chick, and habitat observations were recorded. Nests were located by observing territorial birds and individuals exhibiting nesting behaviours.
- When necessary, protective wire predator exclosures were installed to protect the eggs and nesting adults from most predators. All nests were coded and georeferenced.
- A digital video recorder was deployed on nests with 4 eggs to monitor potential predation and study abandonment rationale.
- Habitat restoration was completed on one section of St. Catherine's River Beach, through the removal of dense marram grass using a tractor and by hand.

RESULTS

- Three pairs of Piping plovers were observed at St. Catherine's River Beach and two nest attempts were documented
- The first nest had an exclosure placed around it to protect it from predators and a video camera was deployed to monitor predation attempts. Unfortunately, this nest was abandoned 1-2 days after cameras were deployed.
- The second nest hatched and fledged four chicks.
- The habitat management area was modified to natural contours on the beach in an effort to mimic natural blow-outs.

YEARS OF DATA

- Ongoing project since 1985

PARTNERS

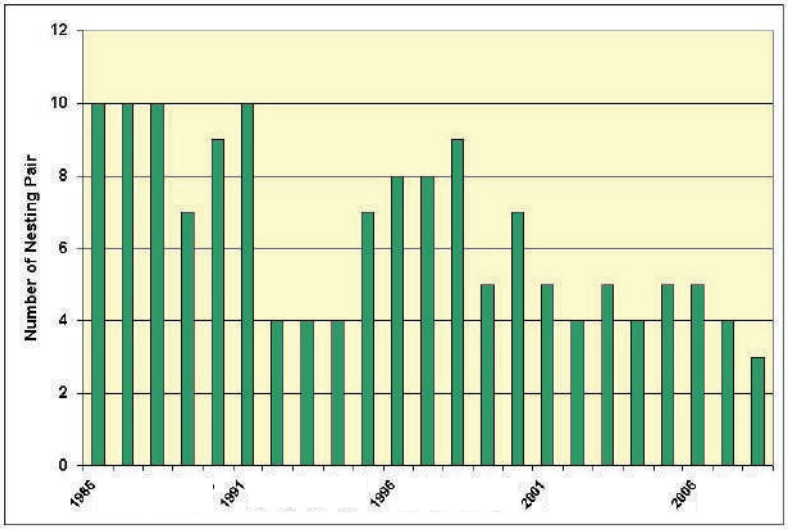
- Parks Canada
- Piping Plover Recovery Team (Eastern Canada)
- Bird Studies Canada
- Environment Canada
- Province of Nova Scotia

Parks Canada

A volunteer working on the habitat restoration project

Parks Canada

Park staff and volunteers observing Piping plover



Parks Canada

Number of nesting pairs of Piping plover on St Catherine's River beach, Kejimkujik Seaside 1986-2008

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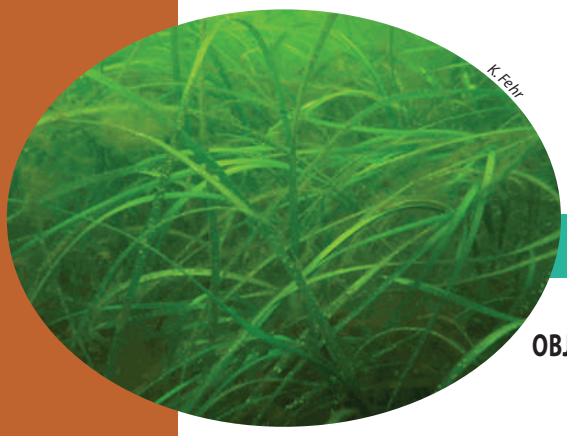
Rationale

Eelgrass is the dominant seagrass species in Atlantic Canada. Eelgrass habitats perform important ecological services in nearshore waters, often referred to as a 'keystone species' due to its ability to enhance biodiversity and productivity. Eelgrass beds provide nursery habitat for juvenile stages of fish and invertebrates and important feeding habitat for migrating waterfowl. The primary production of eelgrass beds and their associated epiphytic community exceeds that of many cultivated terrestrial systems, playing an important role as biological filters, exporters of organic matter to subsidize productivity of other coastal ecosystems, and as valuable carbon sinks. Declines in eelgrass can precipitate cascading ecosystem effects and a loss of valuable ecological services in the nearshore.



K. Fehr

Eelgrass

Monitoring

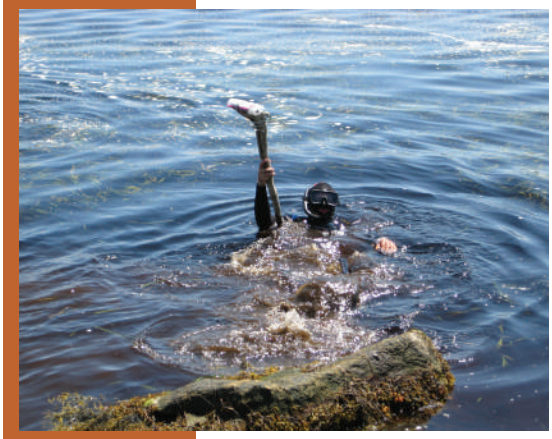
EELGRASS MONITORING AND RECOVERY

OBJECTIVES

- To monitor vegetation parameters that are indicators of the extent and condition of eelgrass habitat.
- To capture temporal trends in eelgrass extent and condition.
- To assess whether these changes are within the normal range of variation expected for eelgrass beds.
- To provide insight into the causes and ecological consequences of these changes.
- To assess whether the observed changes necessitate a management response.

METHODS

- Suitable eelgrass habitat at St. Catherine's River Basin and Little Port Joli Basin are surveyed annually by canoe to determine the presence of eelgrass beds. The extent of each discrete bed are mapped by a swim survey using a mask and snorkel. The surveyor carried a GPS unit with a track function to record a location every 20 seconds for later mapping and area determination.
- The SeagrassNet monitoring protocol was used based on population and shoot-based measures of seagrass condition, as well as important ancillary variables such as grazing, epiphyte loading, wasting disease and water quality variables.



A. Pelletier

Chris McCarthy conducting eelgrass surveys by GPS at Little Port Joli Basin

RESULTS

- Eelgrass extents at Kejimkujik Seaside have declined by 88% since 1987, 6% between 2007 and 2008. It is completely absent from St. Catherine's River Beach Lagoon.
- Eelgrass condition assessments indicate serious concerns. Shoot density is declining and wasting disease is present in the remaining bed. High numbers of European green crabs were observed and the Golden star tunicate, a highly invasive tunicate species, was detected for the first time on eelgrass shoots in 2008. Thick growths of the opportunistic filamentous brown algae were noted along with dense mats of filamentous green algae. Grazing effects were minimal.

RESULTS
Continued

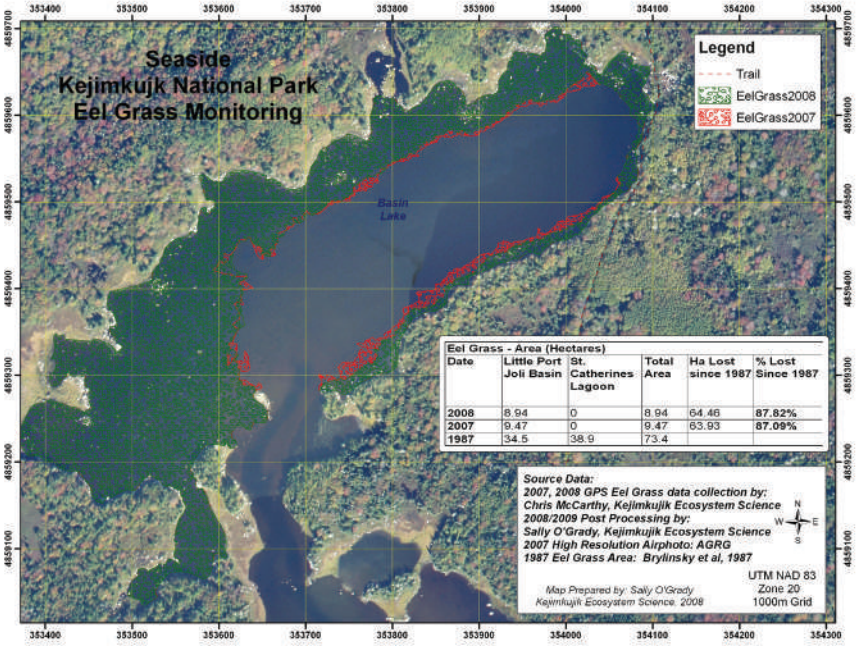
- Lagoon water quality analysis indicates that natural nutrient enrichment occurs in some areas of the lagoon. When compared to an index range and optima for eelgrass growth, mean salinity and sediment type both fall within the optima. The minimum salinity measured in Basin Lake (5 ppt) falls outside the optima for eelgrass growth, but is still within the range. Mean temperatures for July and August measured at the shallow and deep eelgrass transects exceeded the optimum for eelgrass growth, while maximum temperatures greatly exceeded the optimum but still fell within the range of suitable conditions for eelgrass growth.

YEARS OF DATA

Ongoing project since 1987

PARTNERS

- Parks Canada
- Dalhousie University
- Department of Fisheries and Oceans



S. O'Grady, Parks Canada

Remaining eelgrass at Kejimkujik is restricted to Basin Lake at the northern extreme of Little Port Joli Basin

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Rationale

Coastal marine systems world-wide are threatened by invasions of non-native species. The European green crab is an exotic invasive species present along the Nova Scotia coastline. Several studies have shown the green crab to be an 'ecosystem engineer', having significant predation impacts on local species such as soft-shell clams, blue mussels and the physical destruction of eelgrass beds. This project is investigating population dynamics and developing a monitoring program for the green crab population to help address management and restoration considerations.

Female green crab with eggs

Monitoring

EUROPEAN GREEN CRAB COASTAL MONITORING

OBJECTIVES

- To investigate the Little Port Joli Bay Lagoon and Basin Lake (Kejimkujik Seaside) green crab population dynamics.
- To determine the best green crab sampling techniques for the study site.
- To develop a long-term monitoring program for green crab.

METHODS

- A mark-release-recapture study was used to estimate the study site population.
- Different sampling techniques and protocols were explored to assess monitoring requirements: modified eel traps, minnow traps, beach seine, and transect surveys.
- Individual green crab biological data were recorded throughout all sampling investigations.

Three green crabs observed while snorkelling the field site

RESULTS

- Preliminary results indicate the Little Port Joli Basin green crab population to be several hundred thousand individuals (a specific value could not be determined due to a low number of recaptures).
- Both modified eel and minnow traps were determined to be the most efficient methods for sampling green crabs.
- Fourteen permanent green crab monitoring stations have been established to be used on a yearly basis to assess catch per unit effort.

YEARS OF DATA

Ongoing project since 2008

PARTNERS

- Parks Canada
- Dalhousie University
- Department of Fisheries and Oceans

D. Pouliot, Parks Canada

Green crab traps at Kejimkujik Seaside

M. Bojarski

Chris McCarthy and Kristina Benoit refining transect survey methodology

D. Pouliot, Parks Canada

Measuring green crabs

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Rationale

Nutrient enrichment of the coastal zone as a result of anthropogenic inputs of nitrogen and phosphorus can significantly impact ecosystem structure and function in estuaries and lagoons. In shallow waters, nutrient enrichment can cause blooms of fast growing algae and epiphytes, which may eliminate slower growing submerged aquatic vegetation such as macroalgae and seagrasses, both of which provide important nursery habitat in coastal waters for many fish and invertebrate species. Harmful algal blooms and oxygen depletion in bottom waters are also symptoms of nutrient enrichment and can precipitate the collapse of shellfish and fish stocks and changes in benthic species composition. Lagoon water quality is monitored at the Kejimkujik Seaside using the Lagoon Water Quality Index (LWQI), which is composed of measures of dissolved inorganic nitrogen (DIN) concentration, dissolved phosphorous (P) concentration and dissolved oxygen (DO) concentration.

D. Ure, Parks Canada

Little Port Joli Lagoon

Monitoring

LAGOON WATER QUALITY MONITORING

OBJECTIVES

- To monitor water quality in lagoons at the Kejimkujik Seaside.
- To determine if the LWQI is within the range of natural variation at Kejimkujik and if it is decreasing over time.

METHODS

D.Ure, Parks Canada

Eel grass and algae

- Water samples were collected from 18 sites throughout Little Port Joli Basin, one of the two coastal lagoons in the Kejimkujik Seaside. Sample locations were selected to ensure even coverage of the water body.
- Samples were collected bi-weekly from June to September in 2008. Surface water was sampled using a sterile container and samples were analyzed for multiple water quality parameters, including dissolved nutrient content (nitrate, phosphate, silicate and ammonia), phytoplankton biomass (measured as chlorophyll a), total particulate matter (TPM) and coloured dissolved organic matter. Several water chemistry parameters (salinity, dissolved oxygen, temperature, pH and total dissolved solids) were also sampled at each site as ancillary data.
- Locally relevant thresholds for dissolved inorganic nitrogen (≤0.020 mg/L), dissolved phosphorous (≤0.015 mg/L), and dissolved oxygen (≥7.8 mg/L) were developed for the Atlantic shoreline of Nova Scotia by the Canadian Council of Minister's of the Environment (CCME) using the reference condition approach. These thresholds were used to assess the condition of water quality in lagoons at the Kejimkujik Seaside.
- The mean value of each of the three water quality measures (DIN, P, DO) for 2008 was compared to the established threshold and assigned a score (where measures that met the threshold received a value of 1; measures that exceeded threshold received a value of 0).
- The three measures were then averaged to produce a score for the Lagoon Water Quality Index between 0 and 1 (where 1 is the highest water quality). The condition of lagoon water quality was considered 'good' if the LWQI score was greater than 0.66; it was considered 'poor' if the LWQI score was less than 0.33; it was considered 'fair' if the LWQI was between 0.33-0.66.

RESULTS

D.Ure, Parks Canada

Little Port Joli Lagoon

- Mean dissolved inorganic nitrogen concentration in the Little Port Joli lagoon was significantly higher than the reference condition threshold in 2008. This indicates that there may be elevated nitrogen levels and nutrient inputs to the lagoon. As a result, DIN was assigned a score of 0.
- Mean dissolved phosphorous concentration and mean dissolved oxygen concentration both met the reference condition thresholds and were assigned scores of 0, indicating that the condition of these measures is currently not a concern in the Little Port Joli lagoon.
- The scores from the water quality measures were averaged to produce an overall Lagoon Water Quality Index score of 0.66, indicating that the condition water quality in the Little Port Joli lagoon at the Kejimkujik Seaside was fair in 2008.
- Signs of nutrient enrichment were also detected in visual surveys of the lagoon. Dense mats of filamentous green algae were observed in poorly flushed areas of Basin Lake and the western side of the main lagoon. A filamentous brown algae species associated with nutrient enrichment was observed on rockweed and in its free-floating form in some areas of the eelgrass bed in Basin Lake.
- This analysis indicates that nutrient enrichment may be occurring in some areas of the lagoon as a result of restricted tidal flushing, but not to a level that indicates eutrophication at this time.

YEARS OF DATA

- Ongoing project since 2008

PARTNERS

- Parks Canada
- Dalhousie University
- Bedford Institute of Oceanography
- Acadia Centre for Estuarine Research

D.Ure, Parks Canada

Aimee Pelletier processing water samples

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Rationale

The Kejimkujik Seaside has two major Zone 1 (Special Preservation) areas that encompass estuarine lagoons at St. Catherine's River Beach and Little Port Joli Beach. These lagoons are major components of the Boreal Estuarine Ecoregion which covers about 20% of Kejimkujik Seaside, and provides an immense variety of habitats for coastal and marine species in the transition from freshwater to saltwater. The lagoons are protected by barrier beaches (long sand spits with dune complexes) that maintain the integrity of these estuaries. These beaches offer an excellent opportunity to monitor the interaction of a beach/dune/marsh complex advancing landwards as the coastline submerges and sea level rises. Sea level rise is expected to exceed 70 cms this century. By tracking this change, park managers will obtain advance warning of accelerated sand shifts and the ability of the dunes to react to rising sea levels.

C. McCarthy, Parks Canada

Sand encroachment into forest at St. Catherine's River Beach

Monitoring

BARRIER BEACH DUNE DYNAMICS MONITORING

OBJECTIVES

- To monitor change in the established rate of dune movement, based on an analysis of historic aerial photography dating back to 1927.
- To compare different technologies (permanent posts, Wild Survey Level, RTK/PPK GPS, LiDAR, Total Station) to determine the most efficient and cost effective protocol for long-term monitoring of dune dynamics.
- To establish a correlation between this measure and surrounding nearest point DFO-Canadian Hydrographic Service Water Level Tide Gauge Stations to establish the timing and spatial extent of sea level rise and storm surge events on these sensitive barrier beach systems.
- To conduct long term monitoring of major shifts in dune movement and to assess the effects on other coastal ecosystem components.

C. McCarthy, Parks Canada

Little Port Joli Beach dunes

METHODS

- Surveys were conducted at a standardized interval annually, based on tidal cycle, GPS configuration timing and prior storm event timing.
- Measurements were made along permanent transects at a maximum of 5 m intervals, with more frequent fixes for elevation change or major vegetation community change.
- The GPS data were corrected from a fixed base station located over a known survey benchmark.
- Field measurements were interpreted in terms of three elements: 1) profile shape, 2) crest movement, and 3) vegetation community extents change.

RESULTS

- Nine series of air photos have been obtained to track major habitat movement back to 1927. Analysis is still in progress.
- To date, investigation using permanent posts, LiDAR, Wild Survey Level and RTK GPS methods have been completed. Methods are being compared based on cost and accuracy related to repeat interval.

RESULTS
Continued

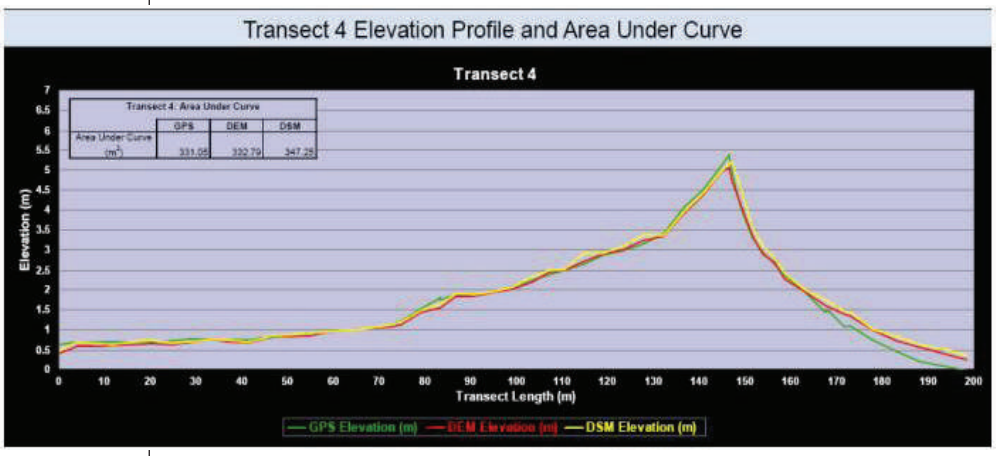
- Observations show that the beach continues to move inland but it is unclear at this time how the sand budget is changing.
- Permanent posts installed in 1995 show up to a 17 m crest movement inland (between x and y) over the past 13 years.
- The GPS technology provided an acceptable level of accuracy and was useful for delineating vegetation community banding along the dune.This was the first year of vegetation community mapping along transects.

YEARS OF DATA

- Ongoing project since 1995

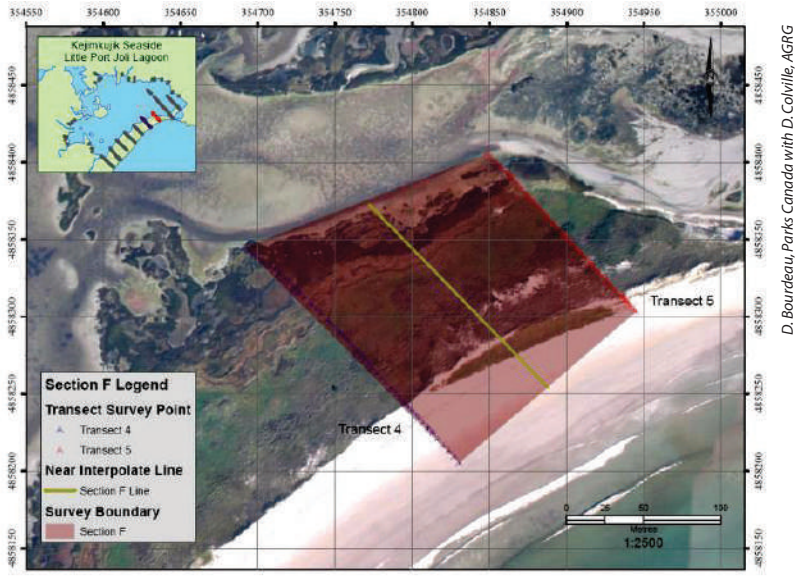
PARTNERS

- Parks Canada
- Applied Geomatics Research Group, Nova Scotia Community College



D. Bourdeau, Parks Canada with D. Colville, AGRG

Profile area calculation using different technologies



D. Bourdeau, Parks Canada with D. Colville, AGRG

Example of dune section area modeling based on transect profiles

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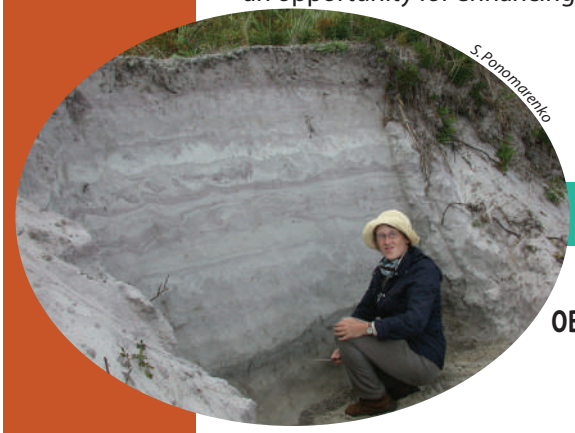
Rationale

Woodland caribou was extirpated from Nova Scotia in the 1920s, and little is known about its migration pattern in the province. In 2007, during the fire history study in the Kejimkujik Seaside, Stratigraphic evidence of repeated seasonal passage of ungulates (hooved animals) was found. The passage is a narrow corridor connecting inland with the coast, cutting through a low coastal dune within 20 meters from the present shoreline of St. Catherine's Beach. Traces of ungulate migration are preserved as hoof print trace fossils associated with seasonal deposits. On the basis of the size and shape of hoof print trace fossils and their occurrence within the depositional sequence in the site, the hoof prints have been identified as those of woodland caribou. This site is the first and only known paleontological site worldwide with the evidence of repeated caribou migrations: finding such a site within the park has great educational potential and presents an opportunity for enhancing visitor experiences.



Elena Ponomarenko working at the bank where a vertical section was manually prepared at Kejimkujik Seaside

Research

PALEONTOLOGICAL STUDY OF A CARIBOU PASSAGE

OBJECTIVES

- To confirm the presence of ancient caribou passage in the Kejimkujik Seaside.
- To preserve evidence of past caribou migration through the area.

METHODS

- A vertical section of the bank cut was manually prepared and described using standard sedimentological protocols; sediment samples were collected from each depositional layer and from a basal pyrogenic layer.
- Charred material from the basal layer was radiocarbon dated to determine the age of the passage.
- Paleontological methods of trace fossil analysis were applied to describe hoof prints on additional horizontal sections.
- Numerous high-quality photos of horizontal planes were made, depicting hoof prints of various shapes and degrees of preservation.
- A trial thin-section of a well-preserved caribou hoof print was made.

