Annual Report of Research and Monitoring in the Greater Kejimkujik Ecosystem 2006

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Mersey Tobeatic Research Institute

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Cover photos from top to bottom:
- Waves crashing at Port Joli Head, Kejimkujik Seaside Adjunct (Photo by P. Hope, Parks Canada)
- Sun shining through forest (Photo by S. Moore)
- Common loon (Photo by G. Corbett, Parks Canada)
- Kejimkujik Lake meets mouth of Grafton Brook (Photo by J. Steeves, Parks Canada)
- Autumn hiking (Photo by S. Leslie, Parks Canada)

Printed on 100% post-consumer paper

ACKNOWLEDGEMENTS

Many thanks to all the researchers who took the time to submit the research and monitoring project summaries that are included in this annual report. Without your hard work and dedication to research, this publication would not be possible.

A steering committee provided guidance and support for the preparation of this report and included Amanda Lavers, Crystal Doggett (MTRI), Sally O'Grady, Darien Ure, Chris McCarthy and Jonathan Sheppard (Parks Canada). We wish to thank the Parks Canada Western Arctic Field Unit and Pierre Martel, editor of the 2005 Greater Kejimkujik edition who established the template upon which this report is based.

Funding for this report was provided by Parks Canada and the Mersey Tobeatic Research Institute.

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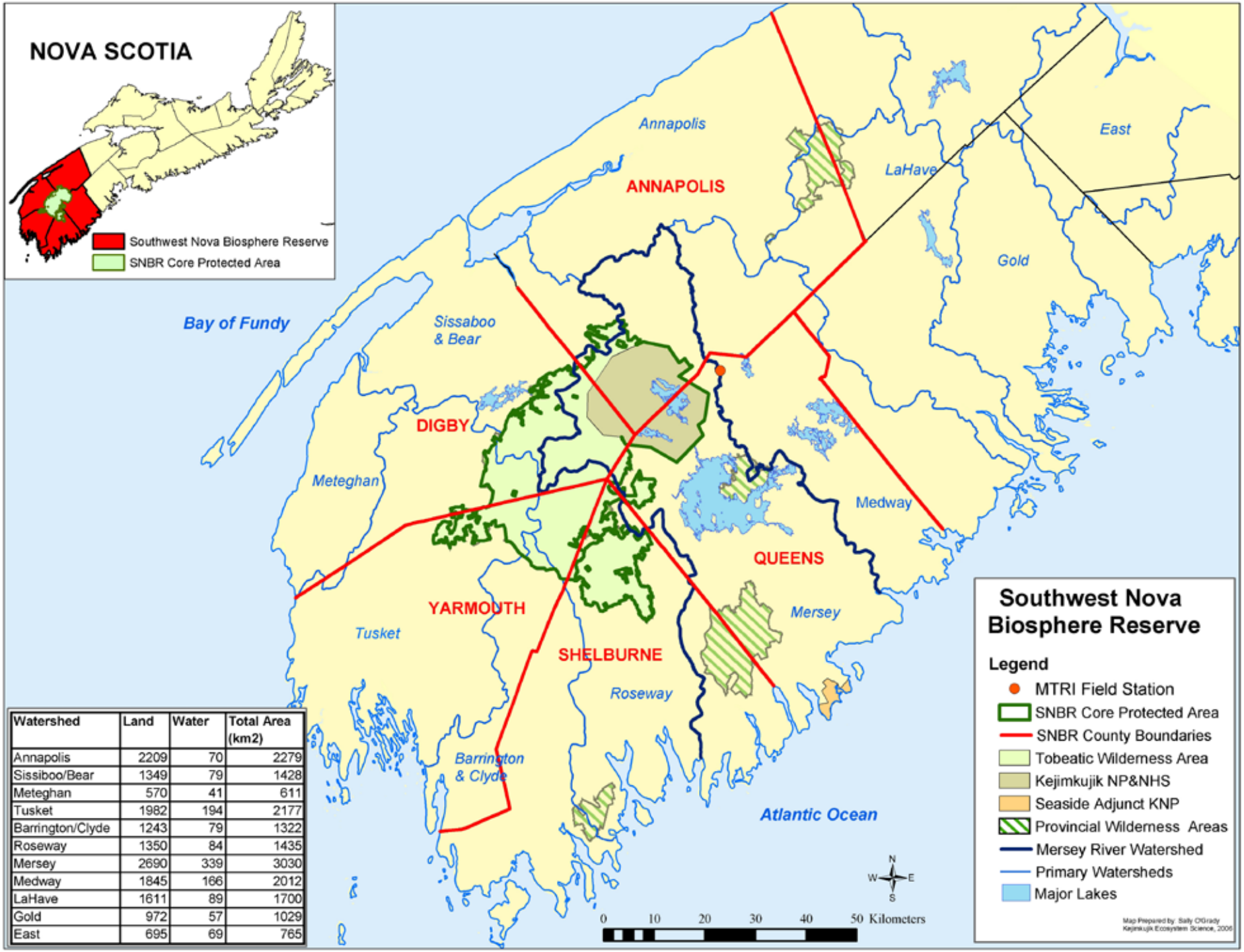
HUMAN DIMENSIONS



Watershed	Land	Water	Total Area (km2)
Annapolis	2209	70	2279
Sissiboo/Bear	1349	79	1428
Meteghan	570	41	611
Tusket	1982	194	2177
Barrington/Clyde	1243	79	1322
Roseway	1350	84	1435
Mersey	2690	339	3030
Medway	1845	166	2012
LaHave	1611	89	1700
Gold	972	57	1029
East	695	69	765

Map prepared by S.O'Grady, Parks Canada, 2006.

INTRODUCTION

This *Annual Report of Research and Monitoring in the Greater Kejimkujik Ecosystem* focuses on Kejimkujik National Park and National Historic Site of Canada (Kejimkujik), Tobeatic Wilderness Area (Tobeatic) and the Mersey and Medway watersheds. This report was produced in spring 2007 and is a compilation of the research and monitoring projects that were conducted in the area in 2006. While not all projects conducted in this geography are detailed in the main body of this report, the Appendix includes a more comprehensive list. This is the second in a series of annual reports that will make information about the research and monitoring projects in the Southwest Nova Biosphere Reserve available to the public, government agencies, researchers and other stakeholders.

The research and monitoring projects detailed in this report are essential 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 disturbances.

This report is a co-production by the Mersey Tobeatic Research Institute (MTRI) and Kejimkujik. The projects are organized in five categories (Coastal, Forest, Wetland, Freshwater and Human Dimensions) and are further sorted as either monitoring or research projects. The summaries included in this annual report are overviews written by the researchers; more details can be obtained from the individuals listed as contacts.