RESULTS

- Collected data demonstrates clearly that the site has been repeatably used as a caribou passage.
- Migrations were seasonal, occurring in either late fall or in early spring time, and involved a number of animals crossing the dune along a narrow path.
- Radiocarbon dating of charred grasses at the base of the section showed that the site had been used by caribou since approximately 500 years ago. At that time St. Catherine's River Beach had been changed radically by the storm that caused a catastrophic water surge and deposited numerous sand dunes in the area.

RESULTS
Continued

- Over 20 episodes of caribou migration are imprinted in dune deposits. In some time periods migrations occurred each year, whereas in other time periods the passage could have been abandoned for several decades.
- Indirect evidence of caribou presence in the area comes from archival materials: caribou has been depicted on Champlain's map of Port Mouton area close to the location of the passage.
- This truly unique site is being rapidly eroded. More in-depth excavations are needed to preserve all possible information on the site before it disappears. Actions could include creation of thin-sections of hoof prints for displaying in museums and interpretive centres, as well as creation of a video clip on techniques of excavation and information revealed.

YEARS OF DATA

- Year 1 of a 1 year project

PARTNERS

- Ecosystem Archaeology Services
- Parks Canada

S. Ponomarenko

Elena Ponomarenko showing a thin section of caribou hoof print

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Clockwise from top left:

- Butterfly in forest near 6th Lake by A. Belliveau, MTRI
- Treetops in Tobeatic Wilderness Area by A. Belliveau, MTRI
- Blue bead lily at Five Hardwood Hills by A.Belliveau, MTRI
- Deer at Jakes Landing, Kejimkujik by A. Belliveau, MTRI
- Pine boughs by A. Belliveau, MTRI

FOREST

Rationale

Christmas Bird Counts have been carried out annually for over a century. They have been conducted at several locations in Nova Scotia over the last 50 years. Currently, within Nova Scotia, approximately 35 Christmas Bird Counts are conducted every year. The counts occur on one day between mid-December and early January (hence the name Christmas Bird Count) within the same set area. The bird counts document early winter birds and can be compared from year-to-year and area-to-area. The Nova Scotia Bird Society maintains a master record of all counts within the province and annually reports the counts with notes on the unique results of that year.

A. Belliveau, MTRI

Hairy woodpecker

Monitoring

CALEDONIA CHRISTMAS BIRD COUNT

OBJECTIVES

- To document early winter birds during an ongoing annual survey.
- To record sufficient data so that the results may be compared from year-to-year and count-to-count.
- To utilize interested volunteer members of the public to complete the annual count.
- To publicize the results to inform and interest the local public in the bird communities of the Caledonia area.

METHODS

- Annually, a one day Christmas Bird Count has been held between specific dates determined by the Audubon Society between mid-December and early January.
- The count was held on one specific day from midnight to midnight.
- The count has always been held in the same area - a circle of 24 kilometers diameter centered where a brook flows northward out of Donnellan Lake in West Caledonia.
- The coordinator organized volunteers to cover different areas so the maximum number of habitats can be searched and the most species located while preventing repeated counting of the same birds in the same areas.
- The bird species and their numbers were recorded.
- The time spent in the woods and at bird feeders, distances traveled, methods of travel and numbers of people involved were recorded to compare the effort by observers.

A. Belliveau, MTRI

Black capped chickadee at bird feeder

RESULTS

- This is Nova Scotia's only entirely inland Christmas Bird Count.
- The December 14, 2008 count noted 37 bird species and 1,930 total birds.
- Forty-one observers participated.

RESULTS
Continued

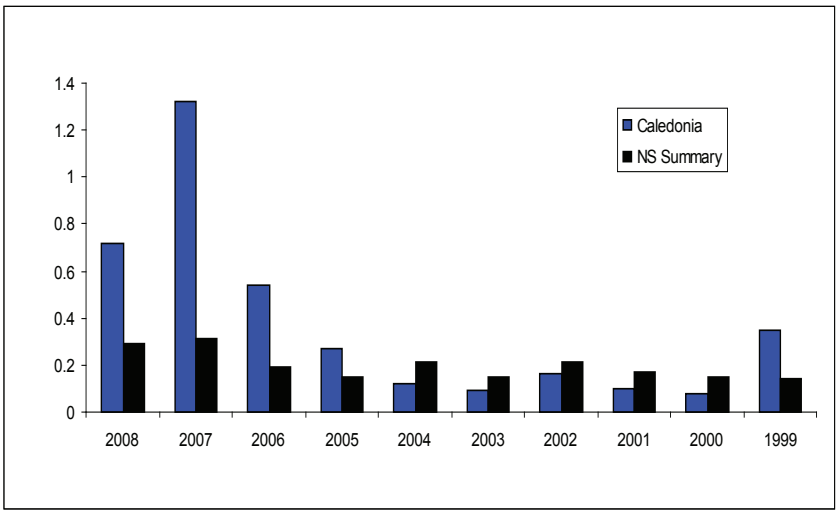
- Over the last 10 years, the Caledonia count has had higher numbers of woodpeckers and lower numbers of Red-tailed hawks than the Nova Scotian average.
- The Caledonia count had six times the frequency of Barred owls as did all other Nova Scotia counts.
- Only 12 species have been reported consistently for every year of the Caledonia count but over 65 species have been noted on one or more counts.

YEARS OF DATA

- Ongoing project since 1991

PARTNERS

- Nova Scotia Bird Society (NS summary data provided by David Currie)
- Mersey Tobeatic Research Institute

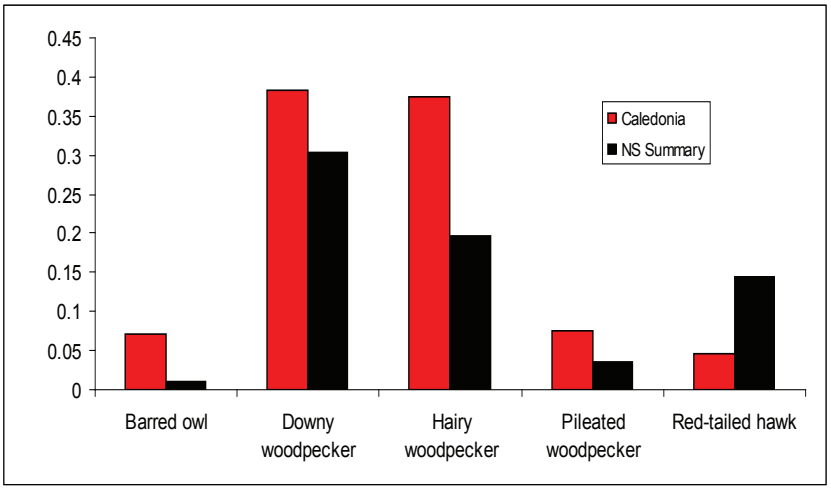


MTRI

Number of Hairy woodpeckers per party hour recorded in the Caledonia Christmas Bird Count graphed against the Nova Scotia Christmas Bird Count summary for the years 1999 to 2008

A. Lavers, MTRI

Young Caledonia birdwatcher, Carter Feltham



MTRI

Comparison of the 10-year average number of birds per party hour recorded in the Caledonia Chrismas Bird Count to the summary of all Nova Scotia Christmas Bird Counts

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Rationale

Nocturnal owls are surveyed across Canada as indicators of forest ecosystem health. As top predators in the food chain, they are vulnerable to habitat disturbance. Barred owls have specialized habitat requirements that link them to large hardwood trees for cavity nesting. Additionally, they are sensitive to forest cover and composition changes associated with forest management activities. Owls are not easy to monitor due to their secretive, nocturnal activities. They roost for much of the day and attempts to conduct visual surveys are challenging. Bird Studies Canada coordinates surveys in all three Maritime provinces. Locally, two official routes have been conducted annually since 2002 while a third, unofficial route, was established in 2005. These surveys document relative owl counts and note changes over time within landscapes being changed by forest harvesting and human developments.

A. Belliveau MTRI

Saw-whet owl

Monitoring

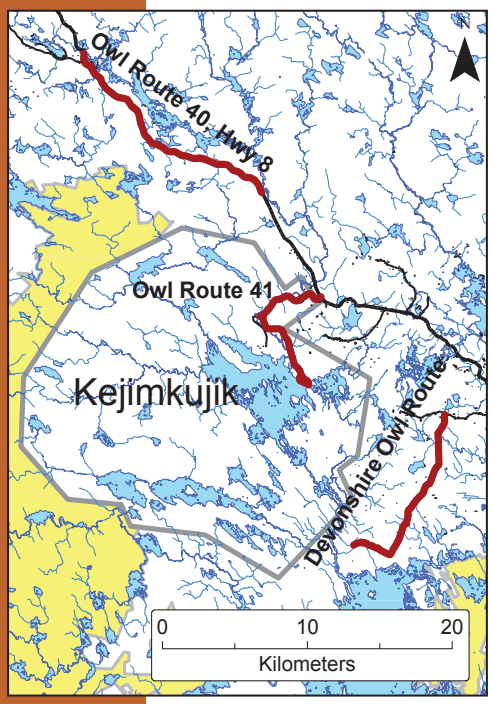
NOCTURNAL OWL SURVEY

OBJECTIVES

- To carry out an annual survey of nocturnal owl populations on established routes.
- To compare local populations within Nova Scotia, within the Maritimes and within Canada.

METHODS

- At night, volunteer surveyors drove their designated route and stopped every 1.6 kilometers. At each stop they broadcast recordings of owl calls prepared by Bird Studies Canada and recorded the number and species of owls heard or seen.
- Route 40 was surveyed by Peter Hope with assistance from and Pierre Martel in 2008 and Peter Croft and Rick Olsen in 2009. This route began on highway Route 8, eight km north of Mersey River Bridge in Maitland Bridge and continued north to South Milford.
- Route 41 was surveyed by Chris McCarthy until 2009 when Donna Crossland became responsible for the route. This route began at the Kejimkujik entrance and ended near the Gold Mines trailhead.
- One unofficial route, using the same protocol, began at the entrance of the Devonshire/ Rossignol Road and continued towards the Mersey River. This route was surveyed by Peter Hope with assistance Daniel Pouliot in 2008 and from Noémi Charron and Hugo Mailhot Couture in 2009.



A. Belliveau, MTRI

Owl survey routes are indicated in red

RESULTS

- In 2008, Barred and Saw-whet owls were reported. In other years, Great horned owls have also been detected.
- The Route 40 survey (along Route 8) detected six Barred owls on April 21/08 and ten Barred owls on April 20/09.
- The Route 41 survey (within the park) detected ten Barred owls on May 15/08 and eight Barred owls during the 2009 survey.
- The Devonshire / Rossignol survey detected six Barred owls on April 21/08. On April 24/09 five barred owls and one Saw-whet owl were detected.

YEARS OF DATA

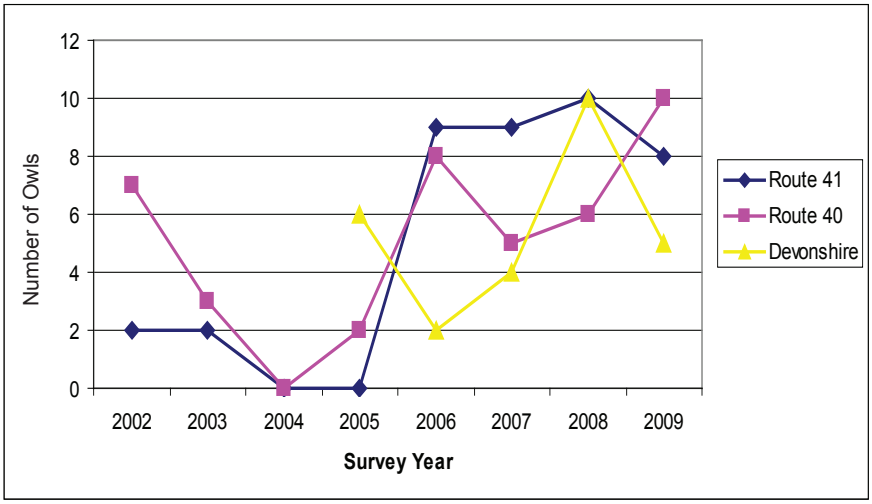
- Ongoing project since 2002

PARTNERS

- Parks Canada
- Bird Studies Canada
- Mersey Tobeatic Research Institute

S. Brouzes

Barred owl



MTRI

Number of barred owls detected on three survey routes. The Highway 8 (Route 40) and Kejimkujik (Route 41) routes have been surveyed since 2002 and the Devonshire/Rossignol route has been surveyed since 2005

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Rationale

Once common throughout Nova Scotia, the American marten is now limited to two known populations in the province: Cape Breton Island and the western portion of mainland Nova Scotia. The mainland marten population, with a hotspot centred near Weymouth, is classified as 'data deficient' by Nova Scotia Department of Natural Resources. This population is believed to be at least partially the result of a reintroduction program that released 116 marten from New Brunswick into 11 sites at Kejimkujik between 1987 and 1994. In 1979, the last reported marten trapped on mainland Nova Scotia was from this area, which suggests a remnant population may have existed prior to the Kejimkujik releases. To determine the presence or absence of rare or endangered mammals in remote areas, hair snag stations can be used to collect DNA samples, which can be used to determine the health and size of a population.

A. Bellliveau, MTRI

Release of marten after incidental catch during live trapping session for flying squirrels

Monitoring

SWNS MARTEN DISTRIBUTION

OBJECTIVES

- To determine the distribution, size and health of the southwestern Nova Scotia (SWNS) marten population.
- To develop an understanding of the multi-scale habitat associations of the SWNS marten population.
- To determine the efficacy of various hair snag techniques using captive animals being held at the provincial wildlife park at Shubenacadie as well as in the field.
- To collect hair samples for future analysis to determine health and size of the SWNS marten population.

METHODS

- Marten habitat models were developed for the five SWNS counties using current forest inventory data and geographic information systems (GIS).
- The Trappers Association of Nova Scotia and other volunteers placed four to eight hair snags (a baited wooden trap equipped with glue patches for hair sampling) within 5 km^2 grids predicted to contain marten habitat (based on the GIS habitat model), in areas that form natural funnels or crossings.
- Snags were checked every four days for twelve days or until tracks, scat or hair was found in or around the snag.
- Hair was collected to verify species identification.
- Habitat information was collected at each hair snag site to populate the GIS habitat model.

H. Clapp

Marten tracks photographed at a marten hair snag station

RESULTS

- 47 blocks were surveyed (seven of which reconfirmed marten presence from 2007) by outdoorsmen, with some help from DNR staff, either through hair snag/track surveys during the winter months, or through discussions with other outdoorsmen (hunters or trappers). Of the blocks surveyed, marten were confirmed in 4 based on tracks, hair or reliable reports.

RESULTS
Continued

- Hair samples collected from the snags have yet to be analyzed to determine if they are marten or not. The first steps will be to look at gross features of the hair and compare them to other similar species that might be present on the landscape at that time of year. Once this is completed information on the health and size of the SWNS marten population will be acquired through DNA analysis, which will aid in determining the status of this rare carnivore.
- The trappers suggest that deer hunters are very likely to see marten around bait piles if marten are present, and thismay present another opportunity to gain reliable records for this species. To this end, two posters have been developed for the general public and hunters, requesting that they report sightings of marten.

YEARS OF DATA

- Year 2 of a 3 year project

PARTNERS

- Trappers Association of Nova Scotia
- Nova Scotia Department of Natural Resources
- Nova Scotia Habitat Conservation Fund

H. Mailhot Couture

Installation of a hair snag by Noémi Charron

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Rationale

White-tailed deer is a major herbivore at Kejimkujik and although it is a naturalized species, it is an important element of the forest trophic structure. Significant increases in deer populations may result in increased pressure on forest communities through overbrowsing. Alternatively, the loss of White-tailed deer populations from the region could also impact forest ecosystem structure and processes, since deer are important prey for top predators, such as coyote and bobcat. White-tailed deer is also a coveted game species and changes in deer populations can provide information about hunting pressure outside the park and the effectiveness of management and enforcement at Kejimkujik.

J.M. Vallieres

Buck along main parkway in Kejimkujik

Monitoring

WHITE-TAILED DEER MONITORING

OBJECTIVES

- To monitor and report on the status and trends in White-tailed deer populations at Kejimkujik. Specifically, to assess and detect changes in: (i) the mean number of deer counted per day; (ii) the mean number of adult males counted per day; and (iii) the ratio of the number of fawns to the number of adult females counted per day.
- To ensure that the White-tailed deer population density is at a sustainable level for the forest to grow and develop without any major shift from its natural succession pattern
- To ensure that the White-tailed deer population remains relatively stable over time helping to maintain relatively stable populations of top predators.

D. Poulliot, Parks Canada

Regeneration stage in forest ecosystem at Kejimkujik

METHODS

- White-tailed deer have been monitored at Kejimkujik since 1976 through an annual roadside count, conducted each day in October along the main parkway and components of Jeremys Bay Campground. The number, age class, and sex of observed deer were recorded.
- Although the sampling frame for this project represents only the roadside population of White-tailed deer at Kejimkujik, data were correlated with provincial population density estimates, indicating that broader population trends can be inferred from the roadside data.
- White-tailed deer roadside count data between 1987 and 2008 were analyzed to detect trends over time.
- The status of White-tailed deer at Kejimkujik was also examined by comparing recent data to established thresholds developed based on statistical variability in the yearly mean of deer counted per day in the roadside survey at Kejimkujik between 1987 and 2007.

RESULTS

- The time-series of roadside counts of White-tailed deer illustrates two distinct periods and population sizes; abundance of deer in the most recent 21 years was much lower than deer abundance prior to 1986 and the abundance of White-tailed deer appears to be stable at Kejimkujik over the last 21 years.

RESULTS
Continued

D. Pouliot, Parks Canada

Coyote along main parkway in Kejimkujik

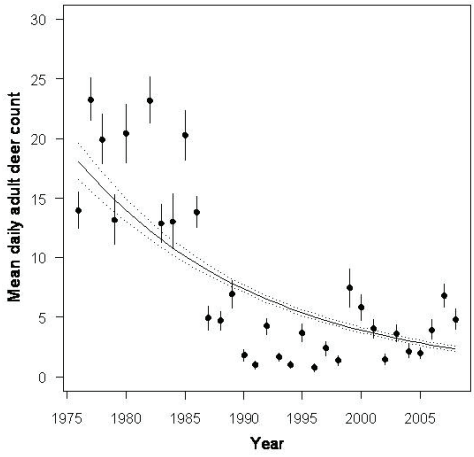
- The current status of White-tailed deer at Kejimkujik was found to be good, meaning that White-tailed deer abundance is considered to be within the suitable range, low enough to not significantly impact forest ecosystem structure, but high enough to support top-predator populations in the region.
- Results of this monitoring project illustrate the broader provincial trend for Nova Scotia of high deer abundance in the late 1970s and early 1980s with a sudden population decline around 1986-87 followed by stable and lower deer abundance over the last 20 years.
- The primary reason for the population decline of White-tailed deer in 1986-87 is unknown, but is likely related to decreased availability of winter forage combined with high competition levels and increased pressure as a staple food source for the Eastern coyote.
- Detailed research is needed to better understand the carrying capacity of White-tailed deer at Kejimkujik, to improve monitoring thresholds and to inform future management needs.

YEARS OF DATA

- Ongoing project since 1976

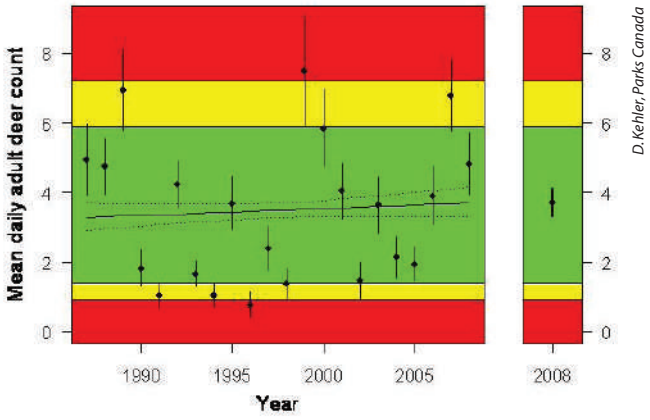
PARTNERS

- Parks Canada
- Nova Scotia Department of Natural Resources



D Kehler, Parks Canada

Mean daily deer counted in a roadside survey at Kejimkujik (1976-2008)



D. Kehler, Parks Canada

Status and trend of white-tailed deer at Kejimkujik (1987-2008)
(Note: Green zone represents good condition, yellow zone represents fair condition, and red zone represents poor condition)

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Rationale

Boreal felt lichen and other rare lichens of the coastal forest community are threatened by forestry practices and air pollution. The threat posed by forestry is largely due to lack of ability to detect the lichens presence and to predict where these lichens will occur. Little is known about which sources of air pollution pose the greatest threats and at what levels. Some progress from the forestry threat has been made in the last three years with the use of the GIS habitat algorithm to identify likely habitat. Since the GIS algorithm was developed in 2005, 22 new Boreal felt lichen locations were found and protected. This project focused on finding new rare lichen sites; getting a better understanding of health of the population, habitat and level of threat; increasing awareness of rare lichens in Nova Scotia and protecting existing Boreal felt lichen sites.

T.Neily,MTRI

Boreal felt lichen on the 'super-tree'

Monitoring

BOREAL FELT LICHEN MONITORING

OBJECTIVES

- To improve the predictive ability of a GIS habitat algorithm to increase likelihood of finding Boreal felt lichen.
- To increase knowledge of habitat characteristics and severity of threats at Boreal felt lichen sites over time.
- To raise the profile of Nova Scotia's rare lichens.
- To protect newly found Boreal felt lichen and rare lichen sites through verbal landowner stewardship agreements.

METHODS

- Sites predicted as likely habitat and adjacent areas were searched for the presence of Boreal felt lichen and other rare lichens.
- GIS data on each searched site were collected and included forest cover, surficial geology, bedrock geology, climate, topography, soil drainage, soil texture, distance from wetland, distance from coast, and wetland density.
- All currently known sites of Boreal felt lichen were permanently marked for long-term monitoring.
- Data were collected on habitat parameters including trees species, tree heights, tree diameters, tree ages, crown cover, slope, aspect, soil drainage, ground cover and other parameters.
- When Boreal felt lichen sites were found the landowners were provided with information about lichens.
- A four-day advanced lichen workshop was held to train people to identify lichens and looks for rare cyanolichens including Boreal felt lichen.

C.Doggett, MTRI

Workshop participants learning to identify lichens during a field trip

RESULTS

- In 2008, Boreal felt lichen was identified at 10 sites. Three of these sites were found in Cape Breton where the lichen has not been found in over 20 years.
- A 'super-tree' was identified with 53 Boreal felt lichen on one tree. The majority of Nova Scotia sites have only 1-2 Boreal felt lichen per tree.

RESULTS
Continued

T. Neily, MTRI

Detached Boreal felt lichen thalli

- Within the sites visited this year, 10 yellow-listed and four red-listed cyanolichen species were identified (as categorized under the Nova Scotia Endangered Species Act).
- Boreal felt lichen at the new sites on Cape Breton Island are much more robust and healthy in appearance compared to those found on mainland Nova Scotia. They do not show signs of herbivory by snails and slugs.
- Four of the newly identified Boreal felt lichen sites were found as a result of searches requested by companies intending to develop or harvest areas they knew to have potential Boreal felt lichen habitat. This is an example of a successful collaboration between conservation researchers and forest companies and industry.
- Permission was obtained to collect a severely detached Boreal felt lichen. It was deposited at the Nova Scotia Museum.
- In 2007, 59 Boreal felt lichen thalli were measured and permanently marked for long term monitoring. In 2008, 57 of these thalli were revisited and an additional 14 other existing thalli were permanently marked. Forty-three thalli were mature and 20 were juveniles. Three thalli have disappeared, four thalli were necrotic, and five thalli were loose or fractured.
- The four-day lichen identification workshop was attended by 15 participants who learned to identify rare cyanolichens including the Boreal felt lichen and to recognize potential habitat for these lichens.

YEARS OF DATA

- Ongoing project since 2006

PARTNERS

- Mersey Tobeatic Research Institute
- Nova Scotia Department of Environment
- Nova Scotia Department of Natural Resources
- Government of Canada Habitat Stewardship Program for Species at Risk
- World Wildlife Fund Endangered Species Recovery Fund
- NewPage Corporation
- Nova Scotia Nature Trust

T. Neily, MTRI

Surveying Boreal felt lichen habitat

C. Doggett, MTRI

Classroom session during the lichen identification workshop

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Rationale

Invasive plants are an important indicator of ecological integrity in forest ecosystems. Their presence in natural areas is positively correlated with disturbance associated with several stressors including pollution, climate change, fragmentation and development. These species often displace native plants because of their innate hardiness and lack of natural controls. Monitoring the presence, abundance and distribution of invasive plants can provide a risk assessment and an early indication of disruption in natural ecological processes and native communities.

J. Randall, Nature Conservancy

Glossy buckthorn

Monitoring

INVASIVE PLANT MONITORING

OBJECTIVES

- To identify and remove occurrences of highly invasive plants at Kejimkujik.
- To monitor the presence, abundance and distribution of priority exotic plants on trails at Kejimkujik.

METHODS

- An inventory of invasive and exotic plants was conducted at Kejimkujik in 2004 and a list of priority invasive plants was developed for long-term monitoring. The plant list was divided into several categories based on level of risk and invasiveness, where Category 1 plants are highly invasive, Category 2 plants are moderately invasive, and Category 3 plants can be invasive in certain conditions.
- Locations of highly invasive Category 1 plants were identified throughout the park and all known occurrences of these species were physically removed in 2008.
- Presence and abundance of all species on the list of priority invasive plants was assessed on 23 trails at Kejimkujik. Trails were selected as a sample of human use areas at the park that may be susceptible to invasive plant introduction. Since the length of trails varies, a standard length of 3 km was selected. For trails less than 3 km in length, the entire trail was sampled. For trails greater than 3 km, the first 3 km from the trailhead were sampled. The combined length of sampled trails from 2006-8 was 49.8 km.

Category	Common name
Category 1 Highly invasive	Glossy buckthorn Purple loosestrife Scotch broom Scotch pine Garlic mustard Common reed
Category 2 Moderately invasive	Black bentgrass Black starthistle Creeping thistle Tall rye grass Black medic
Category 3 Invasive in certain conditions	Gypsy-weed Mouseear Tall buttercup Garden sorrel Brittle-stem hempnettle St. John's-wort Low cudweed

Modified from Stewart, 2004

List of priority invasive plants for monitoring at Kejimkujik

RESULTS

- Four highly invasive plant species (*i.e.*, Category 1) were found at Kejimkujik, including Glossy buckthorn, Scotch broom, Purple loosestrife, and Scotch pine. The occurrence of Glossy buckthorn poses the greatest threat as it became established quickly and covered an area of approximately 3 hectares in 2008, whereas occurrences of the other species were contained to small areas of 1-3 m^2. Furthermore, two additional sites in the park were found where Glossy buckthorn had become established away from the main population near the park entrance.

RESULTS
Continued

- An eradication program for Glossy buckthorn was initiated in 2008 in response to the population status. Plants were hand-pulled through a concerted effort of park staff and all removed plants were incinerated. Eradicated plants were not tallied, but exceeded at least 1000 plants, many which were seedlings. Although some were robust shrubs exceeding 2 m in height. The effectiveness of this eradication program will be assessed annually and additional active management will follow until the population is completely removed.
- Six of the 18 species on the list of priority invasive plants occurred on trails at Kejimkujik in 2006 and 2008. The most common invasive plants encountered on these trails were Mouseear and Gyspy-weed. The trails with the highest presence and abundance of invasive plants were Canning Field and McGinty.

YEARS OF DATA

- Ongoing project since 2004

PARTNERS

- Parks Canada

D. Ure, Parks Canada

Glossy buckthorn

D. Ure, Parks Canada

Park staff removing Glossy buckthorn

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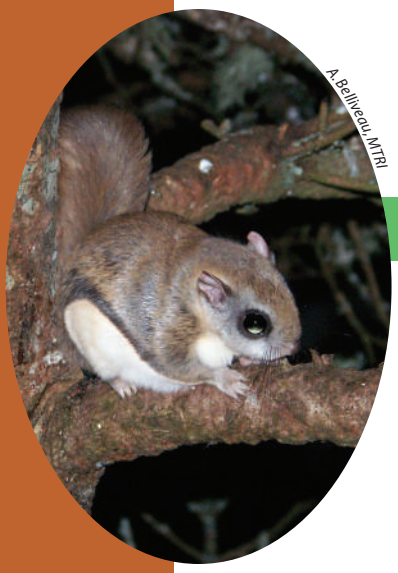
Rationale

Flying squirrels may be sensitive to fragmentation and good indicators of landscape connectivity because they need mature trees to climb for gliding and to sleep in during the day. To understand the connectivity requirements of flying squirrels in Nova Scotia, local life history data are required to determine how long they live, how many young they have and how they disperse. With this project, live-trapping, passive integrated transponder (PIT) tags and nest boxes were used to collect life history data for flying squirrels. PIT tags are small glass microchips that are inserted under an animal's skin and that provide the time, date and unique code for the animal when they pass through a circular antenna.



A.Belliveau, MTRI

Flying squirrel in a tree

Monitoring

MONITORING FLYING SQUIRREL SURVIVORSHIP

OBJECTIVES

- To determine survivorship of flying squirrels.
- To determine fecundity (ability to produce young) of flying squirrels.

METHODS

- Study grids were installed at four sites in the Mersey and Medway watersheds with wooden brackets placed on the south side of trees at chest height.
- Live traps were placed on the brackets and baited with peanut butter and apples.
- Captured flying squirrels were measured, implanted with PIT tags and released where they were caught.
- PIT tag receiving stations were placed within the grid to monitor survivorship.
- Squirrel boxes placed in 2007 were searched for nest material and food.

A.Belliveau, MTRI

Flying squirrel being carefully handled for measurements and PIT-tagging

RESULTS

- Between January and May of 2009, 37 flying squirrels (16 Southern and 21 Northern) were live-trapped near Donnellan Lake, Hemlock Hill, and Grafton Lake.
- Seven flying squirrels were recaptured from previous years. Four of these had been PIT-tagged last year, three had been tagged two years ago and none remained from three years ago.
- Interestingly, two squirrels were captured simultaneously in a trap on two separate occations, once with a Southern and a Northern together.
- Thirty-one flying squirrels visited recording stations, nineteen were recently PIT-tagged, five were originally tagged the previous year, and two had been tagged two years before.
- Another unusual result this year was that 10 squirrels visited the same reader during a one week period at Grafton.
- Incidentally, five captures were made of the rare American marten.

RESULTS
Continued

- One study site for future live-trapping and monitoring has been installed near MTRI's field station in Kempt Provincial Park Reserve but no animals were captured during 105 trap nights.
- Four of forty-nine squirrel boxes contained nesting material, three of them contained food, and the entrance on four boxes had been chewed.

YEARS OF DATA

- Ongoing project since 2005

PARTNERS

- Mersey Tobeatic Research Institute
- Nova Scotia Habitat Conservation Fund
- Cégep de La Pocatière
- Cégep de Sherbrooke
- Natural Resources Canada

H.Mailhot Couture

Nestbox showing signs of use by wildlife

R.Goss, MTRI

Releasing a flying squirrel

A.Belliveau, MTRI

American marten captured in squirrel trap

A.Belliveau, MTRI

Hugo Mailhot Couture and Noémi Charron download data from a squirrel station

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Rationale

Studies across North America have reported population declines for many species of forest birds. Such declines impact biodiversity and the structure and function of forest ecosystems. Birds play important roles in forest ecosystems: for example, flycatchers, wood-warblers, vireos, kinglets, and thrushes consume large quantities of insects and other invertebrates, hawks and owls prey on other vertebrates, and woodpeckers modify trees for other species. Furthermore, the specific habitat requirements of many bird species make them sensitive indicators of terrestrial ecosystem change. Forest bird populations have been monitored in Kejimkujik since 1996. The present study analysed trends in bird abundance over a 12-year period.

H. Toom

The Black-throated green warbler is a neotropical migrant that nests in tall conifers and gleans moth larvae from needles to feed its young

Monitoring

TRENDS IN KEJIMKUJIK FOREST BIRD ABUNDANCE

OBJECTIVES

- To analyse trends in forest bird abundance at Kejimkujik between 1996 and 2007.
- To determine whether various ecological groupings of bird species increased or decreased over time.
- To identify forest-bird monitoring and research priorities for the future.

METHODS

- Point-count surveys were conducted at mature forest sites in Kejimkujik between 1996 and 2007.
- Each site was surveyed twice between late May and early July. All birds detected during a 10 minute period were counted. The maximum number of potential pairs per species was obtained by comparing data for the two visits. This index of abundance was used in trend analyses.
- Data were grouped prior to trend analysis: sites were grouped by habitat, and bird species were grouped by breeding-season habitat preferences, foraging behaviour, nest placement, territorial behaviour, and migratory status.
- Trends were analyzed using linear regression. Bird abundance was the dependent variable, year the independent variable, and the number of years the sample size. The slope of the regression line indicated the strength of the trend and the sign of the slope indicated trend direction (negative trends were declines, positive trends were increases).

K. Morrison

The Pale-winged gray moth outbreak and its defoliation of Eastern hemlocks may partially explain decreases in birds that nest and feed in tree canopies and increases in flycatchers and bark probers

RESULTS

- Trends were negative for all habitat groups, with significant declines for coniferous forest birds. The largest declines occurred in hemlock stands defoliated by the pale-winged gray moth. Bird abundance temporarily increased during the outbreak before dropping below previous levels.
- Birds declined significantly in spruce-fir forest and treed bogs. Species at risk that utilize these habitats include the Olive-sided flycatcher and Canada warbler. These habitats should be monitored in the future and considered for inclusion in Kejikujik's ecological monitoring program.

C. Staicer

Megan Crowley surveying birds in a hemlock stand

RESULTS *Continued*

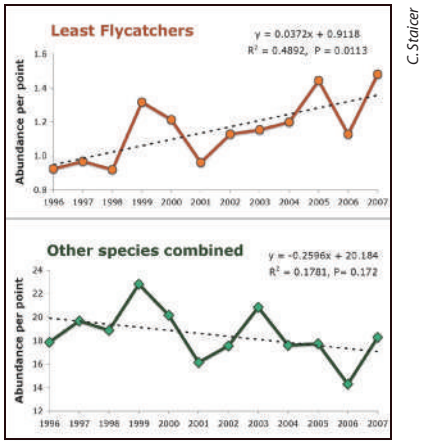
- Trends were negative for most species groups. Significant declines included the canopy-nesting and foliage-gleaning migratory species. Most were long-distance migrants that feed on insects. Decreases were also noted for aerial insectivores (*e.g.*, swifts, nighthawks, swallows), whose continent-wide populations have declined. Even generalist and seed-eating forest species declined.
- Trends for migratory flycatchers and the resident bark-foragers (*e.g.*, chickadees, nuthatches, woodpeckers) were positive. These groups likely benefited from an increase in moths, larvae and dying trees as a result of the pale-winged gray outbreak. The most spectacular increase was for Least flycatchers, typically hardwood specialists, which spread into coniferous habitats, especially where the moth outbreak was most severe.
- Research is required to determine causes behind these changes in forest bird abundance.

YEARS OF DATA

- 1996 to 2007

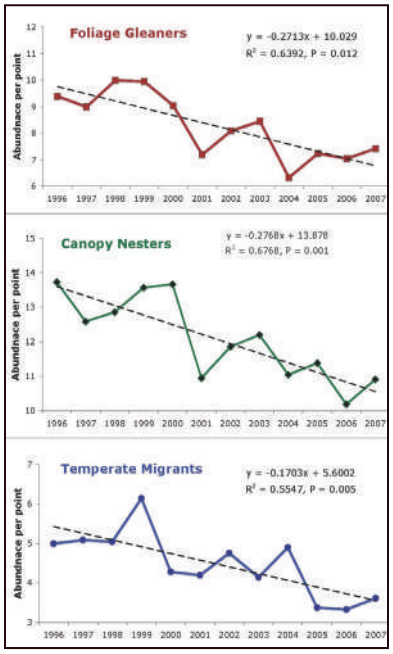
PARTNERS

- Parks Canada
- Dalhousie University



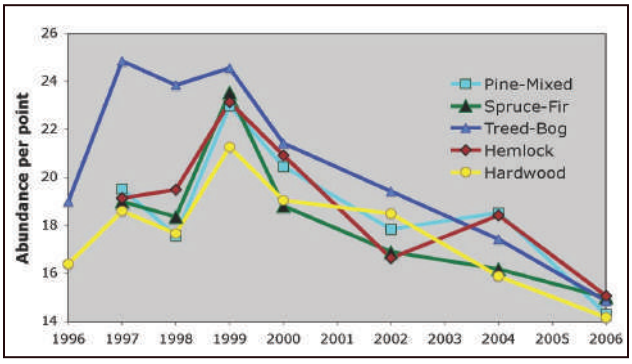
C. Staicer

Trends for Least Flycatchers (top) and all other species of forest birds combined (bottom) across a series of 20 points sampled every year. Graphs plot average



C. Staicer

Birds that gleaned insects from foliage (top), built nests in the tree canopy (middle), or migrated to more southern portions of the temperate zone (bottom) declined significantly between 1996-2007. Graphs plot average abundance per point of species combined by their ecological



C. Staicer

Trends for birds inhabiting five different forest types. Graphs plot average abundance of combined species per point for the different habitats

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Rationale

Plethodontid salamanders lack lungs and breath through their glandular skin and the roofs of their mouths, which must remain moist for respiration; they are vulnerable to desiccation and soil contaminants. Plethodontids can reach high densities in many forest habitats and play an important role in ecosystem food webs and detrital dynamics. They are completely terrestrial, occupy a small home range, and have stable population sizes under normal conditions, making them good indicator species. The only common plethodontid in Kejimkujik is the eastern red-backed salamander. Salamanders are monitored as one component of the integrated forest plots designed to assess and monitor the state of forest ecosystems at Kejimkujik and detect changes over time. Other forest measures assessed at these plots include the following; forest birds, trees, shrubs, ground vegetation, soil decomposition rates and lichens.

D. Pouloit, Parks Canada

Eastern red-backed salamander

Monitoring

PLETHODONTID SALAMANDER MONITORING

OBJECTIVES

- To monitor plethodontid salamander abundance in mixed and hemlock forest ecosystems of Kejimkujik.
- To determine if salamander abundance (*i.e.*, mean annual number of salamanders per plot) is within the range of natural variation (*i.e.*, greater than 16 salamanders per site, as determined through analysis of data between 2003-2008 for twelve long-term monitoring plots) in hemlock and mixed forests at Kejimkujik.

METHODS

- Salamander abundance was assessed at twelve long-term integrated forest plots that were established in 2003 in mixed and hemlock forest ecosystems using a stratified random sampling design.
- Within these plots, salamander abundance was assessed once per week for four weeks in mid-September to mid-October each year.
- At each plot, the number of salamanders observed under forty artificial cover boards was counted and recorded.

D. Poulliot, Parks Canada

Artificial cover board in a Hemlock forest

RESULTS

- A trend analysis suggests that salamander abundance appears to be increasing in hemlock and mixed forests at Kejimkujik over the last six years.
- The abundance of salamanders in 2008 was within the range of natural variation (*i.e.*, above the threshold of 16 salamanders per site) suggesting that salamander abundance in hemlock and mixed forests at Kejimkujik is currently good.
- These results suggest that stressors such as climate change, acid rain, and land use change currently do not significantly influence salamander abundance in forest ecosystems at Kejimkujik.

YEARS OF DATA

- Ongoing project since 2003

PARTNERS

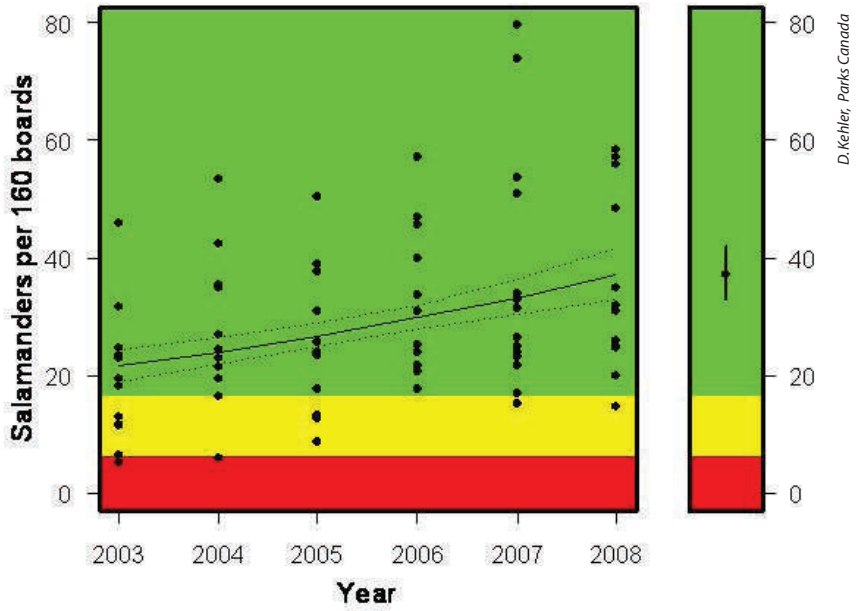
- Parks Canada
- Ecological Monitoring and Assessment Network (EMAN)
- Dalhousie University

D.Pouliot, Parks Canada

Lifting a cover board to check for salamanders

D.Pouliot, Parks Canada

Eastern red-backed salamander



D.Kehler, Parks Canada

Status and trend in salamander abundance in hemlock and mixed forests at Kejimkujik (Note: Green indicates good condition, yellow indicates fair condition, and red indicates poor condition, based on assessment of natural variation in salamander abundance data at Kejimkujik from between 2003-2008)

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Rationale

The Eastern pipistrelle is one of North America's smallest bats. The species is at the northern-most extent of their geographic range in Atlantic Canada, with the only known breeding population residing in southwest Nova Scotia. Relatively little is known about the ecology of the population here, and being presumably geographically disjunct in Nova Scotia makes this species a target of conservation concern. Some unqiue morphological and behavioural traits observed in this population suggest that Eastern pipistrelles in Nova Scotia (and possibly the whole of Atlantic Canada) may represent a subspecies previously unknown to science, and efforts are now underway to better document and understand their phenotypic distinctiveness and their population genetics. If Eastern pipistrelles in Nova Scotia are taxonomically distinct, then burgeoning conservation strategies and management plans for this species must be revised accordingly.

J.Poissant

Female Eastern pipistrelle from Kejimkujik with transmitter

Research

EASTERN PIPISTRELLE BAT TAXONOMIC STATUS

OBJECTIVES

- To characterize the morphology of Eastern pipistrelles in Nova Scotia by examining vouchered specimens in biological collections housed in various museums.
- To determine whether Eastern pipistrelles from Nova Scotia are morphologically distinct when compared with those from other regions in North America, and revise the taxonomic designation of the former if they demonstrate to be unique.
- To determine the conservation genetic status of the population of Eastern pipistrelles in Nova Scotia.

METHODS

- Thirty-four morphological characters from the skin and skull of vouchered specimens of Eastern pipistrelles in museum collections were studied and measured.
- All known vouchered specimens of Eastern pipistrelles originating from Nova Scotia have been examined and measured at various museums (*i.e.,* Canadian Museum of Nature, Nova Scotia Museum, and New Brunswick Museum) and were compared with individuals from other localities in North America (287 individuals all together).
- Univariate and multivariate statistical analyses were performed to determine if the Eastern pipistrelles from Atlantic Canada are morphologically distinct.
- DNA extracted from tissue samples taken from live Eastern pipistrelles captured and released in Kejimkujik and from voucher museum specimens in collections will be studied to determine the conservation genetic status of the population relative to others in North America.

H.Huynh

Makeshift lab bench for processing and sampling bats captured and released in Kejimkujik

RESULTS

- Morphometric analyses have revealed that Eastern pipistrelle bats from Nova Scotia and New Brunswick are cranially distinct, specifically having a longer skull, wider braincase, and longer upper toothrow, compared to other populations from other parts of North America.
- DNA has been extracted from some tissue samples collected from Eastern pipistrelles captured and released in Kejimkujik, as well from tissue samples from voucher specimens from other geographic localities for comparative analysis.
- Testing of mitochondrial and nuclear primers to determine the population genetic structure of Eastern pipistrelles is currently underway.

YEARS OF DATA

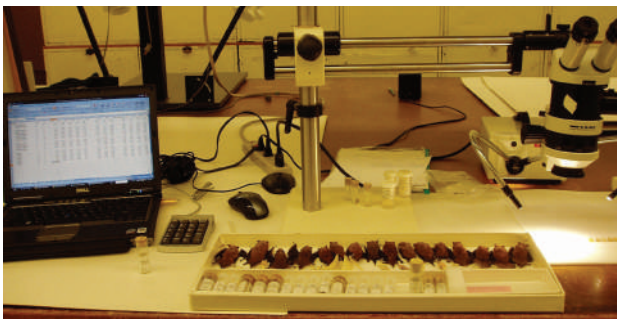
- Year 2 of a 2 year project

PARTNERS

- Acadia University
- Saint Mary's University
- Parks Canada
- Mersey Tobeatic Research Institute

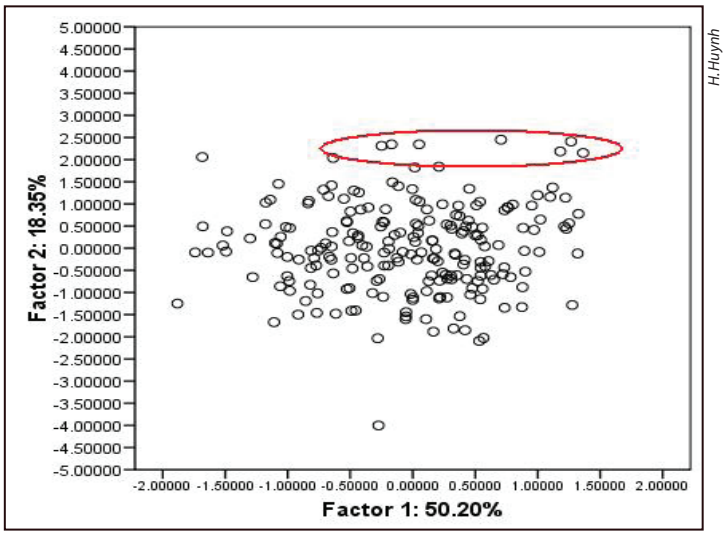
H.Huynh

Howie Huynh examining and measuring eastern pipistrelle skulls at the Canadian Museum of Nature at Aylmer, Quebec



H.Huynh

Work station with Eastern pipistrelle skulls and skins at the Smithsonian Institution National Museum of Natural History



H.Huynh

Principal Components Analysis reveals differences in skull shape between Eastern pipistrelles from Nova Scotia and New Brunswick (designated as points inside red oval) and individuals from other regions of North America

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Rationale

Red oak is an important tree species at the northern edge of its range in the Acadian Forest where it provides food and shelter for a diversity of wildlife. Some forest monitoring plots within Kejimkujik indicate low levels of Red oak regeneration. Past forestry practices and active suppression of forest fires have changed the disturbance regime for Acadian forests. This, combined with herbivory by White-tailed deer and other mammals, may have effected Red oak distribution and regeneration. The aim of this work is to develop a valid method of assessing the age structure and health of mixedwood stands with Red oak, to use this method to survey sites inside and outside Kejimkujik and to select potential sites for regeneration experiments. The proposed experiments will help develop management techniques for Kejimkujik and other parts of the Acadian Forest Region.