Kejimkujik represents the Atlantic Upland Natural Region in Parks Canada's network of protected areas. Kejimkujik consists of 381 km^2 inland and a 22 km^2 adjunct 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 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 of species at risk 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 mandate to advance collaborative research, monitoring and management that promotes sustainable use of natural resources in southwestern Nova Scotia. In partnership with the Southwest Nova Biosphere Reserve, MTRI reflects a spirit of cooperation typical of southwestern Nova Scotia, and features partnerships with the public, communities, educators, governments, businesses and international institutions. MTRI maintains a field station that provides office workspace, basic accommodation for researchers, space for public presentations and a site for training. MTRI provides scientific and research expertise, project coordination services and conducts research 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 on p. 6). 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.

Photos from top to bottom:
• Waves at Cadden Beach (Photo by P. Hope, Parks Canada)
• New Building Cove (Photo by P. Hope, Parks Canada)
• Park visitors on harbour rocks (Photo by P. Hope, Parks Canada)
• Clam flat at the mouth of Bear River, Annapolis Basin (Photo by D. Sullivan, CARP)

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 St. Catherine's River Beach at Kejimkujik Seaside Adjunct. The Piping plover is negatively impacted by a variety of stressors including: habitat disturbance, loss and fragmentation; predation; severe climate and storm events; and problems encountered during migration and over-wintering. The Piping plover is now referred to as a "management dependent species" because sustained management actions are needed to maintain and increase population levels. To assess Piping plover population levels at the Kejimkujik Seaside Adjunct and to implement a suite of management strategies focused on protecting and sustaining plover numbers, park staff have monitored plover adults and chicks within the park since 1985.

Pair of Piping plovers on the beach (Photo by L. Rimmer)

Monitoring

PIPING PLOVER MONITORING PROGRAM

OBJECTIVES

- To observe and evaluate the general status of Piping plover populations, breeding pairs, chick fledgling success, movement patterns and other factors.
- To implement protective measures such as nest exclosures for nesting plovers.
- To educate people about the Piping plover's Endangered status and recovery efforts.

METHODS

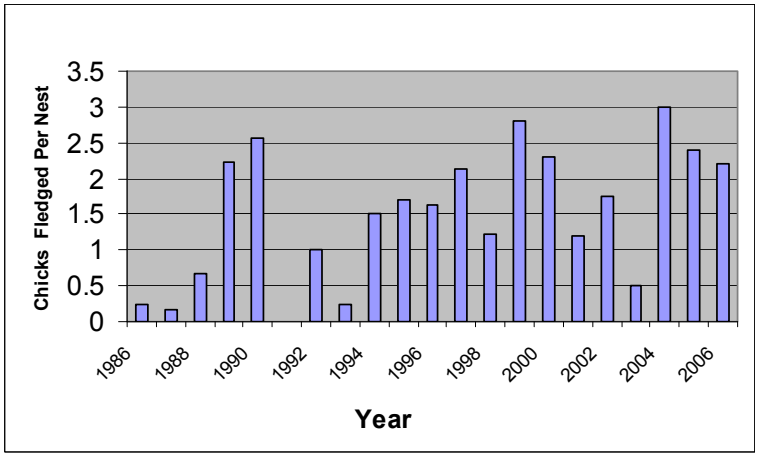
- Park wardens conducted frequent patrols of St. Catherine's River Beach during Piping plover nesting season.
- Piping plover monitoring was accomplished at a distance with binoculars and spotting scopes. Other birds and animals, including predators, were also noted.
- Observations were recorded about plover nests, chicks and habitat and were entered into a digital database. Nests were located by observing territorial birds and individuals exhibiting nesting behaviours.
- After two eggs were laid (of four in a full clutch) protective wire predator exclosures were installed to protect the eggs and nesting adults from most predators. All nests were coded and georeferenced using a Global Positioning System and all this information was recorded in a digital database.

Full clutch of Piping plover eggs (Photo by R. Brunt, Parks Canada)

RESULTS

- Five pairs of Piping plover (12 adult birds) established seven nests of which four were successful during 2006. Two nests were lost through abandonment and one was believed to be predated.
- 28 eggs were laid, 14 hatched and 11plover chicks were fledged (survived past 21 days).

Piping plover sitting on eggs (Photo by R. Newell, Parks Canada)



Piping plover fledging success at St. Catherine's River Beach 1986 - 2006

YEARS OF DATA

- Ongoing project since 1985

PARTNERS

- Canadian Wildlife Service
- Nova Scotia Department of Natural Resources
- Nova Scotia Plover Guardian Program administered by Bird Studies Canada
- Parks Canada

Young Piping plover chicks (Photo by R. Brunt, Parks Canada)

CONTACTS

Richard Brunt
Kejimkujik
PO Box 41, Port Mouton
NS B0T 1N0
Ph. (902) 682-2798
Fx. (902) 682-3367
richard.brunt@pc.gc.ca

Rationale

Piping plovers nest on sparsely vegetated sandy beaches, a dynamic habitat influenced by extreme weather events essential for sand dune formation and destruction. Marram grass stabilizes sand dunes but makes substrate unsuitable for plover nests. Periodic hurricanes and resulting storm surges cause localized destruction of Marram grass by means of 'blowouts', high water surges and shifting sand masses. A lack of such events at St. Catherine's River Beach of Kejimkujik Seaside Adjunct has allowed the Marram grass and Beach pea to dominate previously suitable Piping plover nesting habitat. Habitat management is being undertaken in suitable areas of St. Catherine's River Beach through mechanical removal of root systems in a small area of the dune. This is the first time this management technique has been utilized in eastern Canada and its success is being monitored by the National Piping Plover Recovery Team (Eastern Canada).

Research

PIPING PLOVER HABITAT MANAGEMENT PROJECT

Habitat management zone at Kejimkujik Seaside Adjunct (Photo by R. Brunt, Parks Canada)

OBJECTIVES

- To increase the amount of nesting (and foraging) habitat for plovers and other shorebirds with similar habitat requirements in areas that are presently protected.
- To reduce chick mortality due to predation by decreasing predator efficiency by providing separated areas for nesting (predators may have a greater success with a linear search pattern along the dune edge of the ocean beach).
- To explore feasibility of habitat enhancement through mechanical means.

METHODS

- The habitat management zone is located in the eastern section of the St.Catherine's River Beach dune/lagoon complex.
- Habitat management and site modification was achieved by mechanical harrowing and using hand tools.
- All growth of Marram grass, Beach pea and other woody shrubs was plowed and raked off the management site.
- Vegetation cover was surveyed to measure previous cover, vigour and extent of regrowth. Random quadrats within the habitat management zone were assessed for species association and composition as well as the biomass (number of plants per unit area). Photographs were taken to record site conditions.
- The habitat management zone was surveyed before and after modification with a surveyor's level to establish landscape profile.
- Piping plover presence and nesting success within the habitat management zone was assessed.
- Beach dynamics, substrate alterations and vegetation regrowth will continue to be monitored.

Piping plover (Photo by Parks Canada)

RESULTS

- In 2003, Piping plovers were observed in the habitat enhancement area but no nesting occurred.
- In 2004, a pair of adult plovers nested successfully in the habitat management area and four plover chicks fledged successfully.
- In 2005, two pairs of plovers nested inside the habitat area and five plover chicks fledged.
- In 2006, two pairs of plovers successfully nested inside the management zone with four chicks fledged.
- The managed habitat zone has been used by nesting Piping plovers that have successfully fledged chicks. As Piping plover population levels continue to decline, innovative management efforts like this are becoming more and more significant.
- Due to the success of the habitat management area, a decision was made to expand the area in the fall of 2006. The amount of habitat under management has been enlarged by 50%. Kejimkujik will continue to maintain and evaluate the success of this project.

Sand dune (Photo by Parks Canada)

YEARS OF DATA

- Ongoing project since 2001

PARTNERS

- Piping Plover Recovery Team (Eastern Canada)
- Parks Canada

Mechanical plowing of habitat management zone (Photo by R. Brunt, Parks Canada)

CONTACTS

Richard Brunt
Kejimkujik
PO Box 41, Port Mouton
NS B0T 1N0
Ph. (902) 682-2798
Fx. (902) 682-3367
richard.brunt@pc.gc.ca

Rationale

Research has indicated that both natural and anthropogenic factors may contribute to the seasonal eutrophication of the lower Annapolis River estuary. The dissolved oxygen levels observed have been low enough to cause the death or displacement of aquatic life below the halocline in the estuary. There is concern that the transitory nature of the eutrophic effect may become a more frequent and long-established feature, resulting in a significant degradation of the quality of the estuary. Water samples collected by the Annapolis River Guardian volunteers at Bridgetown in the late summer of 2005 indicated low levels of dissolved oxygen in the lower Annapolis River. Based on these results, a research program was developed to identify the extent and possible causes of depressed oxygen levels in the river.

The sinuous Annapolis River near Belleisle (Photo by K. Maher)

Research

DISSOLVED OXYGEN LEVELS IN LOWER ANNAPOLIS RIVER

OBJECTIVES

- To understand the time period and physical extent of dissolved oxygen depletion in the lower Annapolis River.
- To identify possible causative and/or driving factors for this depletion.

METHODS

- Weekly water samples were collected from the mid-span of Bridgetown bridge by a van Dorn sampler from April 9 to October 29, 2006. Temperature and dissolved oxygen (determined later by Winkler titration) were recorded for each sample.
- Water samples were also collected at fixed locations between Granville Centre and Bridgetown every three to four weeks by boat, between June and November 2006.
- Water quality parameters (temperature, conductivity, salinity, dissolved oxygen, pH) were recorded on-site using a Hydrolab Quanta multi-probe meter.
- Water samples collected were analysed for chlorophyll *a*, turbidity, silicate, nitrate, nitrite, ammonia and phosphate.

A. Sharpe collects a water sample from the lower Annapolis River (Photo by K. MacKenzie)

RESULTS

- During the summer and early autumn of 2006, saline water below the salt wedge of the Annapolis River estuary was found to have reduced levels of dissolved oxygen.
- Using a variety of sampling and analysis methods, dissolved oxygen in the underlying saltwater was found to be in the range of 2 to 5 mg/L, with a lowest recorded value of 1.5 mg/L, on October 5, 2006. Reduction of oxygen to these levels is known to cause stress and/or mortality to aquatic life.
- The zone of oxygen depleted saltwater was found to extend from at least 1 km above the Town of Bridgetown to at least 20 km downstream.
- Elevated nutrient levels, of nitrate in particular, were found in the freshwater portion of the Annapolis River that flows into the estuary.

The Annapolis River near Bridgetown (Photo by K. Maher)

YEARS OF DATA

- Year 1 of a 2 year project

PARTNERS

- Clean Annapolis River Project
- Acadia University – Acadia Centre for Estuarine Research
- Environment Canada – Atlantic Coastal Action Program
- Department of National Defense

CONTACTS

Andy Sharpe
Clean Annapolis River Project
151 Victoria Street, PO Box 395
Annapolis Royal, NS B0S 1A0
Ph. (902) 532-7533
Fx. (902) 532-3038
andysharpe@annapolisriver.ca
www.annapolisriver.ca

Rationale

The soft-shell clams of the Annapolis Basin have historically been very productive and their commercial harvest has played an important role in the communities surrounding the basin. Since the late 1970s however, several factors have contributed to the decline in clam populations as well as an increase in the closure of beaches. The contributing factors include environmental and biological as well as managerial issues. Under the direction of the Annapolis Watershed Resource Committee, a multi-stakeholder group, a clam population survey was conducted. The survey is part of a greater initiative aimed at rehabilitating the soft-shell clam population and habitat as well as supporting sustainable and integrated resource management at the community level. Other related initiatives include water quality monitoring in closed clam harvesting areas as well as enhancement of depleted clam beds.

Researchers carrying sediment to the water's edge for sieving (Photo by D. Sullivan, CARP)

Research

SOFT-SHELL CLAM SURVEY, ANNAPOLIS BASIN

OBJECTIVES

- To evaluate the current state of soft-shell clams in order to allow for better informed and sustainable management of the resource.
- To gather up-to-date information on density, length frequency distribution and biomass of soft-shell clams in the Annapolis Basin.
- To provide the basis for an economic valuation of the resource under current and alternative management scenarios.

METHODS

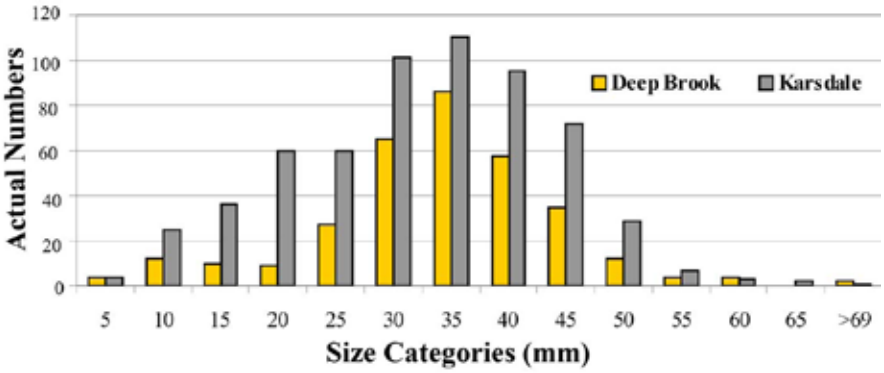
- Two beaches were surveyed: Deep Brook and Karsdale.
- Sample plots were located every 50 m along transects running perpendicular to the shoreline, from the high to low water marks. Transects were placed at every 50 m along the beach to form a square grid over the area to be surveyed.
- 25 x 25 cm plots were dug to a depth of 20 cm and all soft-shell clams within the plot were counted and measured. All clams were then returned to the beach.
- Weight measurements were also taken for various length categories of clams using a ruler and a digital scale. A regression analysis was used to estimate the weight of any given clam.
- The biomass of commercial size clams (44.5 mm) was determined using the formula generated in the regression analysis.