A. Belliveau, MTRI

Mature Red oak in fall foilage

Research

RED OAK REGENERATION IN MIXEDWOOD STANDS

OBJECTIVES

- To determine the number of sites needed to test experimental treatments including prescribed burning, mechanical thinning, tree girdling, canopy opening as well as installing deer exclosures and acorn predation shelters.
- To investigate possible correlations between Red oak regeneration levels, ecological land classifications and soil types.
- To develop a method for quantifying Red oak regeneration in mixedwood stands in and around Kejimkujik.
- To reassess monitoring plots established in fall 2006.
- To quantify damage inflicted on mature Red oaks by the Oak leaf roller and Oak leaf shredder.
- To compare rates of browsed seedlings of all tree species.
- To select potential sites where experiments will be conducted.
- To locate additional mixedwood stands with Red oak outside Kejimkujik for regeneration surveys in 2009.

H. Clapp

Andrew Folkes and Alain Belliveau conduct a soil analysis

METHODS

- A statistical analysis was performed on data from all provincial permanent sampling plots containing Red oak to determine the number of sites needed to test experimental treatments.
- Researchers were trained by NSDNR to conduct ecological land classifications and to determine soil types. This involved observing stand characteristics and digging soil pits.
- Two survey methods for quantifying Red oak regeneration were tested. These were a 20 x 20 m square plot and two belt transects (300 x1 m and 150 x 2 m) covering 300 m^2.
- Established plots were resurveyed during the summer and the data were compared to that of the original fall 2006 survey.
- Insect damage on mature Red oaks was quantified by visually estimating their defoliation percentage.
- Field researchers examined seedlings of all trees species for evidence of browsing while conducting belt transects.

METHODS
Continued

- Potential experimental sites were inventoried for these criteria : minimum size of 1 ha, 40-80% Red oak overstory, well-drained and coarse soil and one of four vegetation types (W30, W34, W23, W25).
- Two helicopter surveys were conducted in late October 2008 to locate oak stands outside of Kejimkujik.

RESULTS

- A statistical analysis suggested at least 17 experimental sites are needed to test the treatments proposed to improve Red oak regeneration.
- Thirty-four surveyed plots fell under eight different ecological land classifications. Those that fell under the W30 vegetation type had the highest regeneration levels. All sites had well to imperfectly drained soil.
- The 150 x 2 m belt transect provided a larger sample than the 20 x 20 m square plots with 2 x 2 m regeneration subplots.
- In six of seven established plots, summer 2008 surveys showed a higher presence of Red oak seedlings compared to observations from fall 2006.
- Mature Red oaks exhibited intermediate levels of defoliation. Defoliation was more severe in stands outside Kejimkujik.
- More than 50% of all observed Red oak and American beech seedlings were browsed. Other hardwoods averaged an 11-15% browsing rate.
- Twenty sites were recommended for treatments with 10 located inside Kejimkujik and 10 outside. Each was randomly designated for treatment or control, except for a prescribed burn site and two mechanical thinning sites on crown land that were previously treated.
- During two helicopter surveys in the fall of 2008, 79 red oak stands were located and their UTM coordinates recorded. Of those 79, seven were estimated to have 40% Red oak in the overstory, 13 had between 25-40% Red oak while 59 stands had less than 25% Red oak.

A. Folkes, MTRI

Stephanie Brouzes performs a prism sweep

YEARS OF DATA

- Year 3 of an ongoing project

PARTNERS

- Mersey Tobeatic Research Institute
- Parks Canada
- Nova Scotia Community College
- Nova Scotia Department of Natural Resources
- Natural Resources Canada
- Service Canada

A. Lavers, MTRI

Evidence of oak leaf roller infestation

A. Belliveau, MTRI

Profile of a Red oak stand

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Rationale

The provincial Forest Ecosystem Classification (FEC) can be thought of as a catalogue of forest and woodland ecosystems in Nova Scotia. The FEC provides information about the site, soil moisture, soil nutrients and tree and understory plant species. Classifying forest ecosystems based on vegetation, soil and site characteristics allows forestry professionals, woodlot owners and researchers to recognize similar forest ecosystem units on the ground and to develop a common understanding of these units. This allows for the development and use of best management practices which address hazards and operational limitations associated with different ecosystems, leading to more predictable and sustainable forest management. Forest ecosystem classifications also provide a means through which ecosystem-based management principles can be applied operationally at the stand level, and a framework from which to communicate the success or failure of different management treatments. Most forest resource values can be evaluated within the classification.


P. Neily, NSDNR

Red oak stand at Holden Lake

Research

FOREST ECOSYSTEM CLASSIFICATION

OBJECTIVES

- To develop a comprehensive forest ecosystem classification system for Nova Scotia.
- To identify and describe recurring vegetation communities and soil types associated with Nova Scotia forests.
- To provide an ecological framework from which to communicate and promote ecosystem-based management at the stand level.
- To provide an ecological framework from which best management practices can be developed and applied to promote sustainable forest management in the province.

METHODS

- A stratified sampling approach was taken to divide the province's forest landscapes into 47 different sampling units (based on earlier biophysical and ecological land classification).
- Cover type maps, soil series map, and surficial geology maps were also used to narrow down potential sampling areas.
- At each sample location, detailed vegetation, soil, and site data were collected from representative plots. Data included an inventory of above ground plants (bryophytes, lichens, herbs, shrubs, and trees) and a full soil profile description. Where applicable, sequential plots were also established along major slopes.
- Similar plant communities and soils were grouped into recurring vegetation types and soil types based on statistical analysis and expert opinion.
- Ecotypes were also delineated which represent general productivity units as reflected by changes in soil moisture and nutrient regimes.


P. Neily, NSDNR

A soil profile under the Red oak stand at Holden Lake, pictured above

P. Neily, NSDNR

Red trillium

RESULTS

- This project was initiated as a pilot from 2000-2003, and as a full scale provincial project from 2004 onward. To date 1278 plots have been measured across the province, with about 362 in western Nova Scotia.
- The Forest Ecosystem Classification of Nova Scotia's Model Forest was published in 2003. This field guide contains information on 28 vegetation types and 16 soil types found in central Nova Scotia (available from the Nova Forest Alliance).
- The Forest Ecosystem Classification for Nova Scotia's Western Ecoregion - Interim Report was published in 2006 and contains fact sheets for 39 vegetation types, descriptions for 16 soil types (plus 3 phases), keys for identifying vegetation types and soil types and information on provincial ecotypes found in western Nova Scotia (available from NSDNR).
- The number of vegetation types and soil types will increase as more data is collected and analyzed. An interim Eastern FEC was produced in 2007. The final Provincial FEC is scheduled for completion in 2010.
- Forest Soil Types of Nova Scotia: Identification, Description, and Interpretation NSDNR Manual FOR 2007-2 is available on line at: http://www.gov.ns.ca/natr/publications/forpubs.htm. This document contains keys to determine soil type and soil texture as well as photographs of the soil types and distinguishing features.
- Field Manual for Forest Ecosystem Classification, NSDNR Manual FOT 2007-1 is available on line at: http://www.gov.ns.ca/natr/publications/forpubs.htm. This report provides the methodology used to establish sample plots for forest ecosystem sampling.

YEARS OF DATA

- Ongoing project since 2006

PARTNERS

- Nova Scotia Department of Natural Resources
- Parks Canada
- Dalhousie University
- Nova Scotia Department of Environment

P. Neily, NSDNR

A large tooth aspen stand at Holden Lake

P. Neily, NSDNR

A white ash, spruce, cinnamon fern wet forest near Sherbrooke Lake

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Rationale

In 2007, the province of Nova Scotia made the decision to purchase 30 parcels of land from the Bowater Mersey Paper Company in Liverpool, Nova Scotia. Among these thirty parcels is 284 hectares located directly behind MTRI in Kempt, Queens County. The province has yet to determine the designation or management plan for this parcel of land but recognize the potential for MTRI to steward this land. MTRI has started gathering on-the-ground natural resource data and compiling geographic information system (GIS) data to assist with the parcel's eventual educational and ecological management goals. For the purposes of this project the land will be referred to as the Kempt Provincial Park Reserve (KPPR).

N. Charron

Forest stream within the KPPR

Research

KEMPT CROWN LAND FOREST MAPPING

OBJECTIVES

- To create a basic forest inventory for the KPPR.
- To compile digital geographic data for the KPPR.
- To map forests and special features of the KPPR.

METHODS

- Forest inventory plots were randomly located using ArcGIS software.
- Forest inventories were completed using a prism sweep.
- Digital geographic data were collected from sources such as the Nova Scotia Department of Natural Resources and the Nova Scotia Geomatics and placed on an ArcGIS map.
- Forests and special features were saved as waypoints on GPS units then downloaded to the ArcGIS map.

H. Mailhot Couture

Noémi Charron working in the rain

RESULTS

- Over 100 forest inventory plots were completed inside the KPPR boundaries.
- At each plot, the size and number of trees within a prism sweep, site and slope description, disturbance evidence, stand age, course woody debris, regeneration, shrubs, herbs, ferns, mosses and club mosses were recorded.
- A map has been created, displaying all relevant data to assist with future research and management decisions.

YEARS OF DATA

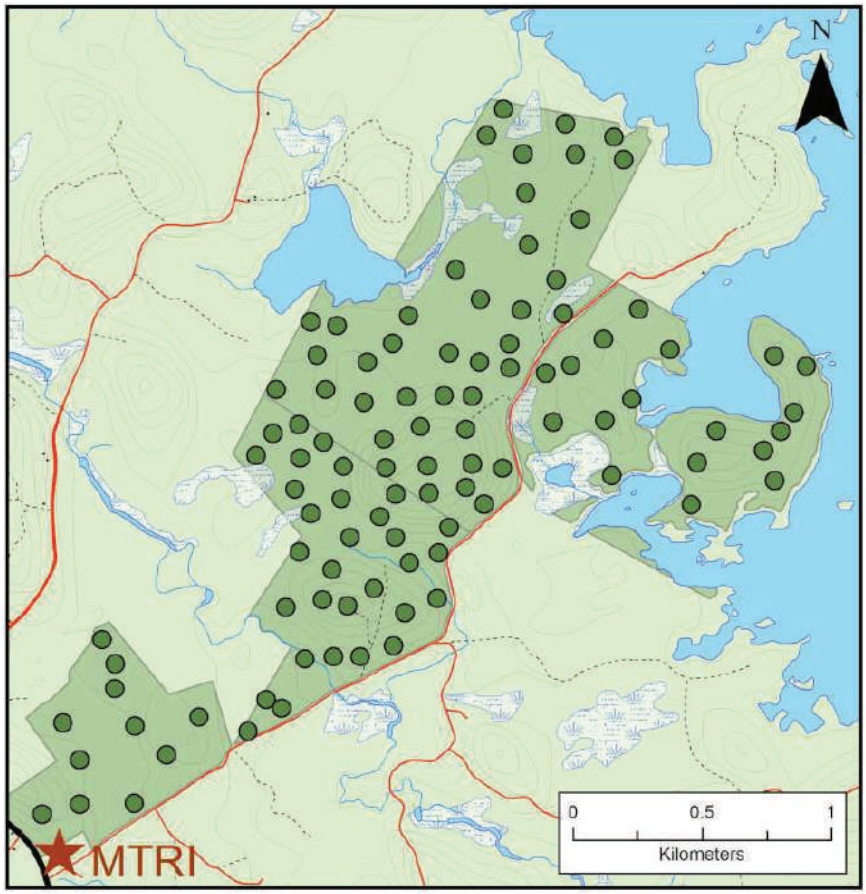
- Ongoing project since 2008

PARTNERS

- Cégep de Sherbrooke
- Cégep de la Pocatière
- Nova Scotia Department of Natural Resources
- Mersey Tobeatic Research Institute

A. Belliveau, MTRI

Ground vegetation at a study plot



A. Belliveau, MTRI

Forest inventory plots in the Kempt parcel of land (the boundaries of the parcel are indicated by the darker green shading)

N. Charron

Jonathan Bolduc and Alexandre Langlais Bourrassa coring a tree to determine its age

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Clockwise from top left:

- Queens County lake by A. Belliveau, MTRI
- Common loons on Peskawa Lake by C. Gray
- Turtle trapping on Sporting Lake stream by B. Caverhill, MTRI
- Sixth Lake stream by A. Belliveau, MTRI
- Beaver dam on Flagstaff Lake by A. Belliveau, MTRI

FRESHWATER

Rationale

The Common loon is a highly visible water bird inhabiting many of the lakes within the Southwest Nova Biosphere Reserve. It is an icon of wilderness and people are captivated by its beauty and haunting call. Concerns have been raised about the health of loons after a study by the Canadian Wildlife Service (CWS) found very high blood mercury concentrations in Kejimkujik loons. These levels have been associated with impaired reproduction and altered breeding behavior in some areas. LoonWatch began on 16 lakes within Kejimkujik in 1996. In 2006, the program was expanded to the greater landscape through MTRI where volunteers are trained to observe and record loon activity and breeding success on their assigned lake throughout the summer using a national protocol developed by Bird Studies Canada. These two program components will provide a picture of how well loon populations are doing in the region.

C. Gray

Adult loon swimming on Peskowa Lake

Monitoring

THE KEJIMKUJIK-MERSEY LOONWATCH PROGRAM

OBJECTIVES

- To observe Common loon abundance and breeding success on lakes within Kejimkujik and in the Southwest Nova Biosphere Reserve with a focus on the Mersey and Medway watersheds.
- To determine status and trends in loon abundance, lake use and reproductive potential of resident birds.
- To monitor water quality on lakes being observed by Loon Watchers outside Kejimkujik.

METHODS

Outside Kejimkujik:

- Lakeside dwellers and cottagers with an interest in loons were recruited and provided with information about loons and the monitoring protocol.
- Trained volunteers were used to survey their lakes in June for loon pairs, in July for newly hatched chicks, and in August for surviving young.
- MTRI staff visited many of these lakes, canoed to the deepest part and measured water quality at one meter intervals, recording temperature, conductivity, dissolved oxygen and pH.
- Volunteer data was collected and compiled, then shared with Bird Studies Canada.

Inside Kejimkujik:

- LoonWatch uses trained volunteers in a coordinated effort to simultaneously survey study lakes within a three hour observation period, in June and during the third week of August.
- Loon monitoring combined data gathered from intensive LoonWatch days involving many volunteers, plus public observations and repeated surveys by Kejimkujik staff.
- The Canadian Wildlife Service is also doing more intensive work to better understand population dynamics and relative mercury levels in loons in the region (See page 54-55).

B. Keoghoe, MTRI

Loon nest with eggs

A. Lavers, MTRI

Volunteer watching loons from the shore of Pitts Lake

RESULTS

- In 2008, the two LoonWatch programs had over 50 volunteers monitoring loons on at least 37 lakes in the Southwest Nova Biosphere Reserve and about the same number monitoring loons on 16 lakes inside Kejimkujik.
- There were 35 territorial pairs of loons observed on the lakes outisde Kejimkujik; some lakes had no territorial pairs while some had multiple territorial pairs.
- Thirteen loon chicks were recorded by LoonWatchers at Cameron, Fancy, First Christopher, Harmony, Eleven Mile, Murphy, Oakleaf, Path, Tupper, Turtle, Wagner, and Wright's lakes and Lake LeMerchant and 10 of the chicks were observed as large chicks that had a good chance of survival.

YEARS OF DATA

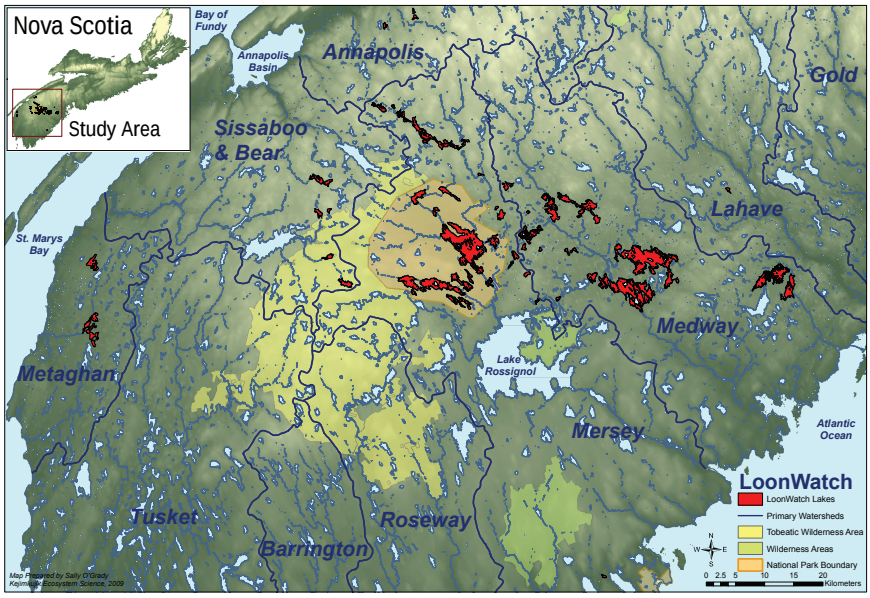
- 2006 was the first year for the Mersey LoonWatch Program.
- 1996-2008 for the Kejimkujik program.
- Monitoring will continue on an annual basis.

PARTNERS

- Parks Canada
- Mersey Tobeatic Research Institute
- Bird Studies Canada
- Pool of 50+ dedicated volunteers

A. Lavers, MTRI

LoonWatchers conducting a survey



S. O'Grady, Parks Canada

Map showing locations of LoonWatchers in the Southwest Nova Biosphere Reserve with Kejimkujik shaded in brown and Tobeatic in yellow

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Rationale

The Common loon is widely used as an indicator of the health of lake ecosystems. The number of chicks that each territorial loon pair is able to raise is monitored on 35 study lakes within Kejimkujik and the surrounding region; this is a measure of the loon's reproductive success or productivity. Loon productivity is adversely affected by such factors as acid rain, structural and recreational development of lake shorelines, disturbance by boaters, water-level fluctuations, predators and mercury pollution. The Canadian Wildlife Service monitored loon productivity in Kejimkujik from 1988 until 1997. Loon productivity was found to be limited by mercury levels in the loons and the fish that they eat. Some lakes in Kejimkujik had high mercury levels in fish and loons and low loon productivity, and vice versa. The Canadian Wildlife Service resumed monitoring of fish mercury levels in 2006 and Common loon productivity in 2007.

B. Caverhill, MTRI

Common Loon

Monitoring

MONITORING COMMON LOON PRODUCTIVITY

OBJECTIVES

- To monitor the number of territorial Common loon pairs on the study lakes.
- To monitor the number of loon chicks produced by these territorial pairs.
- To provide data on loon productivity for each study lake, which can then be related to environmental factors, human disturbance and mercury pollution.

A. Lavers, MTRI

Loon nest with eggs on Mountain Lake

METHODS

- Common loons and Common mergansers were surveyed at least three times from early June until September 2008 by trained researchers on 25 lakes within Kejimkujik and 10 lakes in the surrounding area.
- Surveys included adult loons, nests, eggs and chicks and common mergansers and chicks.
- Surveys were conducted by canoe (except Ben Lake which was only surveyed from shore).
- When loons were located, the time, date, weather, a GPS location of where the loon was first seen and behaviour were recorded.
- Survey results were summarized in a database and productivity was calculated for each territorial loon pair.
- Maps were made of the GPS sightings and territories.

RESULTS

- Eight Common loon chicks were counted on 6 of the 25 lakes within Kejimkujik.
- Two loon chicks were counted on the 10 lakes surveyed outside the park.
- On the 35 lakes surveyed, 52 territorial pairs were counted over the summer, with 14 of these territories showing evidence of breeding.

RESULTS
Continued

- A total of 8 large loon chicks were counted at the end of the summer on the 35 lakes.
- According to these observations, common loon productivity for 2008 was relatively low at 0.15 chicks produced per territorial pair.
- Artificial loon platforms were installed on Mary, Pitts and Menchan lakes in 2008.

YEARS OF DATA

- Year 2 of a 5 year project

PARTNERS

- Parks Canada
- Mersey Tobeatic Research Institute
- Canadian Wildlife Service, Environment Canada
- TD Friends of the Environment Foundation
- Mountain Equipment Co-op
- Service Canada Summer Jobs
- Nova Scotia Community Trust

B.Keoghoe, MTRI

Jake Munroe and Linsdey Beals launching their canoe for loon surveys

B.Keoghoe, MTRI

The Mary Lake loon nesting platform

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Rationale

Climate change has been identified as an important potential influence on ecological integrity at Kejimkujik. A great deal of research has been conducted to support the use of changes in spring ice out date as an indicator of climate change because there is a strong correlation between ice out date and winter air temperature. Monitoring ice phenology and lake ice freeze-thaw cycles can aid in the understanding and prediction of how climate change is affecting aquatic ecosystems. Volunteers are important resources because as citizen scientists they can keep careful track of ice-in and ice-out dates and have provided many long-term datasets.

A. Lavers, MTRI

Ice cover on Donnellan Lake

Monitoring

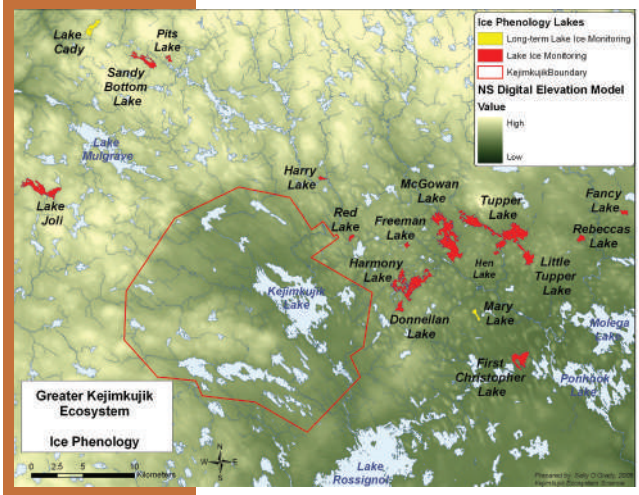
ICEWATCH

OBJECTIVES

- To monitor and assess changes in the duration of ice coverage on lakes around Kejimkujik.
- To determine if the mean duration of ice coverage (*i.e.*, Julian date of ice-off) is within the range of natural variation (*i.e.*, between 82 and 107 days, as determined through analysis of data between 1963 and 2007 for Mary and Cady Lakes) and if it has increased or decreased over time

METHODS

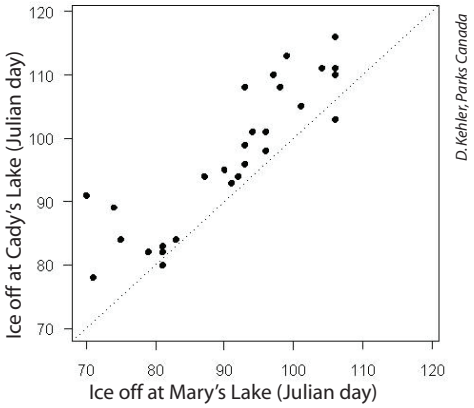
- Two dedicated community volunteers, Reg Baird and Irene Holdright, independantly recorded ice observations for years resulting in a valuable long-term data set for ice phenology in southwest Nova Scotia (starting in 1963 for Mary Lake, Queens County and 1976 for Cady Lake, Annapolis County). These long-term data were used to identify the natural range of variability for lake ice in this region.
- Simple linear regression was used to examine the relationship between ice off dates on Mary and Cady Lakes (1976-2007) and results showed a strong relationship despite differences in location and lake size. As a result, thresholds developed from historical variation in the time-series of ice off data from these two lakes were applied to the suite of lakes surveyed in this program.
- Ice phenology has been assessed on 17 lakes in the Southwest Nova Biosphere Reserve since 2006 through a dedicated group of lakeshore residents and volunteers, coordinated through the Mersey Tobeatic Research Institutes lake monitoring program.
- On each lake, community volunteers that live on watershores or that drive by the lake every day keep track of "ice-on" and "ice-off" events and the duration of complete ice cover until complete ice thaw is recorded.



S. O'Grady, Parks Canada

Locations of IceWatch lakes in Southwest Nova Scotia

RESULTS



Relationship between ice off dates at Cady and Mary Lake (1976-2007) using data from volunteers Reg Baird and Irene Holdright

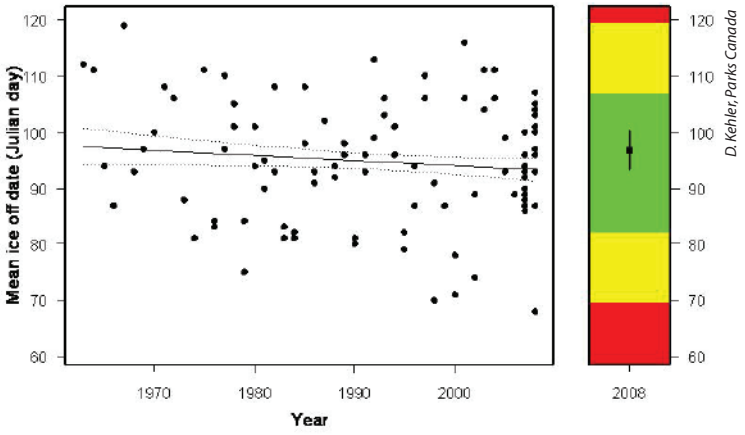
- IceWatch data were examined for trends between 1963 and 2007 using simple linear regression models and no significant trend was detected. As a result, the ice off date appears to be stable on lakes in the Greater Kejimkujik Ecosystem (GKE) over the last 45 years.
- To obtain a status assessment, the trend model was used to estimate the condition of the measure for the most recent year of data (2008) and this was compared to the established thresholds. Using this approach, the current status of ice phenology at Kejimkujik was found to be good.
- Scientific research shows that ice phenology is changing on lakes in the Northern Hemisphere in association with increasing air temperatures over the last 150 years. Much of the research presenting declining trends in lake ice-out dates has been conducted using long-term datasets (i.e., greater than 100 years). The current time-series for the GKE includes 45 years of data. As a result, it is important to continue monitoring ice phenology in this region to determine if long-term trends are occurring.

YEARS OF DATA

- Ongoing project since 2004

PARTNERS

- Parks Canada
- Mersey Tobeatic Research Institute
- Atlantic Salmon Federation
- Ecological Monitoring Assessment Network
- IceWatch program volunteers who generously agreed to participate



Status and trend for ice off date for lakes in the Greater Kejimkujik Ecosystem (1963-2007) (Note: Green indicates good condition, yellow indicates fair condition, and red indicates poor condition as determined through analysis of natural variability in Mary and Cady lakes between 1962 and 2007)

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Rationale

Clean Annapolis River Project (CARP) and the Annapolis River Guardians volunteers have monitored water quality in the Annapolis River since 1992. The program was initiated both to identify sources of contamination to the river and as a public awareness project. It is one of the longest running volunteer-based water quality monitoring programs in Eastern Canada. More than 90 volunteers from the communities of the Annapolis Valley have participated in the program over the years, with over 4000 water samples being collected and analyzed.

The Annapolis River at Granville Centre

Monitoring

ANNAPOLIS RIVER WATER QUALITY MONITORING

OBJECTIVES

- To establish and support a regular observation system that provides an early warning of environmental problems.
- To provide a long-term record of the river's health.
- To develop interest in the Annapolis River and community stewardship to ensure a viable resource for future generations.
- To provide a knowledgeable group of local individuals who can promote the preservation, rehabilitation, and use of these aquatic resources in the future.

METHODS

- Volunteers and CARP staff collected water samples at eight locations along the Annapolis River every two weeks from spring through autumn.
- Additional samples were collected by staff and volunteers during and immediately after high precipitation events.
- The parameters monitored included: weather conditions, air and water temperature, dissolved oxygen, pH, conductivity, turbidity, total suspended solids, benthic invertebrates and fecal bacteria (*E. coli*) densities.
- Dissolved oxygen samples are analyzed by volunteers using the Winkler titration method.
- *E.coli* bacteria samples were sent to an external laboratory for processing.
- Total suspended solid samples were analyzed in-house by CARP.

Ronald Jones, Annapolis River Guardian volunteer, with dissolved oxygen sample

RESULTS

- In 2008, 27% of *E.coli* samples exceeded the guideline for water contact recreation, with higher counts being observed more often in the upper reaches of the river.
- Of the samples collected during the summer months, 66% had water temperatures of 20 ºC or higher.
- For most of the sampling season, pH values were between 6.5 to 9.0, with only 10% of the 108 samples falling outside this range.
- Benthic invertebrate samples taken from the Annapolis River in 2008 had a Family Biotic Index of less than 5.
- In 2008, CARP made use of the Water Quality Index (WQI) to summarize water quality data. The WQI was developed by the Canadian Council of Ministers for the Environment (CCME) as a tool to analyze large quantities of water quality data. CARP's analysis incorporated: *E. coli* bacteria count, dissolved oxygen, water temperature, pH and turbidity.

YEARS OF DATA

- Ongoing project since 1992

PARTNERS

- Clean Annapolis River Project
- Environment Canada – Atlantic Coastal Action Program
- Nova Scotia Department of Environment
- Human Resources and Service Development Canada
- Acadia University – Acadia Centre for Estuarine Research

Site	Water Quality Index for 2008	Water Quality Index Score Poor Water Quality — Excellent Water Quality
Aylesford	64	
Aylesford	46	
Kingston	50	
Wilmot	51	
Middleton	52	
Lawrencetown	51	
Paradise	52	
Bridgetown	51	

The 2008 Water Quality Index for water quality monitoring locations along the Annapolis River

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Rationale

Primary productivity is the rate at which light is converted to biomass through photosynthesis in an ecosystem. The amount of primary productivity by algae in freshwater ecosystems provides important information about food availability and lake trophic status (nutrient level). In naturally oligotrophic (nutrient poor) lakes, such as those in and around Kejimkujik, levels of primary productivity are most strongly influenced by the availability of nutrients, primarily nitrogen and phosphorous. Freshwater systems can receive inputs of nutrients from the surrounding watershed through erosion and runoff containing fertilizers, sewage or animal waste. This nutrient-loading causes heightened growth of algae and plants, which then die and decompose, depleting water of dissolved oxygen and affecting aquatic ecosystem structure and function. The most commonly used and accepted measure to monitor primary productivity and the effects of nutrient loading in lakes is the concentration of the photosynthesizing pigment, chlorophyll *a*.

D. Ure, Parks Canada

Kejimkujik Lake

Monitoring

LAKE PRIMARY PRODUCTIVITY

OBJECTIVES

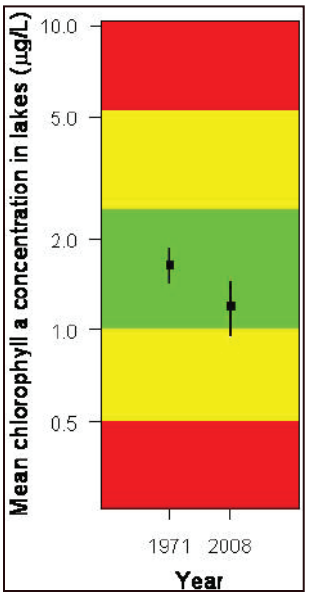
- To monitor the status and trends in primary productivity in lakes in and around Kejimkujik.
- To determine if lake primary productivity (*i.e.*, the concentration of chlorophyll *a*) at Kejimkujik is within acceptable trophic level limits for oligotrophic lakes (*i.e.*, between 1.0-2.5 ug/L) and if it is increasing or decreasing over time.
- To compare primary productivity levels on lakes throughout the greater Kejimkujik ecosystem to detect excessive nutrient inputs and potential impacts to freshwater ecosystem health.

D. Ure, Parks Canada

Sarah Chisholm sampling chlorophyll *a* on Kejimkujik Lake

METHODS

- Eighteen brown and clear lakes were selected for long-term monitoring of primary productivity at Kejimkujik. Twelve lakes that are part of MTRI's lake monitoring program in the Mersey and Medway watersheds outside of Kejimkujik were also sampled.
- Each lake in Kejimkujik was sampled in June, July and August. Lakes outside the park were sampled once in August. Water samples were filtered immediately by vacuum filtration in dim light, preserved, and stored in dark sub-zero temperatures, prior to submission to a laboratory for extraction and fluorometric analysis of chlorophyll *a* content.
- Concentrations of chlorophyll *a* in the lakes were compared to thresholds based on established trophic level limits (OECD 1982). Results from a subset of 14 lakes at Kejimkujik were also compared to historical data collected by Kerekes and Schwinghamer in the early 1970s for the same set of lakes to determine trends in primary productivity over time.



D. Kehler, Parks Canada

Mean chlorophyll *a* concentration (ug/L) from 14 lakes in 1971 and 18 lakes in 2008 at Kejimkujik (Note: Green indicates the range of acceptable values for oligotrophic lakes; Yellow indicates the range of values approaching nutrient loading or nutrient depletion; Red indicates the range of values depicting a change in historic trophic status)

RESULTS

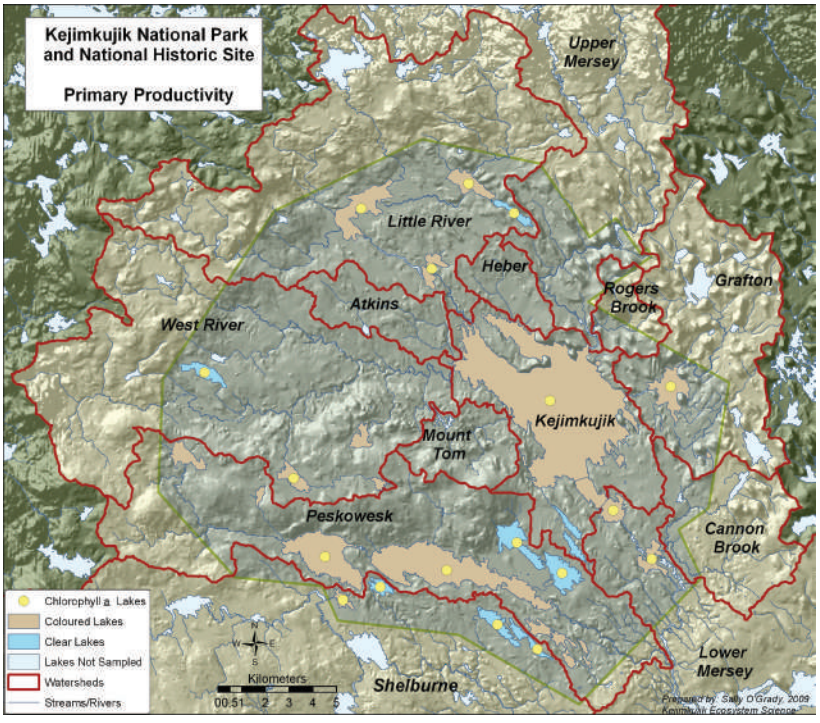
- The mean concentration of chlorophyll a in 18 lakes at Kejimkujik (1.20 ± 0.18 *ug*/L) is within the acceptable range for oligotrophic lakes (*i.e.*, between 1.0 and 2.5 *ug*/L) but approaching ultra-oligotrophic (extremely nutrient poor) status.
- Although within the acceptable range, the mean concentration of chlorophyll a in 14 lakes in 2008 (0.97 ± 0.13 *ug*/L) is significantly less than the mean concentration in 1971 (1.64 ± 0.16 *ug*/L) . These results suggest that lakes at Kejimkujik are not currently impacted by nutrient loading but that nutrient depletion may be a concern.
- The mean concentration of chlorophyll *a* in nine lakes sampled in August in the Mersey and Medway watersheds outside the park (2.02 ± 0.56 *ug*/L) is not significantly different than the mean concentration of chlorophyll a in 18 lakes sampling in August in Kejimkujik (1.71 ± 0.24 *ug*/L).
- The concentration of chlorophyll *a* in lakes sampled in the Mersey and Medway watersheds outside the park is approaching the upper acceptable limit for oligotrophic ecosystems (2.5 *ug*/L), which suggests that some nutrient-loading may be occurring in these lakes.

YEARS OF DATA

- Ongoing project since 2008

PARTNERS

- Parks Canada
- Mersey Tobeatic Research Institute
- Dalhousie University



S. O'Grady, Parks Canada

Locations of clear and brown lakes for primary productivity monitoring in Kejimkujik

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Rationale

Water chemistry is a widely used measure of aquatic ecosystem health. Freshwater processes and biodiversity are strongly influenced by water chemistry. Many of the stressors to freshwater processes, such as acidification, eutrophication, land use change, and climate change, are reflected in changes to water chemistry. The Canadian Council of Ministers for the Environment (CCME) has developed a Water Quality Index (WQI), as a tool to summarize complex water chemistry data into a single index to simplify and standardize the assessment and reporting of water chemistry data. The WQI is an index that examines several key water chemistry parameters and calculates scope (the number of parameters not meeting an established target), frequency (the number of times established targets are not met) and amplitude (the amount by which established targets are not met) (CCME 2001). This monitoring project uses a modified version of CCME's WQI to assess and detect changes in water chemistry in lakes at Kejimkujik.

Kejimkujik Lake

Monitoring

KEJIMKUJIK LAKE WATER QUALITY MONITORING

OBJECTIVES

- To monitor water quality in brown and clear lakes at Kejimkujik.
- To determine if the WQI is within the range of natural variation at Kejimkujik and if it is decreasing over time.

METHODS

- Water samples were collected annually from 18 lakes at Kejimkujik in May, June, August and October.
- Water samples were sent to Environment Canada's analytical lab for processing and analysis. A suite of nine core parameters was identified for assessment of the WQI based on the significant stressors in the region (Lacoul and Freedman 2006).
- Site-specific targets were identified for each water quality parameter based on literature review, expert consultation, analysis of natural variability in historic data from Kejimkujik (1982-1997), and use of CCME's water quality guidelines where they exist and are locally relevant.
- Data from 18 lakes at Kejimkujik were analyzed for status and trend over the period from 1998 to 2007. Historical data were not available for all nine parameters so a subset of six parameters was used for the analysis *(i.e.*, pH, dissolved organic carbon, nitrogen, nitrate, aluminum, calcium).

Water Quality Index Parameters		
Eutrophication	**Acidification**	**Land use change**
Total phosphorous Total nitrogen Dissolved oxygen	pH Calcium Aluminum	Turbidity/Suspended solids Nitrate Dissolved organic carbon

Adapted from Lacoul and Freedman, 2006

Figure 1. Core parameters for calculation of the modified WQI at Kejimkujik

RESULTS

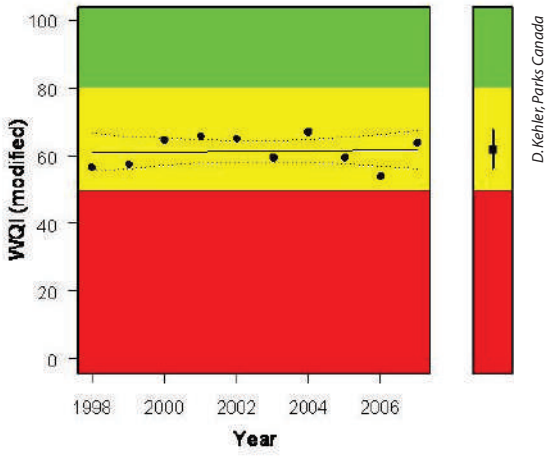
- No significant trend was detected for the WQI in 18 lakes from 1998 to 2007. As a result, the WQI appears to be stable in brown and clear lakes at Kejimkujik over the last 10 years.
- Trends in each of the individual water quality parameters were also examined for all 18 lakes at Kejimkujik between 1983 and 2007. From this assessment, total nitrogen, nitrate and aluminum all appear to be increasing in recent years. When brown and clear lakes were examined separately, pH and DOC also appeared to be increasing in clear lakes.

RESULTS
Continued

- The current status of the lake WQI at Kejimkujik was found to be fair when compared to the thresholds established for the index based on expert opinion.
- The results of this assessment reflect a large body of research findings that water chemistry at Kejimkujik and the surrounding region is highly influenced by acidification.

D. Ure, Parks Canada

Water quality monitoring on Mountain Lake



D. Kehler, Parks Canada

Status and trend for WQI for 18 lakes at Kejimkujik (1998-2008) (Note: Green indicates good condition, yellow indicates fair condition, and red indicates poor condition, based on expert opinion)

YEARS OF DATA

- Ongoing project since 1982

PARTNERS

- Parks Canada
- Environment Canada
- Dalhousie University

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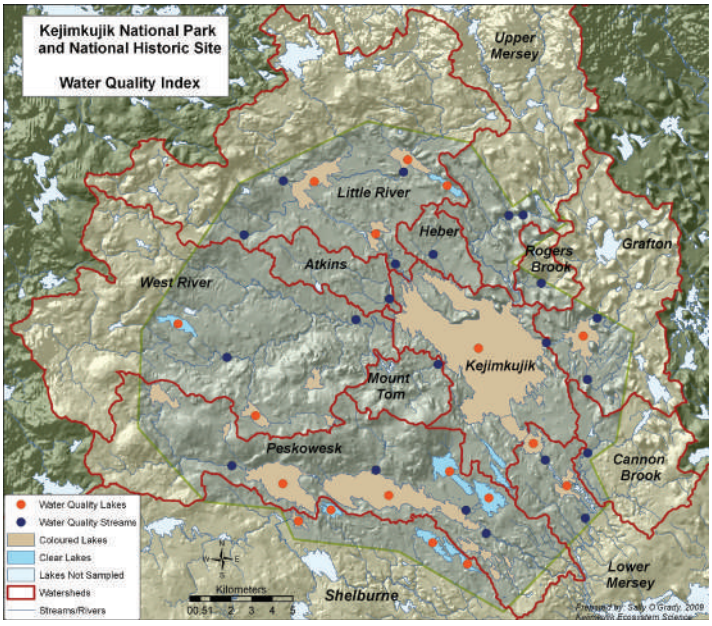


Locations of brown and clear lakes for water quality monitoring in Kejimkujik (Note: Stream water quality monitoring station are also shown)

Rationale

Acidification and lake thermal sensitivity of freshwater lakes in Nova Scotia is causing concern in many aspects of its ecosystems, including Common loon productivity levels and Brook trout habitat. Kejimkujik and surrounding areas contain poor acid buffering geology and soils. The area is topographically low in comparison to the surrounding areas, and receives deposition of acid rain from major emission producers in central Canada and northeastern United States. This causes relatively low pH levels in freshwater lakes of the area. Most of Nova Scotia's lakes are small and shallow, however, there are a number of lakes which are deep enough to contain cold water habitat for species such as Brook trout in the summer. Evidence shows acidity to be recovering in precipitation after a reduction in emissions, but at a slower rate than originally expected, and lakes are beginning to show a loss of their thermoclines. Monitoring has been undertaken to acquire information on water quality and lake thermal sensitivity that will lead to a model for future management plans.

A. Lavers, MTRI

Menchan Lake

Monitoring

LAKE AND COLD WATER HABITAT

OBJECTIVES

- To measure pH, dissolved oxygen, temperature and conductivity of selected lakes in and around Kejimkujik.
- To monitor temperature at 2 m depth intervals in Mountain and Menchan Lakes.
- To determine how emission reductions and climate variations affect acidity and thermal sensitivity.
- To determine how water quality and lake temperature effect ecosystems in the long term.

METHODS

- Water quality data were collected to determine pH, dissolved oxygen, temperature and conductivity in 32 lakes within Kejimkujik and the surrounding areas using a YSI multiprobe Sonde and a Secchi disk.
- In the spring and again in the fall, datalogging thermistors were retrieved from each of two lakes, the data were downloaded onshore and then the thermistors were returned.
- Samples were also collected to assess chlorophyll a concentrarions for lake primary productivity monitoring. Refer to pages 58-59 for results.

MTRI

Benna Keoghoe measuring water quality

RESULTS

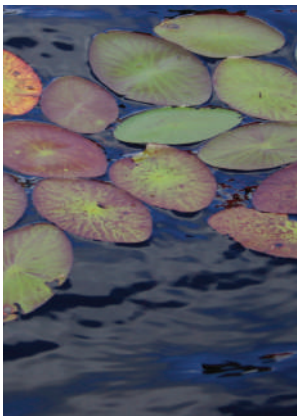
- In 2008, 53% of 32 lakes monitored had a pH below 5, 41% had a pH between 6-5 and 6% had a pH above 6.
- Of 15 lakes surveyed in multiple years, all but two (Sandy Bottom and Kempton) had declining surface pH values between 2006 and 2008.
- Both Menchan and Mountain lakes react strongly to short term weather patterns, even in the thermocline.
- An understanding of variances in the thermal sensitivity of lakes can be used to better understand how lakes will evolve and are essential to the implementation of species monitoring and conservation programs. These results are part of a long-term study to gain information to use to create models for future management plans.