Soft-shell clam seed (Photo by D. Sullivan, CARP)

RESULTS

Annapolis Basin (Photo by D. Sullivan, CARP)

- The combined area of beach surveyed was approximately 67 hectares, and included 244 plots and over 900 clams counted and measured.
- The mean density for all clams at Deep Brook was 61 ± 12 clams/m^2. The mean density for all clams at Karsdale was 61 ± 9 clams/m^2.
- The total mean density for clams of commercial size was 11 ± 2 clams/m^2 at Deep Brook and 12 ± 2 clams/m^2 at Karsdale.
- Few clams in the smallest size categories (25 mm) were collected during the survey at Deep Brook. The majority of clams occurred in the 30-45 mm size category. A similar length frequency distribution was found at the beach in Karsdale; few clams were found in either end of the length categories, with the majority of clams falling in the 20-45 mm category.
- The total mean biomass for commercially harvestable clams at Deep Brook is estimated at 27,200 kg, with a range of approximately 17,000-37,000 kg. The total mean biomass for commercially harvestable clams at Karsdale is estimated at 70,125 kg, with a range of approximately 50,000-90,000 kg.



Length frequency distribution of soft-shell clams at Deep Brook and Karsdale (D. Sullivan)

YEARS OF DATA

- Single year project with possibility of more surveys in the future

PARTNERS

- Clean Annapolis River Project
- Digby County Clam Diggers Association
- Area II Clam Harvesters Association
- Annapolis Watershed Resource Committee
- Gulf of Maine Council on the Marine Environment
- Environment Canada
- Shell Environment Fund
- Human Resources and Skills Development Canada, Summer Career Placement Program

CONTACTS

Denise Sullivan
Clean Annapolis River Project
151 Victoria Street, PO Box 395
Annapolis Royal, NS B0S 1A0
Ph. (902) 532-7533
Fx. (902) 532-3038
denisesullivan@annapolisriver.ca
www.annapolisriver.ca

Photos from top to bottom:
- Red-eyed vireo (Photo by Parks Canada)
- Forest monitoring workshop (Photo by M. Crowley)
- Lung lichen (Photo by T. McMullin)
- Tall pines (Photo by M. Wood, Parks Canada)

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.

Black-capped chickadee (Photo by S. Sheppard)

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.

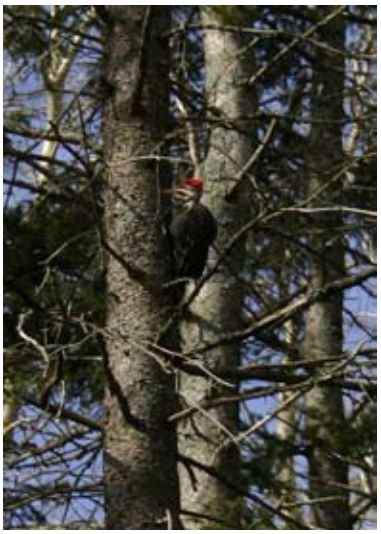
Barred owl (Photo by M. Lavers)

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 12 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.

RESULTS

- This is Nova Scotia's only entirely inland Christmas Bird Count.
- The December 17, 2006 count noted 39 bird species and 1,945 total birds which was an above-average result for diversity and abundance.
- Forty-five observers participated.
- Five species (Ruffed grouse, Common loon, Mourning dove, American crow and Black-capped chickadee) set abundance records, four other species tied as most abundant.
- Pileated woodpeckers are often found in above-average numbers and Barred owls are common in the Caledonia count relative to 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.
- For full details and results from previous years, visit: www.merseytobeatic.ca



Pileated woodpecker (Photo by A. Lavers)

YEARS OF DATA

- Ongoing project since 1991

PARTNERS

- Nova Scotia Bird Society
- South Shore Naturalists Club
- Annapolis Field Naturalists Society
- Parks Canada
- Mersey Tobeatic Research Institute

CONTACTS

Peter Hope
PO Box 923
South Brookfield
NS B0T 1X0
Ph. (902) 682-2512
peterhope@ns.sympatico.ca

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.

Barred owls (Photo by P. Hope, Parks Canada)

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 1.8 kilometers. At each stop they broadcasted 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. 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. 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 (surveyed by Peter Hope) and continued towards the Mersey River.

Saw-whet owl (Photo by P. Hope, Parks Canada)

RESULTS

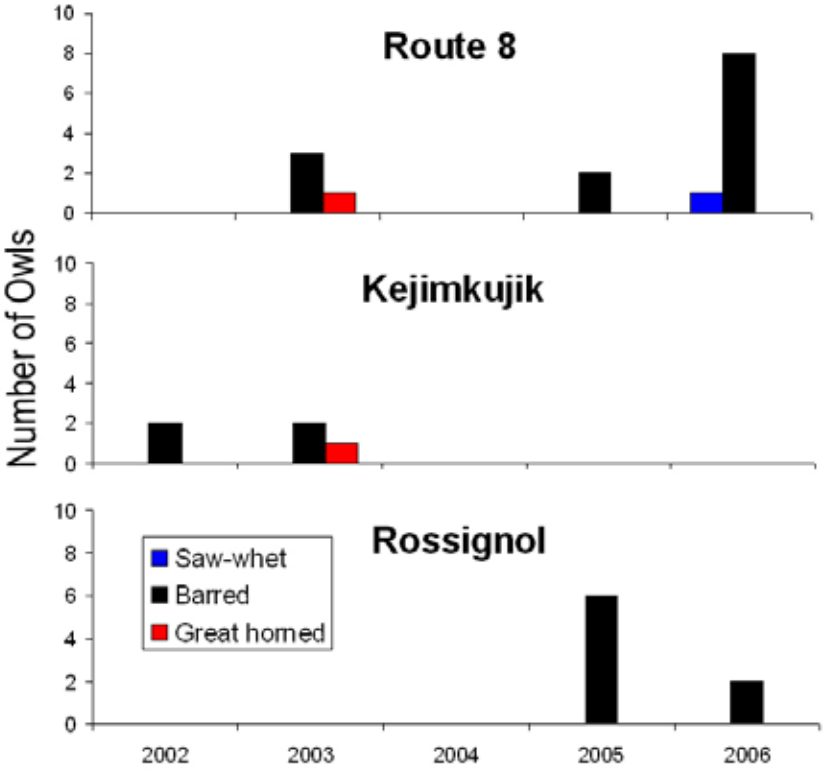
- In 2006, Barred and Saw-whet owls were reported. In other years, Great horned owls have also been detected.
- Route 40 along Route 8 detected eight Barred owls and one Saw-whet on April 23/06.
- Route 41 within the park detected nine Barred owls on May 14/06.
- The Devonshire / Rossignol survey detected three Saw-whet and two Barred owls on May 7/06.

YEARS OF DATA

- Ongoing project since 2002

PARTNERS

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



Number of owls detected on three survey routes. The Route 8 and Kejimkujik routes have been surveyed since 2002 and the Rossignol route has been surveyed since 2005. Saw-whet owls are indicated in blue, Barred owls in black and Great horned owls in red

CONTACTS

Peter Hope
PO Box 923
South Brookfield
NS B0T 1X0
Ph. (902) 682-2512
peterhope@ns.sympatico.ca

Chris McCarthy
Kejimkujik
PO Box 236
Maitland Bridge
NS B0T 1B0
Ph. (902) 682-4100
Fx. (902) 682-2093
chris.mccarthy@pc.gc.ca

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 the 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.