YEARS OF DATA

- Ongoing project since 2005

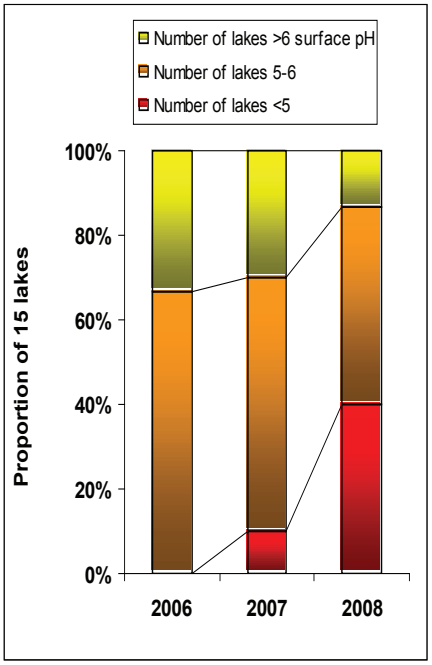
PARTNERS

- Mersey Tobeatic Research Institute
- Parks Canada
- Acadia University
- Environment Canada



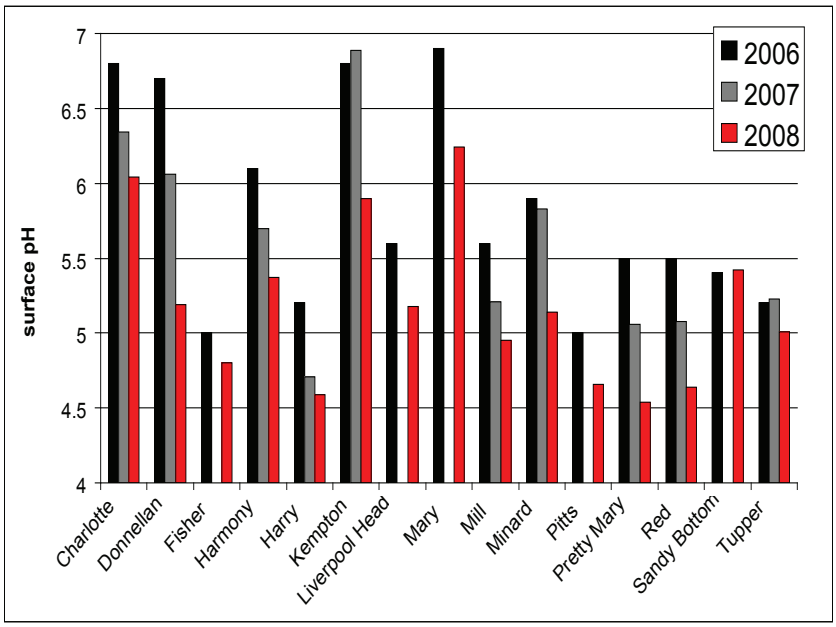
A.Lavers, MTRI

Kejimkujik Lake



MTRI

Proportion of lakes at pH values of greater than 6, between 5 and 6 and less than 5 for the years 2006, 2007 and 2008



B.Keoghoe, MTRI

Surface pH values for 15 lakes surveyed from 2006 to 2008

P.Martel, MTRI

Amanda Lavers downloading data from thermistor at Menchan Lake

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Rationale

The hydrological regime of a stream plays a critical role in determining the biodiversity and ecological processes of aquatic, wetland and riparian ecosystems. Stressors such as roads, dams, water diversions, deforestation, municipal development and climate change affect and alter hydrological processes. As a result, hydrological characteristics provide important information on the integrity of freshwater systems and how they may be changing over time. Critical parameters of hydrologic condition are assessed in five watersheds and used to monitor and report on the status and trends in a Stream Flow Index at Kejimkujik.

D. Ure, Parks Canada

Mersey River, Kejimkujik

Monitoring

STREAM FLOW MONITORING

OBJECTIVES

- To monitor the status and trends in stream flow in major transboundary watersheds at Kejimkujik.
- To determine if the Stream Flow Index is within the range of natural variation for major transboundary watersheds at Kejimkujik and if it is changing over time.

METHODS

- Stream flow was monitored at one site in each of five major transboundary watersheds at Kejimkujik (Mersey River, Little River, West River, Grafton Brook and Peskowesk Brook). The Mersey River site has been monitored by the Water Survey of Canada since 1968 and Parks Canada has been monitoring the other sites since 2008.
- A permanent stream gauging station was installed at each site, using an automated data logger to record a continuous record of water level.
- Measurements of water depth and stream flow were taken across a cross section of each stream periodically throughout the year to determine total discharge. These discharge measurements were done at a range of different water levels to define a rating curve for the relationship between water level and discharge for a given site.
- A time series of discharge data was generated from the measured water level data using the defined rating curve for each site.
- Historic discharge data from the Mersey River site were used to calculate five parameters, selected to represent the critical characteristics of hydrologic processes.
- Thresholds for each parameter were established based on statistical variability in historical data from each site between 1968 and 1988 (*i.e.*, the condition is good if it is within one standard deviation from the historic mean; the condition is poor if it is more than two standard deviations from the historic mean). Using the thresholds, each parameter was given a score for each year and the scores were averaged to obtain a Stream Flow Index value for the Mersey River for each year between 1989 and 2006.

Hydrologic characteristic	Stream flow parameter
Magnitude	Mean daily flow
Duration	Min. average flow for 30-day period
Timing	Julian data of annual min. flow
Frequency	Number of high flow pulses greater than 3 times median flow
Rate of change	Richards-Baker Index (RBI)

Parameters used to calculate the Stream Flow Index

D. Ure, Parks Canada

D. Ure, Parks Canada

Pierre Martel monitoring stream flow at Peskowesk Brook

RESULTS

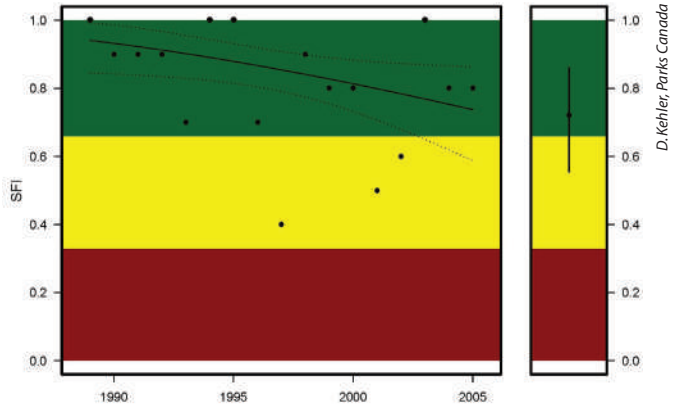
- A significant trend was detected and the Stream Flow Index appears to be declining for the Mersey River at Kejimkujik between 1989 and 2006, indicating that hydrologic condition of the watershed is decreasing over time.
- The current condition of the Stream Flow Index for the Mersey River is between fair and good, when compared to the thresholds established for the index based on statistical variation in historic data (1989-2006).

YEARS OF DATA

- Ongoing project since 2006

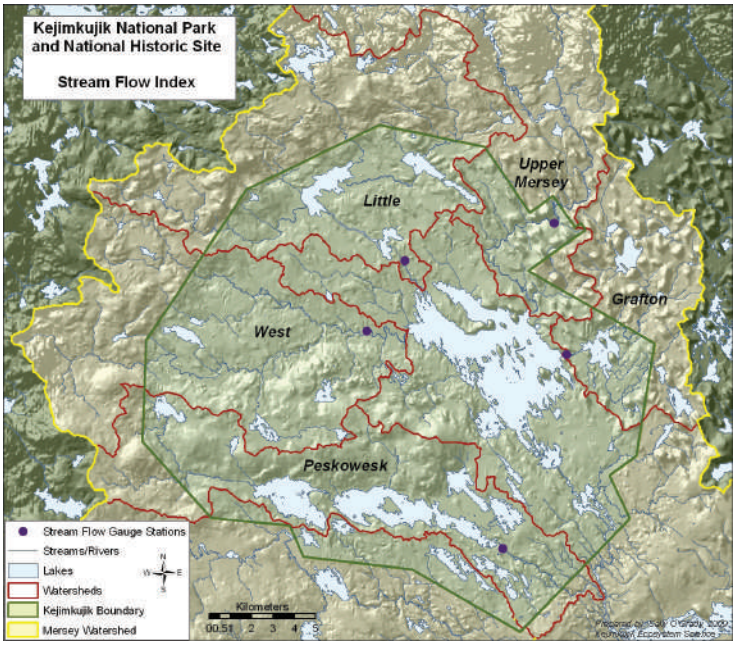
PARTNERS

- Parks Canada
- Water Survey of Canada, Environment Canada
- Dalhousie University



D. Kehler, Parks Canada

Status and trend in the Stream Flow Index for the Mersey River (1989-2006) (Note: Green indicates good condition, yellow indicates fair condition, and red indicates poor condition, based on statistical variation in historic data)



S. O'Grady, Parks Canada

Locations of stream gauging stations in five major transboundary watersheds at Kejimkujik

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Rationale

Connectivity is a critical component of freshwater ecosystem health. The connectivity of a watershed can be impacted through development of dams and through improperly functioning stream crossings such as culverts and bridges. Brook trout, and other fish species, require high levels of connectivity to move throughout a watershed to access feeding grounds, spawning areas and summer habitat. As watersheds become increasingly fragmented, the ability to support viable populations decreases. Aquatic fragmentation is identified as a significant threat to freshwater ecological integrity at Kejimkujik. Dams (constructed to facilitate logging operations prior to park establishment) and road culverts act as barriers to fish movement throughout the Mersey watershed and cause artificial water levels that may impair freshwater ecosystem. As a result, aquatic connectivity was identified as an important component of the monitoring program to identify barriers to aquatic connectivity and to prioritize management action to eliminate these barriers.

O. Woods, Parks Canada

Impassable culvert for fish due to outflow drop, Canning Field Road, Kejimkujik

Monitoring

AQUATIC CONNECTIVITY

OBJECTIVES

- To inventory and assess each stream crossing at Kejimkujik and prioritize culverts based on fish habitat importance and connectivity.
- To calculate the percentage of flows during which Brook trout (and other species) can pass through each prioritized culvert.
- To identify culverts requiring increased attention and/or restoration.
- To determine if the connectivity of aquatic ecosystems at Kejimkujik is similar to natural conditions and if it is decreasing over time.

D. Ure, Parks Canada

Pierre Martel measuring water depth at culvert outflow in Kejimkujik

METHODS

- An inventory was conducted to identify the locations of all culverts at Kejimkujik. A visual assessment was performed to identify culverts in potential fish habitat.
- A preliminary survey was conducted for culverts on potential fish bearing streams, which included culvert size, shape, material, condition, length, gradient, slope, bottom surface, water depth at outflow and inflow, outflow drop height and outflow pool depth.
- From the preliminary assessment, culverts were identified to be full barriers, partial barriers, or fully passable culverts and passability values were assigned *(i.e.*, fully passable = 1; partial barrier = 0.5; full barrier = 0).
- Passability values were used to calculate a connectivity index as established by Cote *et al*. 2008, for aquatic ecosystems at Kejimkujik to quantify the structural connectivity of watersheds and assess the cumulative impacts of barriers to connectivity.

RESULTS

O. Woods, Parks Canada

Main park road culvert at Rogers Brook, Kejimkujik

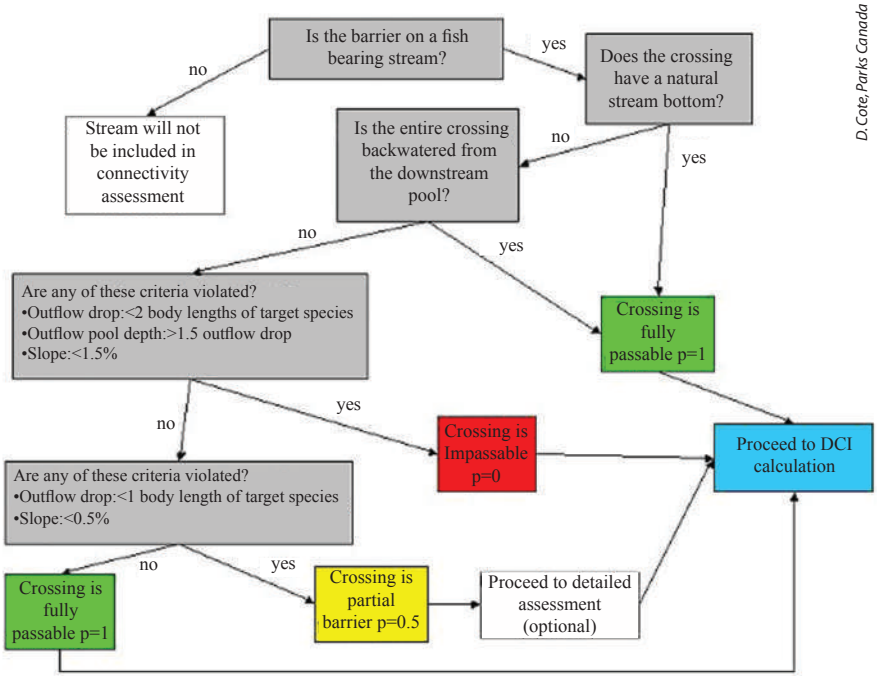
- On the main and backcountry roads of Kejimkujik, a total of 74 culverts were surveyed.
- Based on habitat assessment from the initial survey, 20 of the 74 culverts were identified as medium or high priority fish habitat. Of the 20 culverts on fish-bearing streams, one was assessed to be fully passable, 16 were partial barriers and three were full barriers. Culverts with a slope of greater than 0.5% were found to be the most common barrier to fish passability at Kejimkujik.
- From a maintenance standpoint, 24 culverts were identified in the initial survey as requiring additional attention, cleaning, or restoration.
- Five culverts were identified as requiring immediate maintenance attention and were also identified as top habitat priorities.
- More detailed assessments will be conducted in 2009 for barriers that were identified as full or partial barriers.

YEARS OF DATA

- Ongoing project since 2008

PARTNERS

- Parks Canada
- Mersey Tobeatic Research Institute
- Clean Annapolis River Project



D. Cote, Parks Canada

Flow chart for preliminary culvert assessment

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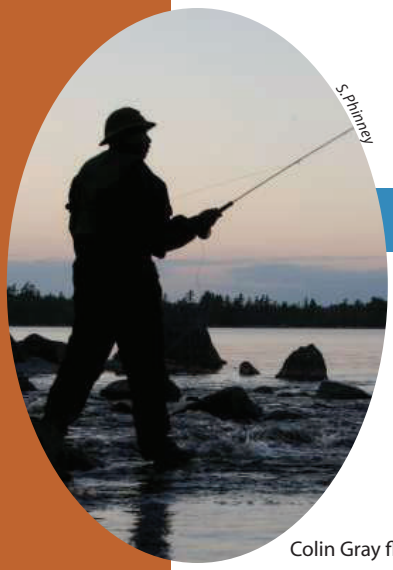
Rationale

Trout and salmon are threatened by numerous regional and local factors including acid precipitation, overfishing, climate change, habitat alteration and fragmentation, and the introduction of invasive alien organisms. These fish are an important part of the local biodiversity and cultural history because they were a historical food source for predators and aboriginal people, early settlers, and a coveted catch for sportfishers. Although generally pristine and free of point source pollution, surface waters in the acidic Medway, LaHave, and Gold River watersheds have a low buffering capacity and have collected inputs of acid precipitation from the long-range transport of air pollution. Acid emission reductions have not, on their own, resulted in sufficient improvements to water quality and Atlantic salmon populations continue to decline. Although not tested in Nova Scotia to date, catchment or terrestrial liming merits consideration to mitigate the effects of acid precipitation and to improve salmonid habitat.



S.Phinney

Colin Gray flyfishing

Research

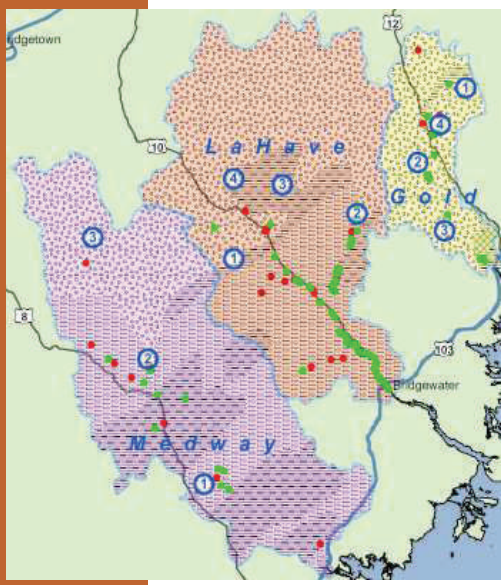
TERRESTRIAL LIMING TO IMPROVE SALMONID HABITAT

OBJECTIVES

- To gather information relating to salmonid habitat in the Medway, LaHave and Gold River watersheds.
- To map salmonid habitat information using ArcGIS software.
- To identify potential terrestrial liming sites by overlaying soil, forest, property ownership data, and current salmon populations.

METHODS

- Published and mapped data were gathered from the Geological Survey of Canada, the Nova Scotia Department of Natural Resources and the Nova Scotia Geomatics.
- Published and unpublished electrofishing data were collected from the Department of Fisheries and Oceans, Bluenose Coastal Action Foundation and Nova Scotia Power Incorporated
- Representatives from the following associations were interviewed to determine where salmon populations persist: LaHave Salmon Association, Medway Salmon Association, Queens County Fish and Game Association, Nova Scotia Salmon Association and the Atlantic Salmon Federation.
- All of the data were mapped using ArcGIS software.
- The information was interpreted with mapping technology and used to select potential liming areas in each watershed which deserve future study.



A. Belliveau, MTRI

Watersheds with bedrock and three recommended sites in each watershed (red and green dots are salmon)

RESULTS

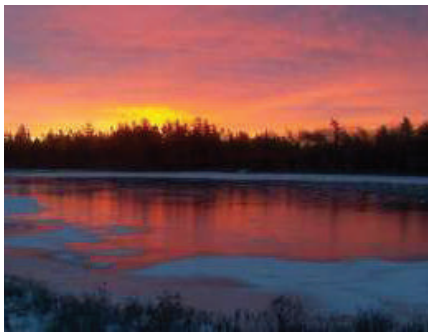
- Data relating to salmonid habitat in the Medway, LaHave and Gold watersheds were mapped, organized and stored in a database.
- Eleven sites were selected as the best known areas for potential liming areas.
- A report with all results and recommendations was presented to Environment Canada in preparation for the next phase of the research project.

YEARS OF DATA

- Ongoing project since 2008

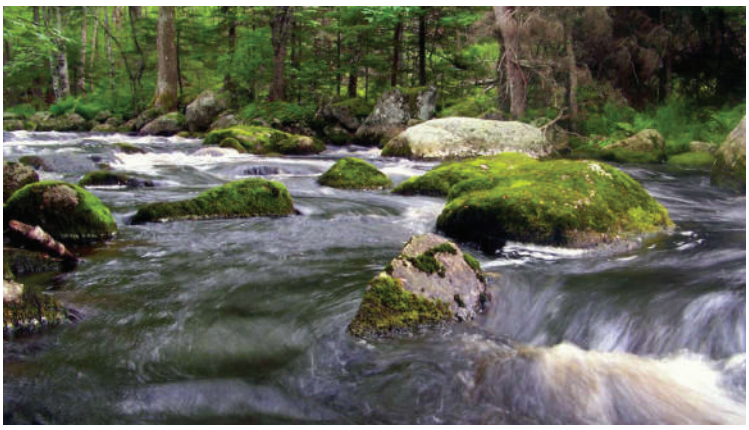
PARTNERS

- Environment Canada
- Nova Forest Alliance
- Atlantic Salmon Federation
- Nova Scotia Salmon Association
- Bluenose Coastal Action Foundation
- Department of Fisheries and Oceans
- Nova Scotia Power
- Queens County Fish and Game Association
- LaHave River Salmon Association
- Nova Scotia Department of Fisheries and Aquaculture



A. Belliveau, MTRI

Medway Lake watershed



A. Belliveau, MTRI

Typical fish habitat

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Rationale

Dissolved organic carbon (DOC) absorbs solar radiation in freshwaters and gives them a characteristic brown color. As such, it acts as a sunscreen protecting aquatic organisms from damaging ultra violet (UV) radiation. When DOC is exposed to UV radiation it breaks down to produce carbon dioxide (CO^2) . This process is important because it produces carbon dioxide (a greenhouse gas), reduces the ability of DOC to bind contaminants in the water and results in increased UV exposure to aquatic organisms. The objective of this research project was to quantify the rate of DOC breakdown by ultraviolet-A (UVA) and ultraviolet-B (UVB) radiation in a series of lakes in Kejimkujik.

A. Lovers, MTRI

Dark Kejimkujik water

Research

BREAKDOWN OF DISSOLVED ORGANIC CARBON

OBJECTIVES

- To quantify dissolved organic carbon oxidation with solar radiation.

METHODS

- Five lakes in Kejimkujik were sampled from May 13th to May 15th, 2008. The lakes sampled were: Big Red, Pebbleloggitch, Puzzle, Grafton, Big Dam East.
- In each lake, spectral attenuation measurements were taken using an Ocean Optics USB-4000 spectra-radiometer probe with depth. A YSI multiprobe Sonde was used to measure water quality parameters at each site.
- Water samples were collected from each lake in 26 L polyethylene containers and kept frozen and in the dark prior to analysis.
- Samples were filter sterilized through a 0.2 micron polypropylene filter, sub-sampled into sealed quartz vials, irradiated with either UVA or UVB radiation, and analyzed for DOC and DIC (dissolved inorganic carbon) in triplicate using a Shimadzu TOC (total organic carbon) analysis system. Irradiation times of 0, 2, 4, 6, 9, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, and 72 hours were used to determine the rate of abiotic DOC photo-oxidation.

A. Belliveau, MTRI

Big Dam East Lake

RESULTS

- Results show measurable and linear decreases in dissolved organic carbon and concurrent increases in dissolved inorganic carbon with exposure to ultra violet radiation.
- UVB radiation is more effective at DOC degradation than UVA radiation. However, whole lake models showed that due to attenuation effects and intensities UVA radiation results in much more degradation of DOC in each lake.
- While annual DIC production is low at <1000 kg per lake, this amount is significant in terms of DOCs capacity to shield organisms from damaging UV radiation and to bind toxic metals.

YEARS OF DATA

- Single year project

PARTNERS

- Acadia University
- Natural Sciences and Engineering Research Council of Canada
- Parks Canada
- Canada Research Chairs

N.O'Driscoll

Sarah Haverstock measuring absorption of ultra violet radiation in Big Dam East Lake

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Rationale

Mercury is a toxic metal with several different forms within a lake ecosystem. Recent work has demonstrated that much of the mercury falling into lakes as precipitation may quickly change to one of three forms. One form, elemental mercury, is rapidly lost to the air while another form, methyl mercury, may be more efficiently incorporated into the food chain. Dissolved organic carbon and solar radiation are known to be key factors controlling these processes. However, this has not been examined for a wide range of lakes. Using controlled laboratory experiments, this ongoing project examines how mercury changes form in the presence of solar radiation. This work will lead to the development of a model to predict which lakes are more likely to retain mercury deposited from rain. In addition, methyl mercury values in lake water will be compared to values measured in the year 2000 to determine whether there have been significant changes over time.

A. Lavers, MTRI

Maple leaf floating on the surface of a dark water lake in Kejimkujik

Research

MERCURY PHOTO-REACTIONS & DISSOLVED ORGANIC CARBON

OBJECTIVES

- To quantify mercury reduction with ultra violet radiation in lakes..

METHODS

- Nine lakes in Kejimkujik National Park were sampled from May 13th to May 15th, 2008 and six lakes in May of 2009. The lakes sampled were: Peskowesk, Big Red, Pebbleloggitch, Hilchemakaar, North Cranberry, Puzzle, Grafton, Big Dam East, and Big Dam West.
- Samples were analyzed for total mercury, methyl mercury, and dissolved organic carbon (DOC).
- Photo-reduction rates in UVA and UVB radiation were calculated for mercury using a system developed at Acadia University.

B. Keoghoe, MTRI

Canoe on Peskowesk Lake

RESULTS

- Initial results suggest that the DOC content of Kejimkujik lakes may directly control the rate at which volatile mercury is produced.
- Results also show that oxidation and reduction rate are very different from ocean water and that microbial reduction and oxidation may play only a minor role in total redox processes.
- A predictive relationship is currently being developed between DOC and mercury reduction using a wide range of DOC containing lakes in Kejimkujik.