Marten after release (Photo by P. Hope, Parks Canada)

Monitoring

SOUTHWESTERN NOVA SCOTIA 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.

Hair snag trap (Photo by R. Brunt, Parks Canada)

METHODS

- Marten habitat models were developed for the five SWNS counties using current forest inventory data and geographic information systems (GIS).
- Four to eight hair snags (a baited wooden trap equipped with glue patches for hair sampling) were placed within 5 km^2 grids predicted to contain marten habitat (based on the GIS 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.

RESULTS

- Complete results are not yet available.
- Studying the demographics of the SWNS marten population will assist in filling the information gap on this 'data deficient' population and will also assist in determining its viability.
- Understanding and assessing the habitat needs and preferences of SWNS marten will provide information on the most appropriate release location for translocation and reintroduction. In addition, recording preferred habitat, landscapes and marten locations will be beneficial for future GIS spatial habitat models.
- Monitoring the efficiency of various hair snag designs using captive animals well help determine: (i) the best technique; (ii) the number of times the unit needs to be entered before suitable hair samples are collected for determining presence/absence; and (iii)the length of time the unit(s) need to be in the field.
- Gaining information on the health and size of the SWNS marten population through DNA analysis will aid in determining the status of this rare carnivore.

YEARS OF DATA

- Year 1 of a 3 year project

PARTNERS

- Trappers Association of Nova Scotia
- Nova Scotia Department of Natural Resources
- Nova Scotia Habitat Conservation Fund
- Parks Canada
- Mersey Tobeatic Research Institute
- Acadia University

Marten in a tree (Photo by Parks Canada)

CONTACTS

Peter J. Austin-Smith
Nova Scotia Department of Natural Resources
136 Exhibition Street
Kentville, NS
B4N 4E5
Ph. (902) 679-6221
Fx. (902) 679-6176
AUSTINPJ@gov.ns.ca

Rationale

Between 1987 and 1994, Kejimkujik reintroduced 116 American marten in the park. Monitoring of marten was conducted throughout the reintroduction until 1995. Very little research has been conducted within the park to assess Fisher and Bobcat populations. Recent sightings and local knowledge suggest that these three species currently live within Kejimkujik, however their status within the park and in the surrounding area is unknown. To address this knowledge gap, a project was designed and implemented in winter 2004-05. Assessing and monitoring these species is important because: (i) their status provides information on the trophic structure of forest ecosystems at Kejimkujik; and (ii) there is a need to assess the effectiveness and success of American marten reintroduction programs that occurred in the 1980s and 1990s.

Marten detected at Eel Weir bait station, February 2006 (Photo by R. Brunt and B. Mailman, Parks Canada)

Monitoring

SMALL MAMMALIAN PREDATOR DETECTION

OBJECTIVES

- To refine a methodology for monitoring mammalian predators.
- To assess and monitor presence and distribution of American marten, Fisher and Bobcat within Kejimkujik.
- To assess the effectiveness of past American marten reintroduction programs.
- To provide reliable baseline data on mammal predators for future research initiatives.

Photographic bait station (Photo by D. Ure, Parks Canada)

METHODS

- The use of photographic bait stations to detect mammalian predators was developed by the US Department of Agriculture Forest Service and has been a widely used technique for the past 20 years.
- The experimental design for this project involved dividing the park into thirty 16 km^2 sampling units based on home range of the target species. Each year, two to five sampling units were selected for monitoring. A minimum of two photographic bait stations (PBSs) were established within each sampling unit.
- Each bait station included a piece of bait (*i.e.,* venison or beaver) placed approximately 2 m up a tree. A Trailmaster infrared sensor attached to a 35 mm camera was positioned so that movement at the bait triggered the infrared sensor and resulted in a photograph of animals that visited the bait station.

Sideview of a marten (Photo by Parks Canada)

METHODS (Continued)

- The bait stations were placed in areas of most appropriate habitat or where unconfirmed sightings have occurred within the sample unit.
- Bait stations were visited once every 7-10 days during December - March to check sensor and camera batteries, replace film, check for species detection or other evidence of presence and replace bait if necessary.
- Hair snag stations were also established according to the methodology outlined on pp. 26-27.

RESULTS

Marten at Eel Weir Road bait station in March, 2006 (Photo by B. Mailman and R. Brunt)

- In 2005, two bait stations were established in two different sampling units. A total of 220 pictures were captured at the four stations, 83 of which were positively identified as triggered by an animal (38% photo success); however, only one of these pictures captured a target species (Fisher – Fire Tower Rd, Feb. 9-21, 2005).
- In 2006, the same bait stations were re-established to refine sampling methodology. A total of 360 pictures were captured at the four stations, 100 of which were positively identified as triggered by an animal (28% photo success). One bait station confirmed presence of marten (Eel Weir Road). Fisher and marten tracks were also identified between the 12-24 km markers along Eel Weir Road near Peskowesk Lake.

YEARS OF DATA

- Year 2 of a 6 year research and monitoring project

PARTNERS

- Parks Canada
- Nova Scotia Department of Natural Resources

Sample Unit	PBS	Date	Species detected
North 1	Big Dam Cabin	Jan 21-Feb 17/05	Weasel
		Jan 21-Feb 17/05	Squirrel
		Jan – Mar 2006	Gray jay
	Hemlocks & Hardwoods	-	-
South 1	Eel Weir Road	Jan 19-Feb 9/05	**Bobcat (tracks)**
		Feb 9-Feb21/05	**Fisher**
		Feb 9-Feb 21/05	Mouse
		Feb 21-Mar 18/05	Mouse
		Jan – Mar 2006	**Pine marten**
	Fire Tower Road	Jan 19-Feb 9/05	Shrew
		Feb 9-Mar 3/05	Northern flying squirrel
		Mar 3-Mar 22/05	Northern flying squirrel
		Jan – Mar 2006	Northern flying squirrel

Data collected from four bait stations in Kejimkujik in 2005 and 2006

CONTACTS

Richard Brunt, Blaine Mailman and Darien Ure
Kejimkujik
PO Box 236, Maitland Bridge
NS, B0T 1B0
Ph. (902) 682-2770
Fx. (902) 682-3367
richard.brunt@pc.gc.ca
darien.ure@pc.gc.ca

Rationale

The Eastern pipistrelle is a small, non-migratory bat that is widely distributed throughout eastern North America. However, in Nova Scotia they have a restricted range, exhibit distinct behavioral and morphological characteristics and are likely disjunct from the main part of their range. Nova Scotia Eastern pipistrelles require Old-man's-beard lichen for roosting, typically found in mature spruce trees. This association may make them vulnerable to forest alteration, however, their summer distribution in the province remains poorly understood. It is critical to have a thorough understanding of a species' distribution in order to assess its status, abundance and habitat requirements. The goal of this study is to delineate the regional distribution of this small, disjunct population of Eastern pipistrelles and provide insights into landscape-level habitat requirements. If the viability of the Eastern pipistrelle in Nova Scotia is related to particular landscape elements, then monitoring their activity may also be valuable as an indicator of changes in landscape structure and connectivity over large spatial scales in the region.