YEARS OF DATA

- Year 1 of a 3 year project

PARTNERS

- Acadia University
- Natural Sciences and Engineering Research Council of Canada
- Canada Research Chairs
- Parks Canada
- Canada Foundation for Innovation
- Environment Canada

N.O'Driscoll

Nelson O'Driscoll performing methyl mercury analysis at Acadia University

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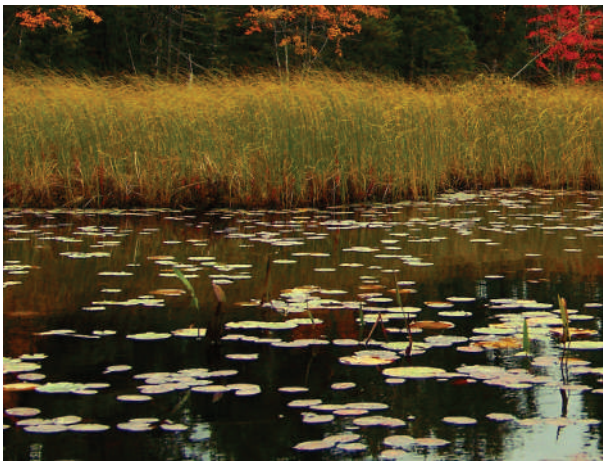
Clockwise from top left:

- Blanding's turtle at McGowan Lake, A. Belliveau, MTRI
- McGowan Lake by A. Belliveau, MTRI
- Flander's Meadow by A. Belliveau, MTRI
- Grafton lake by H. Mailhot Couture
- Ribbonsnake at Grafton Lake by H. Mailhot Couture



WETLANDS

Rationale

The Rare Plant Monitoring program is part of the Nova Scotia Nature Trust's (NSNT) Plants on the Edge project, an initiative to protect critical habitat for unique coastal plain plants found along lakeshores and bogs in southwest Nova Scotia. Monitoring helps to determine how these rare plant populations behave over time. Are they migrating over the shoreline? Are they staying in one established location? Are the numbers of plants increasing or decreasing? This information improves our ability to understand population changes and to protect these exceptional plants and their habitat. The Atlantic coastal plain flora is one of the most endangered plant groups in Canada. There are now 90 ACPF, of which 11 are considered Endangered, Threatened, or Special Concern by the Committee on the Status of Endangered Wildlife in Canada, occurring within Canada only in Nova Scotia. Five species are considered to be globally at risk of extinction and 25 are listed as 'at risk' or 'sensitive' by the Nova Scotia provincial government.

P. Green, NSNT

Rare plant monitor begins a survey

Monitoring

RARE PLANT MONITORING

OBJECTIVES

- To involve local landowners, recreational land users and other interested individuals in the conservation and recovery of Atlantic coastal plain flora in southwest Nova Scotia.
- To collect information on the geographic distribution of Atlantic coastal plain flora on private lands in southwest Nova Scotia.
- To track changes and assess threats to Atlantic coastal plain flora populations and habitat in southwest Nova Scotia.

P. Green, NSNT

Rare plant monitor learning to identify ACPF

METHODS

- Outreach and education initiatives were conducted with landowners in Lunenburg, Queens, Shelburne, Yarmouth, Digby and Annapolis counties about the importance of protecting coastal plain plants and habitat on their property.
- Volunteers were trained to identify Atlantic coastal plain flora species, observe changes and threats to habitat and record information using Nature Trust data sheets.
- Volunteers visited selected coastal plain sites on private lands a couple of times each year to count plant populations, photograph the sites and record observations of habitat.
- Monitoring data collected by the Nature Trust were submitted to the Atlantic Coastal Plain Flora Recovery Team, who use the data to plan the conservation and recovery of Atlantic coastal plain flora.

RESULTS

- A National Recovery and Conservation Plan for Atlantic coastal plain flora was finalized in 2005 with input from the Nature Trust's monitoring program.
- Nature Trust volunteers assisted with the monitoring of 29 sites, on four lakeshores or bogs in 2008, contributing significantly to long-term data records of habitat characteristics and species occurrences.

RESULTS
Continued

- Eight new volunteer monitors have been engaged in the program since 2007.

YEARS OF DATA

- Ongoing project since 1999

PARTNERS

- Nova Scotia Nature Trust
- Atlantic Coastal Plain Flora Recovery Team
- Nova Scotia Department of Environment and Labour
- Nova Scotia Department of Natural Resources
- Government of Canada Habitat Stewardship Program for Species at Risk
- Nova Scotia Habitat Conservation Fund
- Nova Scotia Species at Risk Conservation Fund
- Home Depot Foundation
- Municipality of the District of Shelburne
- Aveda International
- Parks Canada

NSNT

Rare plant monitors measure area covered by Golden crest

P. Green, NSNT

Rare plant monitor in a lovely Pleasant River bog

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Rationale

Blanding's turtles in Nova Scotia exist in three small populations on the Mersey and Medway watersheds and have been listed as Endangered under both the federal Species at Risk Act and the Nova Scotia Endangered Species Act. One of the concerns for this long lived (80+ years), slow maturing (20+ years) species is the lack of young adults in the population. This is of particular concern in the population at Kejimkujik where only 5 young known females have been recorded during the last decade. Rates of predation of unprotected nests are variable but can reach 100%. Raccoons are the primary nest predators and their populations may be unusually high in human inhabited areas (*e.g.,* campgrounds and communities). An annual volunteer-based nest protection program was established in Kejimkujik and later expanded to populations outside the park to engage the public in helping to protect and care for turtle nests.


J. McNeil, Parks Canada

A nesting Blanding's turtle

Monitoring

BLANDING'S TURTLE NEST MONITORING

OBJECTIVES

- To protect Blanding's turtle nests from predation to improve recruitment into the populations.
- To provide an opportunity for volunteers to engage in Species at Risk recovery.
- To collect long-term data on female survivorship, clutch size, hatching success, and site fidelity.
- To reduce threats to females and their hatchlings by enhancing nest site habitat and turtle awareness near roads.

METHODS

Nest Protection (June)

- Known nesting sites were monitored on a nightly basis during nesting season.
- Individual turtles were radio tracked to locate new nesting sites.
- Beginning at 7:30pm, volunteers and researchers walked each site watching for turtles. Observers watched females go through the nesting process and recorded data related to behaviour and movements, weather, timing of activities, and clutch size.
- Once a nest was completed and the female had left the site, volunteers covered the nest with a wire mesh cage and secured it with large rocks to protect the nest from predation.

Nest Monitoring (September – October)

- Nests were monitored periodically until the first nest emerged and then were monitored daily by volunteers and researchers who marked, measured, weighed and released hatchlings at the nest site.
- Select hatchlings were outfitted with tiny transmitters and were radio-tracked throughout the fall to document their travel paths and locate overwintering sites.


J. McNeil, Parks Canada

Volunteers recording data as Blanding's turtles nest in June

RESULTS

Nest Protection

- 2008 was a very successful year. One hundred and twenty five volunteers and researchers put in over 2500 hours of search effort during nest protection season and another 2800 hours of effort during nest monitoring.
- Fifty Blanding's turtle nests were protected in the three populations (24 in Kejimkujik, 16 in McGowan Lake and 10 in Pleasant River).

Nest Monitoring

- Nests were very successful with over 360 hatchlings emerging from protected nests; 28 of these were radio-tracked after emergence.

Reducing Threats via Road Signs

- Road signs and speed bumps were installed in Kejimkujik in June to reduce or prevent mortality of adult turtles nesting in June and emerging hatchling turtles in September and October. These signs drew attention to the turtles and the bumps reduced driving speeds.
- In July, with support from the Department of Transportation, large road signs were placed on the major roads coming into Blanding's turtle habitat to alert motorists. Smaller signs will be placed seasonally near where turtles are known to cross the road or nest.

YEARS OF DATA

- Ongoing project since 1989 in Kejimkujik
- Ongoing project since 2000 at McGowan Lake
- Ongoing project since 2002 at Plesant River

PARTNERS

- Parks Canada
- Blanding's Turtle Recovery Team
- Acadia University
- Friends of Keji Cooporating Association
- Mersey Tobeatic Research Institute
- Government of Canada Habitat Stewardship Program for Species at Risk

J. McNeil, Parks Canada

Enclosure protecting a roadside Blanding's turtle nest

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Rationale

Water quality and quantity are important determinants of wetland condition. The chemistry of the water in a peatland system is determined by two principal factors: the quality and quantity of the water coming into the system and the chemical transformation within the system itself. As a result, the quality and quantity of water in a wetland can be strongly influenced by many stressors, including land use change and forestry practices, infrastructure and road development, hydrological modification, acid deposition and long-range transport of air pollutants and climate change. This project aims to monitor water quality and quantity in peatlands at Kejimkujik. The specific measures that are reported on are a water quality index, developed based on the status of key wetland water quality parameters (*i.e.*, pH, conductivity, salinity, phosphorous, nitrogen, potassium, and calcium) and mean monthly water level. These water quality and quantity parameters affect the growth of plants and peatland communities, so changes in these parameters are indicative of significant changes in peatland communities.

D. Ure, Parks Canada

Heber Meadows, Kejimkujik

Monitoring

WETLAND WATER QUALITY AND QUANTITY

OBJECTIVES

- To monitor and detect changes in mean monthly and minimum water level in bogs at Kejimkujik.
- To monitor and detect changes in key water quality parameters (pH, conductivity, salinity, Ca, N, K, P) in bogs at Kejimkujik.

METHODS

- Wetland water quality and water level was assessed at ten long-term monitoring plots that were established in bogs throughout Kejimkujik using a stratified random sampling design.
- Water quality and quantity were sampled in piezometers (small wells) that were installed at each site. Water quality measurements were completed twice (May & October) using in-situ probes and by collection of water samples for laboratory analysis.
- Water quantity was sampled by continuous data loggers that are deployed in the piezometers from May to October each year.

R. Brunt, Parks Canada

Daniel Pouliot recording data in a wetland

RESULTS

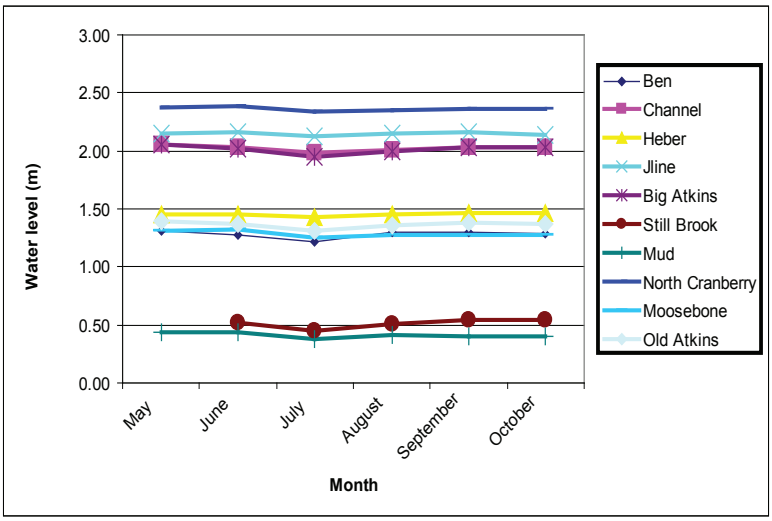
- Between May and October 2008, mean monthly water level in 10 different bogs was generally highest in May and lowest in July.
- Data on water quality parameters and water levels will continue to be collected and a trend assessment will be conducted after five years.

YEARS OF DATA

- Ongoing project since 2007

PARTNERS

- Parks Canada
- Mersey Tobeatic Research Institute



Mean daily water level of 10 wetlands in Kejimkujik between May and October 2008

D. Pouliot, Parks Canada

A typical peatland in Kejimkujik

D. Pouliot, Parks Canada

Fall syhagnum

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Rationale

The Nova Scotia population of Blanding's turtle has been listed as Endangered through the federal Species at Risk Act and the Nova Scotia Endangered Species Act. This small population is geographically isolated from the species' main range and low juvenile recruitment has been observed. Headstarting, along with other conservation strategies, has been used in an attempt to increase juvenile recruitment. Headstarting involves the captive rearing of hatchlings collected from the wild and their subsequent release back into their natural habitat. This conservation tool allows turtles to grow under optimal conditions and avoid the high mortality rates associated with early life stages of Blanding's turtles. Little is known about the behaviors of released headstarted turtles or their ability to adapt to their new environment. Studying the survival, growth, movement, and behavior of headstarts following their release will allow us to evaluate the headstarting program for Nova Scotia Blanding's turtles.

Keji, a released Blanding's turtle headstart with radio transmitter is two years old and was released in July 2008

Research

BLANDING'S TURTLE HEADSTART TRACKING

OBJECTIVES

- To track headstarted turtles released in 2008 throughout the summer and fall.
- To trap and conduct visual surveys for wild juvenile Blanding's turtles.
- To assess the ability of headstarts to behave like wild juvenile turtles by comparing survival, growth, movement, and behavior of released headstarts to wild juveniles.
- To evaluate the effectiveness of a headstart program for Nova Scotia Blanding's turtle by examining the ability of headstarts to adapt to their new environment.

METHODS

- Headstarts were released into their natural habitat in the summer of 2008. Prior to their release, turtles were measured, weighed, photographed, given individual notch codes, and fitted with radio transmitters.
- Visual surveys and trapping sessions using baited hoop traps were conducted to find wild juveniles. Once found, wild juveniles were also fitted with radio transmitters.
- Headstarts and wild juveniles were tracked during the summer and fall to study their movements and behavior.
- Headstarts and wild juveniles were weighed monthly to assess growth rates.

Jack, a released Blanding's turtle headstart in Kejimkujik is 2 years old and was released in July 2008

RESULTS

- A total of 24 headstarts, all two years of age, were tracked. One headstart was predated and five turtles were lost due to radio failure.
- A total of 17 wild juveniles were found through trapping and visual surveys. Radio transmitters were attached to 14 of these turtles. Wild juveniles ranged from 1 to 18 years of age. A total of four one year old turtles were found through visual surveys.
- One nine year old wild juvenile was predated and eight were lost due to radio failure.

RESULTS
Continued

- Headstarts gained weight following release and appear to have had similar growth rates to wild juveniles. These results suggest successful foraging for headstarts.
- Headstarts were found in the same areas as wild juveniles indicating similar habitat use.
- Nest codes were found still present on wild juveniles as old as 9 years.

YEARS OF DATA

- Year 1 of a 2 year project

PARTNERS

- Acadia University
- Blanding's Turtle Recovery Team
- Parks Canada
- Endangered Species Recovery Fund
- Friends of Keji Cooperating Association
- Mersey Tobeatic Research Institute
- Oaklawn Farm

L.Arsenault

One year old wild juvenile Blanding's turtles in Kejimkujik

P.Kydd

Lilianne Arsenault tracking a juvenile Blanding's turtle in Kejimkujik

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Rationale

Although it is known that the Blanding's turtles in Nova Scotia repeatedly use the same nesting sites, summering grounds, and overwintering sites, there is often little data on the precise movements to and from these areas. As these travel routes are often crossing roads, passing through industrialized and residential areas, as well as land designated for logging operations, it is vitally important that these travel routes are well defined. If important corridors for travel routes are not indicated to be critical habitat, and eventually protected, the Blanding's turtles could potentially lose their ability to travel from one component of critical habitat to another. It is the precise timing of the travels that is so unpredictable, and because these turtles can move long distances unexpectedly fast, the identification of travel routes has proven challenging. The technology and methods that are currently being used to follow these animals are costly and labour intensive and potentially disruptive to turtle movement. Developing new technology, which is not costly and light enough to deploy on Blanding's turtles, could potentially aid in determining the fine scale travel routes, home ranges, and habitats used by them.


P. Kydd

Adult Blanding's turtle with textaline mesh pocket at Heber Meadow Brook

Research

TRACKING BLANDING'S TURTLES USING GPS

OBJECTIVES

- To evaluate the effectiveness of GPS technology in documenting turtle movement patterns.
- To compare the GPS technology to conventional radio telemetry.
- To map travel routes and use data to identify critical habitats.
- To identify previously unknown nesting and overwintering sites, and summering areas.

METHODS

- GPS units and custom software were designed by Norm Green. Points were logged on a flash memory card contained in the unit and downloaded once the unit was retrieved.
- The data collection interval, maximum attempt time to obtain a location, and number of points to sample before storing for each unit were easily customized.
- Units were encased in 12 gauge vinyl for waterproofing.
- A small transmitter was embedded in the unit to facilitate relocation of the turtle.
- Two Tadiran TLH-5903 3.6 V AA batteries were used to minimize weight and maximize battery life.
- Units were sealed in 12 gauge vinyl for waterproofing. Then the units were placed in a textaline mesh pocket which was glued to the shell. This enabled the subsequent deployment of GPS units on the same turtle, avoiding the unnecessary stress of re-gluing.
- Initial weight of the complete unit with epoxy and textaline® mesh pocket was approximtely 100 g.
- In 2008, GPS loggers were deployed on ten Blanding's turtles, two males and three females at each of two different sites within Kejimkujik.


P. Kydd

Blanding's turtle habitat at Little Kempton Lake

RESULTS

- GPS units successfully recorded more than 1500 location points of Blanding's turtles from April 23, 2008 until October 31, 2008.
- GPS data were downloaded and compared against known locations; most points accurately reflected the actual location of the turtle.
- 95% home ranges and 70% core use areas were estimated using several techniques. Home ranges estimated using the GPS logger data were compared with those calculated from conventional radio telemetry points.
- Preliminary investigation indicates that home ranges determined using the GPS logger points are more accurate and included more of the known habitat for individual turtles. This could be because of the increased amount of location points acquired when using GPS loggers.
- Daily movement rates were calculated and indicated that the peak movement time is between 4:00 am and 8:00 am for both males and females. A small spike in movement rate also occurs in early evening between 4:00 pm and 8:00 pm.
- Annual movement rates indicated that the largest movements occur between June 15th and July 15th, which corresponds to the nesting season. There are also small spikes in movement rates in early April and early October, corresponding with travel from and to overwintering sites, respectively.
- Other data analyses are currently underway.

P.Kydd

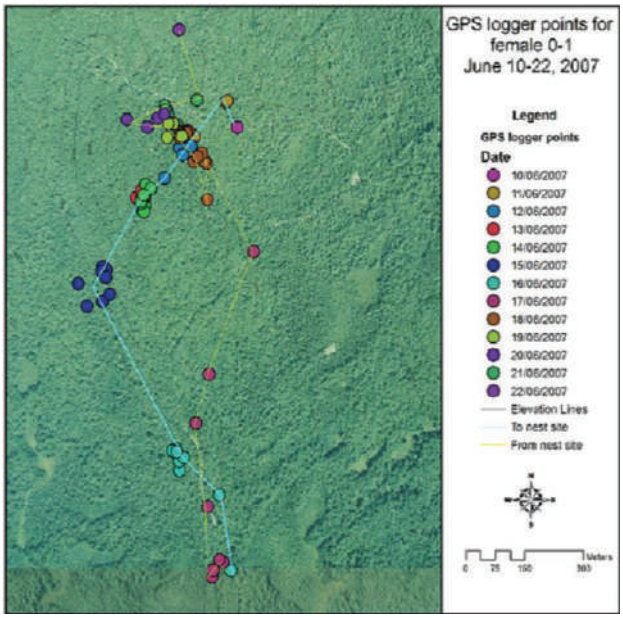
Blanding's turtle with GPS at Little Kempton Lake

YEARS OF DATA

- Year 2 of a 2 year project

PARTNERS

- Acadia University
- Friends of Keji Cooperating Association
- Endangered Species Recovery Fund
- Government of Canada Habitat Stewardship Fund
- Parks Canada



J. McNeil, Parks Canada

2007 travel route of a female to and from her nesting site shows that she spent a couple of days on top of a hill in the woods, a movement she suprisingly made again in 2008

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Rationale

Eastern ribbonsnakes in Nova Scotia are active at surprisingly low temperatures in the spring and fall. Little is known about how these snakes might be able to raise their body temperatures above that of their environment. The ability to do so allows the snakes to maximize their active season, and increases their chance of escaping predation in cooler temperatures. The focus of this study was to better understand the function of thermoregulation in Eastern ribbonsnakes.

J.Amiel

Juvenile ribbonsnake exploring some rocks near the MTRI field station, Kempt

Research

RIBBONSNAKE THERMOREGULATION

OBJECTIVES

- To determine whether Eastern ribbonsnakes captured in the spring and fall have a tail temperature lower than their body temperature. This would be evidence that the snakes have a way of restricting blood flow to the tail, thus conserving heat for the rest of the body.
- To investigate the ribbonsnakes' ability to raise their temperature by "head basking", exposing its head to direct sunlight while keeping the rest of its body under cover.

METHODS

- Immediately following emergence from hibernation in the spring, ribbonsnakes were photographed with an infrared camera and their body and tail temperatures compared.
- The same experiment was conducted later in the summer, when environmental temperatures were high.
- The head-basking experiment was a controlled laboratory study, which took place at the MTRI field station. Snakes were kept in experimental containers overnight to reduce their body temperatures to 10°C. In the morning, snakes were photographed using the infrared camera then allowed to head-bask. Their temperatures were then recorded again after head-basking.

R. Thibedeau

Searching for ribbonsnakes with the infrared camera in hand

RESULTS

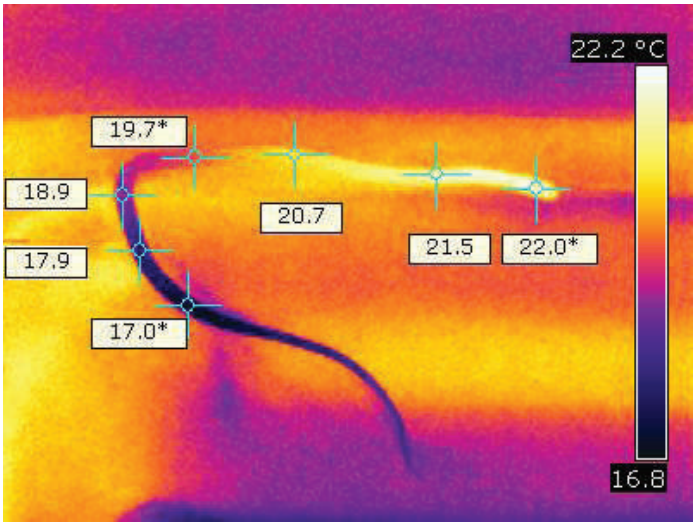
- In cool temperatures, ribbonsnakes show a large temperature difference between their bodies and tails. This difference disappears at higher temperatures.
- Ribbonsnakes were found to be able to significantly raise their body temperature just by exposing their heads to sunlight.

YEARS OF DATA

- Single year project

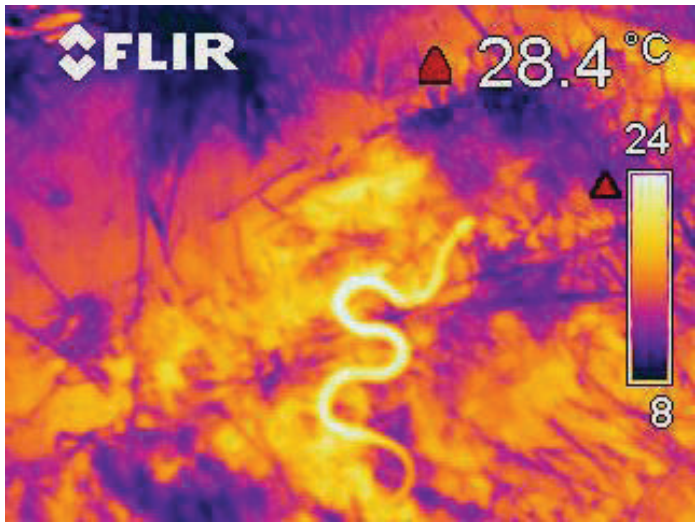
PARTNERS

- Mersey Tobeatic Research Institute
- Eastern Ribbonsnake Recovery Team
- Nova Scotia Museum of Natural History
- Natural Sciences and Engineering Research Council of Canada
- Parks Canada



J. Amiel

Infared photograph of a juvenile ribbonsnake immediately following head basking, the blue crosshairs and associated values are temperatures in degrees celcius



J. Amiel

Infrared photograph of a warm ribbonsnake in its natural surrounding (grass, rocks, and sedge) with gradient bars showing the range of temperatures (the lowest temperature is 8°C and the highest temperature is 24°C)

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Rationale

The Eastern ribbonsnake is listed as a threatened species under the Federal Species at Risk Act. The Nova Scotian population is at the northeastern edge of its range, occurring within Kejimkujik and the surrounding area. Limited research has left much unknown about the snake. This study intends to deliver a deeper understanding of ribbonsnake movements between ajoining patches of wetland within an active season. This understanding will improve conservation efforts for the Eastern ribbonsnake.