Eastern pipistrelle bat
(Photo by J. Poissant)

Monitoring

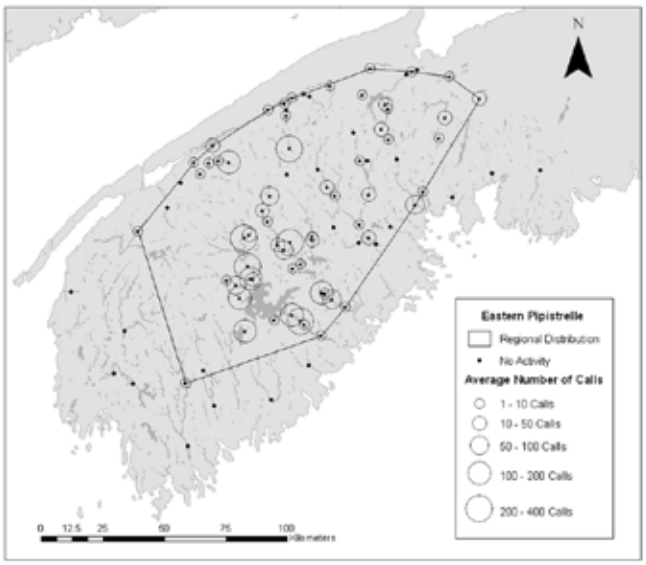
DISTRIBUTION OF THE EASTERN PIPISTRELLE BAT

OBJECTIVES

- To determine the regional distribution of the Eastern pipistrelle in southwest Nova Scotia through the use of remotely placed acoustic detectors.
- To quantify the effects of landscape and site-level characteristics on their activity.
- To assess the value of an acoustic survey monitoring program to identify landscape elements associated with Eastern pipistrelle activity.

METHODS

- Ninety forested river sites throughout southwest Nova Scotia were monitored from June to August, 2005 and 2006.
- Sites were monitored for three days at a time using broadband Anabat II detectors (Titley Electronics) suspended from trees to reduce interference by vegetation.
- Eastern pipistrelle call sequences were identified based on comparison with known call characteristics and the number of calls per night was calculated as an index of relative activity.
- Site and landscape-level characteristics were quantified by field measurements and by extraction from forest inventory data from the Nova Scotia Department of Natural Resources using GIS.



Sites monitored for the Eastern pipistrelle in southwest Nova Scotia, the population's regional distribution and the average number of calls recorded per night at each site (Map by L. Farrow)

RESULTS

Bat monitoring took place along rivers in southwest Nova Scotia (Photo by L.Farrow)

- Activity of the Eastern pipistrelle is restricted to the interior of southwest Nova Scotia and is greatest in the Mersey and Medway River watersheds, with smaller concentrations detected in the LaHave River area, Gaspereau River valley and the Annapolis River valley, which are some of the warmest areas in the region in the summer.
- Isolation of southern affiliated populations to warm areas of southwest Nova Scotia is characteristic of a number of other disjunct populations of aquatic and terrestrial flora and fauna.
- Ongoing model selection will attempt to determine if activity levels of this species are associated with site and landscape characteristics, which may make them useful for monitoring changes in landscape structure.
- These results will help to better assess the status of this small, disjunct population of Eastern pipistrelles, which may have special conservation value because they may be ecologically and genetically distinct from those inhabiting the central part of their range.

YEARS OF DATA

- Year 2 of a 2 year project

PARTNERS

- Nova Scotia Habitat Conservation Fund
- Mersey Tobeatic Research Institute
- Parks Canada
- Saint Mary's University
- Bat Conservation International
- Natural Sciences and Engineering Research Council

Anabat II acoustic detector used to monitor activity of the Eastern pipistrelle (Photo by L. Farrow)

Anabat II detector suspended from a tree along the Medway River (Photo by L. Farrow)

CONTACTS

Lesley Farrow and Hugh Broders
Biology Department
Saint Mary's University
Halifax, NS B3P 3C3
Ph. (902) 496-8193
lesley.farrow@gmail.com

Rationale

Long-term integrated forest monitoring plots have been established at Kejimkujik to understand and track changes in ecological integrity in two representative forest ecosystems: Eastern hemlock- and hardwood-dominated forests with Red maple, Red oak, White birch and White pine. Terrestrial, lungless salamanders have been proposed as indicator species in forest ecosystems because: (i) respiring through their skin makes them sensitive and vulnerable to soil contaminants and changes in soil moisture regimes; and (ii) they are present in high densities in forests and play an important role in forest food chains and nutrient cycling and decomposition. The rate of humus decomposition is a fundamental driver of forest productivity and a process that may be affected by climate change, acid deposition, trampling and disturbance. As a result, this project aims to develop and implement monitoring for salamander abundance and annual decay rates as measures of forest ecosystem health.

Red-backed salamander
(Photo by S. Siblot)

Monitoring

SALAMANDER AND DECOMPOSITION MONITORING

OBJECTIVES

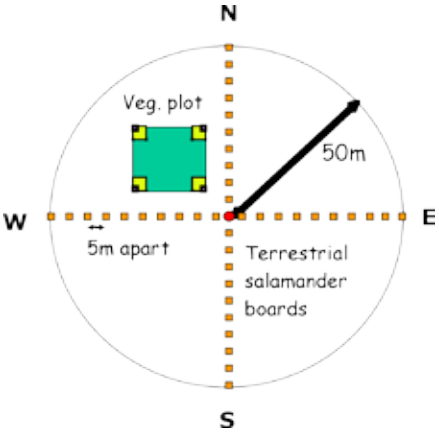
- To develop an appropriate protocol and study design for long-term monitorning of salamanders and decomposition.
- To implement pilot monitoring to field test the protocols.
- To identify monitoring targets and thresholds.
- To provide recommendations for long-term monitoring.
- To monitor status and trends in: (i) terrestrial, lungless salamander abundance and (ii) annual decay rate of the humus layer in zonal forest in Kejimkujik.

METHODS

- Salamander abundance and annual decay rates were assessed at 12 long-term integrated forest monitoring plots in Eastern hemlock and mixed forests at Kejimkujik. In these same plots, other measures of forest biodiversity, ecological processes and stressors are also assessed: coarse woody debris; tree growth rate and recruitment; species composition and abundance of trees; shrubs; ground vegetation; epiphytic lichens; forest birds; and terrestrial arthropods.
- Salamander methodology was developed in collaboration with Ecological Monitoring and Assessment Network (EMAN), Dalhousie University, and Parks Canada. At each plot, salamanders are surveyed under a series of 40 wooden boards (24 x 30 cm) weekly in the early fall. Salamander abundance, weight, length, sex, species and soil temperature were measured.
- Annual decay rates methodology was developed in collaboration with EMAN, Canadian Forest Service (CFS), Dalhousie University and Parks Canada. Standardized wood pieces (tongue depressors) were buried in the litter and organic layers for one year and dry weight loss was measured.

S. Julliand retrieving the first annual decay rates samples in October 2005
(Photo by C. Staicer)

RESULTS



Arrangement of long-term integrated monitoring forest plots. At each site 40 salamander boards are located along cardinal directions. Annual decay rates stations are located at the corners of the vegetation plot.

- Salamander detections varied across sites, a result consistent across years. The site with the highest and lowest number of salamanders under boards was in the Canning Field Road plot, where the Pale-winged gray moth outbreak was most severe. Humus moisture, temperature and pH did not differ among sites and did not explain variation in salamander detections.
- The number of salamanders found under boards was positively correlated with annual humus decay rates across sites and with the amount of coarse woody debris in the moderate to very decomposed stages, especially in the hardwood-dominated stands.
- On average, salamanders were found under 16-18 % of boards per year but the standard deviation was high at 11 %. The same seasonal trend was found each year, with a decline through October. There was no year-to-year trend.
- Four wood types have been used for cover boards in equal abundance, their placements randomized within both hardwood and hemlock sites: pine, spruce, hemlock and maple. When all four years of data were included, significantly more salamanders were found under pine boards in the hardwood-dominated plots.

Standardized wood pieces (tongue depressors) retrieved from humus layer following one year (Photo by J. Grzeslo and C. Staicer)

YEARS OF DATA

- Salamanders: Ongoing since 2003
- Annual Decay Rates: Ongoing since 2004

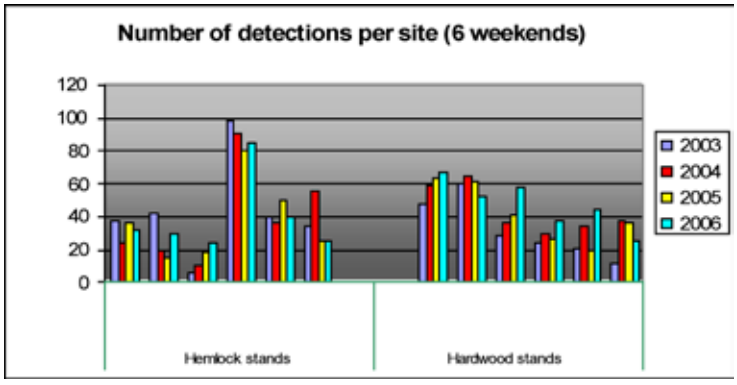
CONTACTS

Darien Ure
Kejimkujik
PO Box 236
Maitland Bridge
NS, B0T 1B0
Ph. (902)682-4003
Fx. (902)682-3367
darien.ure@pc.gc.ca

Cindy Staicer
Dalhousie University
Biology Department
Dalhousie University
1355 Oxford St
Halifax, NS B3H 4J1
Ph. (902)494-3533
Fx. (902)494-3736
cindy.staicer@dal.ca
http://biology.dal.ca/

PARTNERS

- Parks Canada
- Dalhousie University
- Ecological Monitoring and Assessment Network
- Canadian Forest Service



Number of salamanders found under the 40 wooden boards in each plot between early September and mid-October 2003-2006

Rationale

Keji Quest is an innovative outreach program intended to foster stewardship and a sense of ownership in youth living near Kejimkujik. It is based on a philosophy that ecological integrity (EI) will be improved by (i) providing meaningful first-hand experiences that re-connect youth with nature; (ii) encouraging hands-on, minds-on science that focuses on learning through doing, exploring and observing; (iii) promoting science as observation so that local residents realize that important environmental changes can be detected from long-term monitoring; and (iv) building an ethics of care by involving youth in monitoring the health of forests. Three new long-term integrated forest monitoring plots were established within Kejimkujik, and two field measures (salamander abundance and soil decay rates) were pilot-tested and implemented with Grade 4 audiences. A curriculum-linked interpretive program was developed complete with park and school visits, costumes and plot, posters, student workbooks, teacher guides and website.

Monitoring

KEJI QUEST: INVOLVING YOUTH IN ECOLOGICAL MONITORING

C. Anderson burying wood standard to measure decay rate (Photo by J. Sheppard, Parks Canada)

OBJECTIVES

- To establish three new long-term integrated forest monitoring plots for youth monitoring that build on the existing plot network at Kejimkujik (see pp. 32-33).
- To contribute long-term forest ecosystem data collected by local youth to Kejimkujik's ecological integrity monitoring program.
- To provide an enhanced, curriculum-linked education program that engages local youth.
- To provide first-hand, meaningful nature experiences that foster environmental stewards.

METHODS

- Three youth monitoring plots were established at Mill Falls, Merrymakedge and Jim Charles Point. Plot design is consistent with the long-term integrated forest monitoring plots (see pp.32-33).
- Five potential field measures were pilot-tested with school audiences for ability to provide useful data and be meaningful, exciting and rewarding for youth.
- Protocol selection criteria included: (i) established protocols by Ecological Monitoring and Assessment Network and Parks Canada to ensure data comparability; (ii) consistency with field measures conducted in Kejimkujik's long-term integrated forest monitoring plots; (iii) easy ecological rationale for youth to understand; (iv) direct tie to curriculum links and program themes; (v) novel data collection so that effort is not redundant; and (vi) ease of reporting back (both for students to take notes, and for staff to present results back to participants).
- A margin of error assessment was conducted to validate the data being contributed.
- Forest plot measures were selected based on the assessment of the ecological impact of student involvement (minimized trampling, digging, species handling and collection).

P. Lalonde teaching students about forest decomposition (Photo by J.Sheppard)

METHODS
(Continued)

- Site selection was conducted to ensure the location of plots was in the two required forest types (eastern hemlock and mixed wood stands) for the EI monitoring program, had easy accessibility for groups and was in reasonable proximity to washroom facilities and shelters.
- The EMAN IceWatch community science program was adapted and used as a follow-up activity for students in their own communities. The provincial LeafWatch program was also used as a pre-visit activity.

RESULTS

Student recording salamander abundance data (Photo by J. Sheppard, Parks Canada)

- Two field measures were selected for the youth monitoring plots: salamander abundance and rate of soil decay (see p. 33). Field-testing discarded three others: coarse woody debris measurement and typing (not enough quality control and too much redundancy), community age and spacing (too much identification of species, not enough time to complete with youth audiences), and seedling regeneration (too much redundancy and environmental impact).
- A youth monitoring program was implemented and 450 students in 16 classes in 9 local schools participated in the program.
- Data collected by students will be added to decay rate database.
- Across the 100 m diameter of each plot, artificial cover objects were placed every 5 m, and students conducted salamander abundance and species identification.
- To measure the rate of soil decay, students buried wood standards for 1 year, and weight loss was measured as index of decomposition.
- Interpretive staff provided quality control on the data collection.