Captured ribbonsnake tasting the air

Research

EASTERN RIBBONSNAKE MOVEMENTS

OBJECTIVES

- To gain evidence of Eastern ribbonsnake movements through capture-recapture techniques and the use of PIT tagging.
- To find and survey several new high-density sites of ribbonsnakes along the shore of Keddy's Cove in Molega Lake.
- To compare movements of individual snakes between high-density sites.

METHODS

PIT tag shown for scale next to mechanical pencil

- High priority sites for surveying were chosen based on previous sighting reports as well as habitat similarities. These sites were located at differing distances, but not exceeding 1.5 km from a known high-density central site.
- Five sites, including the central site, were surveyed for ribbonsnakes on a regular basis. Surveyors varied in number, from 1 to 5, and survey effort was recorded. Observed snakes were captured in most cases and identified.
- PIT tags were inserted subcutaneously into ribbonsnakes of a minimum size to permanently mark them for future identification.
- Data was gathered for all observations, including captures and escaped snakes. These data included temperatures, weather data and snake physical and behavioural data.

RESULTS

- Eastern ribbonsnakes were found in four of the five areas surveyed, with the one inland area having no sightings. Sightings in the areas peripheral to the central zone were much lower than within the central zone itself. This was consistent throughout the season.
- Ribbonsnakes were typically found close to the water's edge, and in one location at the end of the summer they were found to concentrate in specific areas.

RESULTS
Continued

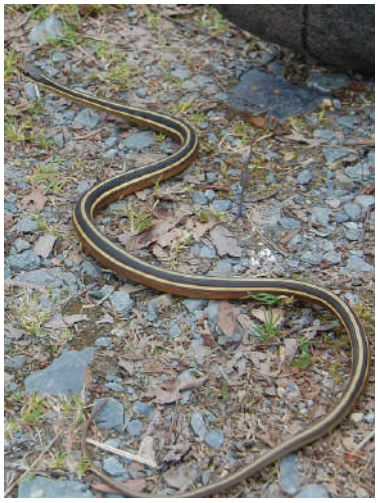
- Snake movement data gained from recaptures showed individual snake movement to be low, with an average of 30 m moved and a maximum of approximately 125 m. No recaptures occurred in more than one zone, suggesting a lack of movement between zones. The maximum movement observed was less than the smallest distance between two zones.
- Twenty-one PIT tags were inserted successfully into adult ribbonsnakes, nine of which were recaptured later in the season. An individual snake which was PIT tagged in 2007 was also observed on two occasions throughout the season.

YEARS OF DATA

- Ongoing project since 2004

PARTNERS

- Acadia University
- Eastern Ribbonsnake Recovery Team
- Dalhousie University
- Parks Canada
- Mersey Tobeatic Research Institute



J. Saroli

Eastern ribbonsnake at Molega Lake

Keddy Cove Site	# of Hours Surveyed	# of Ribbonsnake Observations
Back of Cove	118.75	18
Beaver Dam	49.75	3
High Ground	52.5	0
Causeway	164.5	70

Visual survey effort at Keddy`s Cove on Molega Lake in 2008

T.Imlay

Kylie Sands (left) Jesse Saroli (right), measuring a ribbonsnake at Molega Lake

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Clockwise from top left:

- Peter Kydd trapping turles in Kejimkujik by Josianne Caron
- Jamie Patriquin at Lake of the Five Hardwood Hills by A. Belliveau, MTRI
- Amanda Lavers addressing a group of youths at MTRI by B. Caverhill, MTRI
- Canoe trip on Irving Lake by A. Lavers, MTRI
- Outflow campsite in the Tobeatic by A. Belliveau, MTRI

HUMAN DIMENSIONS

Rationale

The Southwest Nova Biosphere Reserve (SNBR) is one of Canada's "Biodiversity Hotspots". It is home to approximately 75% of the more than 40 Species at Risk (SAR) that live in Nova Scotia. SAR Stewardship Biologists from Kejimkujik have partnered with MTRI and other organizations, such as First Nations, schools, community groups, industry, and all levels of government to help recover the SAR that live in this unique region. Their work is to learn about SAR in the SNBR, share this knowledge with the public, and engage interested families and communities in the conservation of these species and the habitat in which they live.

Christian Kasperkovitz, Elkpen Fine Art

This Monarch butterfly postcard is one in a beautiful set of Species at Risk postcards intended to raise awareness of rare species

Research

SPECIES AT RISK STEWARDSHIP IN SNBR

OBJECTIVES

- To increase awareness and understanding within the general public about SAR in the SNBR, and generate sighting reports.
- To promote environmental stewardship and advocacy and create ambassadors for SAR.
- To help recover key SAR, including Blanding's turtle, Eastern ribbonsnake, Piping plover, Southern flying squirrel, Monarch butterfly, Water-pennywort, and endangered Atlantic coastal plain flora.

METHODS

- Outreach strategies have linked art & science, including: the creation and distribution of Species at Risk Postcards and Greeting Cards, and the development and delivery of the play, "Society for Humans At Risk in Kejimkujik" (SHARK).
- Volunteer opportunities continue to be provided for Kejimkujik visitors and communities in the SNBR, including: Blanding's turtle nest monitoring, trapping, radio tracking, and visual surveys; Eastern ribbonsnake surveys; Piping plover habitat restoration; and Atlantic coastal plain flora monitoring.
- Partnerships continue to be established with individuals and organizations that work with SAR in Nova Scotia to enhance communication and collaboration and ultimately the recovery of SAR.

B. Caverhill, MTRI

Performers in character for the play "SHARK"

RESULTS

- Thousands of cards and postcards were sold or given away, generating revenue to recover costs at MTRI, and to spread awareness throughout Nova Scotia about SAR.
- The play "SHARK", which was about people and SAR in the Biosphere Reserve, was delivered 13 times to over 500 people throughout the summer and fall or 2008.
- Volunteer stewards continue to monitor SAR on their properties throughout the SNBR, and participate in volunteer programs - over 250 individuals volunteered a total of more than 10,000 hours for the second year in a row in the Greater Kejimkujik Ecosystem in 2008. That is over 25,000 hours of volunteering from 2006-2008.

RESULTS
Continued

- In June, 40 headstarted Blanding's turtles were released at Kejimkujik, which included a Mi'kmaw ceremony and celebration that was attended by over 200 people.
- "Healthy Lakes and Wetlands for Tomorrow: A Landowner Stewardship Guide for Species at Risk in Nova Scotia", a collaborative effort spearheaded by Megan Crowley at Kejimkujik, was completed with help from dozens of individuals and organizations across the province. It will be distributed to landowners throughout the SNBR in 2009.
- Over 100 volunteers and stewards attended a volunteer banquet in December to celebrate their achievements, and plan for the future.

YEARS OF DATA

- Year 3 of a 3 year project

PARTNERS

- Parks Canada
- Acadia University
- Bear River First Nations
- Mersey Tobeatic Research Institute
- Southwest Nova Biosphere Reserve Association
- Government of Canada Habitat Stewardship Program
- Friends of Kejimkujik Association

Parks Canada

Landowner stewardship guide providing practical information for managing your property to protect and provided habitat for Species at Risk in Nova Scotia

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Rationale

MTRI was established in 2004 and within a couple of years was able to purchase its field station in the small rural community of Kempt, Queens County. To achieve its goal of promoting sustainable resource use, members of the MTRI co-operative have adopted ambitious education and outreach objectives and always strive to keep the lines of communication open between members and researchers and with the public. MTRI's plan for outreach includes a number of signature events such as monthly seminars about local research projects through the winter and a weekly series of seminars throughout the summer. Each year, MTRI hosts a Woodlot Demonstration in the fall and an Open House around the Christmas holiday. MTRI also works with North Queens schools to bring students to the field station in early summer to meet researchers. All of these education projects, and others, are advertised through local newspapers, by word of mouth, and other means. To evaluate the success of these efforts, phone surveys to local residents have been ongoing.

B.Caverhill, MTRI

MTRI relies on a number of different media to inform people about the research centre and invite them to events, presentations and workshops such as the summer lecture pictured above

Research

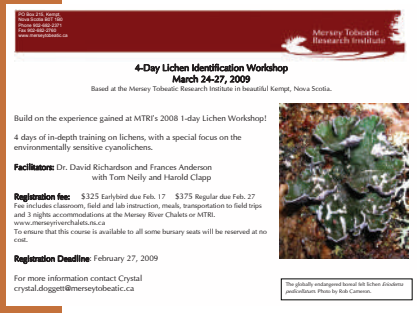
SOUTHWEST NOVA SCOTIA PHONE SURVEY

OBJECTIVES

- To determine how successful MTRI's education and outreach activities have been at reaching members of the local community.
- To create a database of baseline information related to the perceptions of the residents of southwest Nova Scotia to activities taking place in and around MTRI.
- To enable local citizens of southwest Nova Scotia to become involved in research and monitoring activites in their area.

METHODS

- A series of questions was developed to assess the participant's awareness of activities in and surrounding MTRI, including topics such as: whether people have heard about MTRI and what are their information sources; asking if people know what MTRI does; creating a profile of willing respondents which describes their outdoor activities, dependance on the forest industry, their visitation of Kejimkujik, their age, and their gender; determine what people know about invasive fish, old forests, and species at risk; determine the values and concerns of respondants about economic and environmental issues.
- Random phone numbers in the North Queens exchange were called and permission was requested of the household resident to answer the survey.
- Volunteers Nancy Bingham and Jamie Ryan collected answers and analysed the data gathered from phone conversations with local citizens.


Mersey Tobeatic Research Institute

4-Day Lichen Identification Workshop
March 24-27, 2009
Based at the Mersey Tobeatic Research Institute in beautiful Kempt, Nova Scotia.

Build on the experience gained at MTRI's 2008 1-day Lichen Workshop!

4 days of in-depth training on lichens, with a special focus on the environmentally sensitive cyanolichens.

Facilitators: Dr. David Richardson and Frances Anderson
with Tom Neily and Harold Clapp

Registration fee: $325 Earlybird due Feb. 17 $375 Regular due Feb. 27
Fee includes classroom, field and lab instruction, meals, transportation to field trips and 3 nights accommodations at the Mersey River Chalets or MTRI.
www.merseyriverchalets.ns.ca
To ensure that this course is available to all some bursary seats will be reserved at no cost.

Registration Deadline: February 27, 2009

For more information contact Crystal
crystal.doggett@merseytobeatic.ca

The globally endangered boreal felt lichen *Erioderma pedicellatum*. Photo by Rob Cameron.

52 people who responded to the survey had read posters like the one above which MTRI posts around the community and sends out by e-mail

RESULTS

- The community of North Queens includes approximately 800 households. Of those who were phoned, 180 people agreed to answer a series of questions and of those, 108 had heard of MTRI; 62 of those who had heard about MTRI had read about it in newspaper articles; 52 had seen posters in the community; 56 had heard about MTRI's public talks (most by word of mouth but also via posters and newspaper articles). Public talks were attended by 8 people, and 24 had visited MTRI's website.

RESULTS
Continued

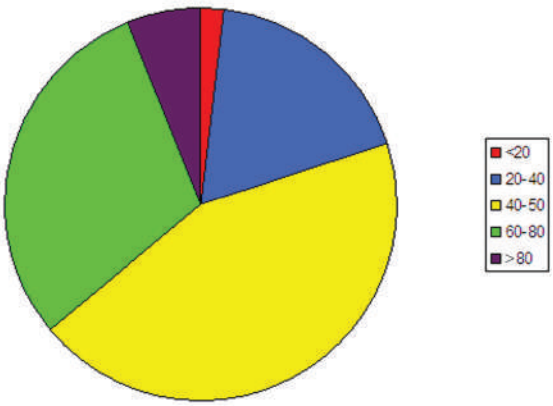
- When asked what MTRI works on, the most common responses (in this order) were: Blanding's turtles, loons, forestry, wildlife, species at risk, and ribbonsnakes but there were a variety of answers.
- Of the 180 respondants,117 said they participated in outdoor activities: the most popular activities were (in order): birdwatching (70), canoeing (58), hiking (58), fishing (55), camping (54), bicycling (48), hunting (39), and cross-country skiing (12).
- Of those interviewed, 31% said someone in their household worked in the forest industry.
- Kejimkujik had been visited in the past year by 42% of respondents.
- Of those interviewed, 90% think old growth forests are important for habitat, animals, historical reference, ecosystem function, lumber, and beauty.
- When asked whether environmental conservation is good for the economy 84% either agree or strongly agree that it is.
- The most common responses regarding the major economic problems and issues facing North Queens were: lack of jobs and problems in the forest and fishing industries although there were a variety of answers.
- When asked what comes to mind as major environmental problems or issues in North Queens, the most common responses were: clear cutting, acid rain and pollution, although there was a large variety of different answers.
- There were 97 out of 180 respondents who had heard of the smallmouth bass and chain pickerel, and of those, most knew about the environmental problems that they cause.
- When asked to identify some endangered species, the most common answers were: Blandings turtles, ribbonsnakes, and Mainland moose but people also suggested lady slippers, loons, and a number of other species.

YEARS OF DATA

- Ongoing project since 2007

PARTNERS

- Mersey Tobeatic Research Institute
- Service Nova Scotia



Age demographic of participants in the phone survey

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Rationale

Over the past four centuries, little of Nova Scotia's forested areas have escaped human influences. The outcome has been a proliferation of relatively young, even-aged, early successional forests types across an increasingly fragmented landscape. Less than 1% of Nova Scotia's forest cover remains as old forest, which makes it increasingly difficult to maintain ecological connectivity between them. Old forests are a vital component of the forest ecosystem and biodiversity; they are important habitat for wildlife including mosses, lichens, cavity nesting birds and mammals. Most of Nova Scotia's forest land (70%) is privately owned with almost half in small private holdings. Small private landowners must be included in collaborative work to maintain landscape connectivity, conserve biodiversity and restore old forests in western Nova Scotia.

A. Belliveau, MTRI

Very old hemlock tree on Dennis Boot Lake

Research

RESTORATION OF OLD FORESTS

OBJECTIVES

- To find and characterize old forest features on small privately owned land in northern Queens County and southern Annapolis County.
- To conduct local surveys to better understand woodland owner values and attitudes towards old forests.
- To foster stewardship of old forests on private land utilizing research findings to design communication products and community outreach opportunities.
- To assist woodland owners with the creation of management plans for their woodlands that promote restoration of old forest characteristics.
- To map and inventory public and private old forests.

METHODS

- Potential old forest sites in a ~50,000 hectare area were surveyed with GIS using Nova Scotia Department of Natural Resources (NSDNR) Forest Inventory database, and also using Land Registry information provided by Service Nova Scotia and Municipal Relations.
- Queries were developed in ArcMap to identify, in order of priority: (i) tolerant hardwoods stands; (ii) coniferous stands; and (iii) lower quality coniferous and hardwood stands. These queries included height restrictions according to species and a minimum one hectare forest stand.
- At each site, sample points were randomly selected where parameter measurements were taken including tree species, age, height and coarse woody debris using NSDNR's Old Forest Scoresheet.
- Stewardship work with landowners was undertaken to assess interest in management plans and the prospects of restoration on their woodlands.
- Educational talks with landowners and other members of the community were also undertaken.
- A GIS map and information database for public and private old forests was initiated.

A. Belliveau, MTRI

Kyle Rowter talking to a landowner about woodlot management

RESULTS

- Eighteen letters were sent to landowners with potential old forest to explain the project and ask permission to visit their woodlands. Fifteen landowners were contacted by telephone to discuss potential old forests on their woodlands.
- Thirteen new sites were identified on small private land. Twenty-five plots were set up on these sites. The average score for these plots was calculated at 43%. The lowest score feature was dead woody debris averaging 4/15 and is a result of past anthropogenic disturbances such as fire and logging.
- The oldest tree on private land was 225+ years old and was 50 cm in diameter. The oldest tree on public land was 352+ years old and was also 50 cm in diameter.
- Twelve land owners expressed interest in management plans after being engaged in discussions either at their properties or on the telephone.

YEARS OF DATA

- Ongoing project since September 2006

PARTNERS

- Mersey Tobeatic Research Institute
- Private Landowners
- Nova Scotia Department of Natural Resources
- Environment Canada Eco Action Program
- Nova Forest Alliance
- Nova Scotia Department of Environment and Labour
- Natural Resources Canada
- Mountain Equipment Co-op
- Sage Environmental Fund
- ESRI
- Nova Scotia Community College

A. Lavers, MTRI

Alain Belliveau using a prism to measure tree density

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Rationale

Community-based environmental projects are an important means to promote environmental sustainability. In addition to generating direct environmental benefits, such projects can also indirectly promote environmental sustainability by fostering environmental knowledge, skills, attitudes, sensitivity, motivations and behaviours among community members. In other words, community-based environmental projects may promote environmental literacy. The purpose of this study was to show whether a sample of community-based environmental projects funded by Environment Canada's EcoAction Community Funding Program contributed to the environmental literacy of the community members who participated in the projects.

Environmental education in the outdoors

Research

INCREASING ENVIRONMENTAL LITERACY

OBJECTIVES

- To explore whether participants in five EcoAction-funded projects gained environmental literacy competencies (*i.e.* environmental knowledge, skills, attitudes, sensitivity, responsibility, empowerment, intention to act, and behaviour) as a result of participating in an EcoAction-funded project.
- To explore the specific factors that contributed to participants' increased environmental literacy or their lack of increase in environmental literacy

METHODS

- Semi-structured interviews were conducted with four to six participants from each of five EcoAction- funded projects in Atlantic Canada. Projects included MTRI's Old Forest project, a Sustainable Transportation project (New Brunswick), a Watershed Restoration project (PEI), a High School Environment Club project (Nova Scotia) and School-Based Ecological Footprint Education project (Nova Scotia).
- Interviews were analysed qualitatively. Some simple quantitative analysis was also used to compare results between groups.

Old forest walk in Queens County on private land

RESULTS

- All projects studied fostered environmental literacy to some degree. The environmental literacy competencies most often gained were knowledge and empowerment. Changes in attitudes and environmental sensitivity were reported least often.
- The project that had the greatest impact on the environmental literacy of its participants was the High School Environment Club project, mainly because this project involved the greatest degree of hands-on participation, for the longest term, in the greatest diversity of activities, and involved youth who are less likely to already have environmental literacy competencies than adults.

RESULTS
Continued

- Results of this study show that projects such as MTRI's Old Forest project, which included community members who already had a high degree of environmental literacy, still have a very important role to play even though they may not increase environmental literacy levels to the same degree as projects involving youth.
- Environmental literacy is a life-long learning process that requires continuous reinforcement and learning opportunities. All participants in MTRI's project felt that participating in the project reinforced their environmental literacy.
- MTRI participants were revealed as a significant resource for community-based projects because they were eager to participate in environmental conservation and research projects and felt that they had much to contribute, including land access, knowledge, expertise, resources and time.
- Projects such as MTRI's Old Forest Project allow the capacities that are present within a community to be shared and contribute to the social capital available for environmental action.

YEARS OF DATA

- Year 2 of a 2 year project

PARTNERS

- Dalhousie University
- Environment Canada
- EcoAction Community Funding Program recipients (including MTRI)
- Canadian Wildlife Federation's Orville Erickson Scholarship Fund

A.Belliveau, MTRI

Demonstration in Annapolis County at Royce and Christina Ford's Western Region 2008 Woodlot of the Year

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APPENDIX 1

PROJECTS IN KEJIMKUJIK AND THE GREATER KEJIMKUJIK ECOSYSTEM IN 2008

	Kejimkujik	Greater Kejimkujik Ecosystem	Monitoring	Research
Coastal				
Piping Plover Monitoring Program	X	X	X	
Eelgrass Monitoring and Recovery	X		X	
European Green Crab Coastal Monitoring	X		X	
Lagoon Water Quality Monitoring	X		X	
Paleontological Study of a Caribou Passage	X			X
Barrier Beach Dune Dynamics Monitoring	X		X	
Projects not included in this report:				
Salt Marsh Vegetation Monitoring	X		X	
Soft-shell Clam Monitoring	X		X	
Forest				
Caledonia Christmas Bird Count	X	X	X	
Nocturnal Owl Survey	X	X	X	
Southwestern Nova Scotia Marten Distribution	X	X	X	
White-tailed Deer Monitoring	X		X	
Boreal Felt Lichen Monitoring		X	X	
Invasive Plant Monitoring	X		X	
Monitoring Flying Squirrel Survivorship		X	X	
Trends in Kejimkujik Forest Bird Abundance	X		X	
Plethodontid Salamander Monitoring	X		X	
Eastern Pipistrelle Bat Taxonomic Status		X		X
Red Oak Regeneration in Mixedwood Stands		X		X
Forest Ecosystem Classification		X		X
Projects not included in this report:				
Eastern Pipistrelle Bat Ecology	X			X
Tree and Shrub Monitoring	X		X	
Lichen Monitoring	X		X	
Park Infrastructure Footprint Monitoring	X		X	
Land Cover Change Monitoring	X		X	

	Kejimkujik	Greater Kejimkujik Ecosystem	Monitoring	Research
Freshwater				
The Kejimkujik-Mersey LoonWatch Program	X	X	X	
Monitoring Common Loon Productivity	X	X	X	
IceWatch	X	X	X	
Annapolis River Water Quality Monitoring		X	X	
Lake Primary Productivity	X	X	X	
Lake Water Quality Monitoring	X		X	
Acidity and Cold Water Lake Habitat	X	X	X	
Stream Flow Monitoring	X		X	
Aquatic Connectivity	X		X	
Terrestrial Liming to Improve Salmonid Habitat	X	X		X
Breakdown of Dissolved Organic Carbon	X			X
Mercury Photo-Reactions & Dissolved Organic Carbon	X			X
Projects not included in this report:				
Mercury Concentrations in Fish	X		X	
Benthic Invertebrate Monitoring	X		X	
Brook Trout Creel Census	X		X	
Wetland				
Rare Plant Monitoring	X	X	X	
Blanding's Turtle Nest Monitoring	X	X	X	
Wetland Water Quality and Quantity	X		X	
Blanding's Turtle Headstart Tracking	X	X		X
Tracking Blanding's Turtles Using GPS	X	X		X
Ribbonsnake Thermoregulation	X	X		X
Eastern Ribbonsnake Movements	X	X		X
Projects not included in this report:				
Wetland Vegetation Monitoring	X		X	
Barren Meadow Blanding's Turtle Population	X			X
Human Dimensions				
Species at Risk Stewardship in SNBR	X	X		X
Southwest Nova Scotia Phone Survey		X		X
Restoration of Old Forests		X		X
Increasing Environmental Literacy		X		X
Projects not included in this report:				
Community-Based Mi'kmaq Education		X		X

APPENDIX 2

INDEX OF PROJECTS BY RESEARCHER NAME

Annual Report of Research and Monitoring in the Greater Kejimkujik Ecosystem 2008

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