YEARS OF DATA

- Ongoing project since 2006

PARTNERS

- Parks Canada
- Nova Scotia Department of Education

Students checking for salamanders under cover logs (Photo by J. Sheppard, Parks Canada)

CONTACTS

Jonathan Sheppard, Colleen Anderson and Darien Ure
Kejimkujik
PO Box 236, Maitland Bridge
NS, B0T 1B0
Ph. (902) 682-2770
Fx. (902) 682-3367
colleen.anderson@pc.gc.ca,
darien.ure@pc.gc.ca,
jonathan.sheppard@pc.gc.ca

Rationale

Air pollution and acid rain are threats to maintaining ecological health of protected areas. Protected area managers require a meaningful way to measure impacts of these threats. Lichens are one of the most sensitive groups of organisms to acid rain and air pollution and can provide an early warning indication of impacts to ecosystems. Hundreds of studies have linked lichen communities to air quality. Lichens have been used in long-term monitoring of air quality in Europe and in mapping air quality zones in cities throughout the globe.

Boreal felt lichen is an Endangered species in Nova Scotia whose recent decline in the province is partly due to air pollution (Photo by R.Cameron, NSDEL)

Monitoring

AIR QUALITY MONITORING WITH LICHENS

Lichen technicians surveying for lichens (Photo by L. Helmer, NSDEL)

OBJECTIVES

- To determine current impacts of acid rain and air pollution on ecosystems in Nova Scotia.
- To help determine how air pollution varies within Nova Scotia and use these data to help map air pollution zones in the province.
- To establish permanent lichen monitoring plots that will enable long-term monitoring of air pollution and acid rain.

METHODS

- Fifty-two plots were randomly located across the province; 38 of which are in protected areas.
- Each plot was visited in 2005 or 2006 and presence and frequency of 16 indicator lichen species were measured.
- An index of air purity was calculated for each plot based on the lichen species presence and frequency. Higher air purity scores indicate areas with low levels of air pollution.

RESULTS

- Urban and industrial centers (Sydney, Port Hawkesbury, Pictou, Halifax) had the lowest lichen air purity scores.
- Much of the province had very high lichen air purity scores, including most of Cape Breton, central Nova Scotia and the eastern shore.
- Southwestern Nova Scotia shows some areas where lichens suggest slightly lower air purity than central Nova Scotia and Cape Breton.
- The permanent plots provide the foundation for long-term monitoring of air pollution effects on ecosystems in Nova Scotia.

Blistered jellyskin is one of the most sensitive lichens to air pollution (Photo by R.Cameron, NSDEL)

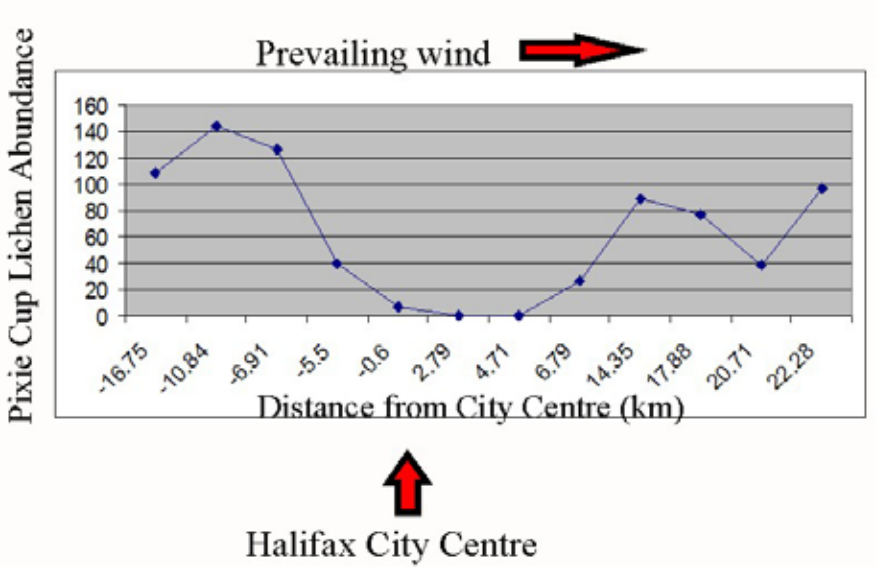
Lichen technicians laying out monitoring plots (Photo by L. Helmer, NSDEL)

YEARS OF DATA

- 2006 and 2007
- Re-measurement in 2 to 5 years

PARTNERS

- Nova Scotia Environment and Labour, Protected Areas Branch and Air Quality Branch
- Saint Mary's University
- Nova Scotia Youth Conservation Corps



Pixie cup lichen abundance increases as distance from Halifax City center increases.

CONTACTS

Robert Cameron
Nova Scotia Environment and Labour
Protected Areas Branch
5151 Terminal Road
PO Box 697
Halifax, NS B3J 2T8
Ph. (902) 424-2176
Fx. (902) 424-0501
camerorp@gov.ns.ca
www.gov.ns.ca/enla/

Rationale

Lichens are well-established bioindicators and have been used globally for many years to monitor air pollution. They are particularly sensitive to changes in their environment due to the lack of a cuticle, uptake of nutrients from the atmosphere and slow rate of growth and development. As a result, lichens can provide an early warning for air pollution and acid rain impacts on forest ecosystems. Lichen species vary in their sensitivity to pollutants. Therefore, an understanding of the prevailing air quality in an area can be obtained by monitoring the assemblage and abundance of different species. Monitoring lichens can also provide a measure of biodiversity and overall forest health because of demonstrated associations of lichen species with forest structure, seral stage, fragmentation and disturbance history. Lichens are monitored as one component of the integrated forest plots at Kejimkujik designed to assess and monitor the state of forest ecosystems and their changes over time.

Powder-headed tube lichen
(Photo by T. McMullin)

Monitoring

LICHEN MONITORING

OBJECTIVES

- To determine if the abundance of pollution-sensitive epiphytic (growing on a tree) lichen species is decreasing over time in representative forest ecosystems.
- To determine if epiphytic lichen diversity is changing over time in representative forests at Kejimkujik.
- To identify key measures for assessing and monitoring lichen communities.
- To develop an appropriate protocol and study design for monitoring lichens.
- To implement pilot monitoring to field test the protocols.
- To provide recommendations for long-term monitoring.

S. Sibot and M. Jones
monitoring lichens
(Photo by M.Crowley)

METHODS

- The project approach was to sample lichen species at six previously established integrated forest plots in maple-oak-birch-pine stands at Kejimkujik. Also being measured in these integrated forest plots were trees, shrubs, ground vegetation, salamanders, forest birds, arthropods, decomposition and coarse woody debris.
- Presence and abundance of approximately 40 field-identifiable lichen species were assessed in permanent sampling quadrats ('ladders') on twelve Red maple trees at each forest plot. An air quality index will be developed based on this information.
- A list was developed for lichen species located on the lower boles (trunks) of Red maple, Red oak and White pine trees (co-dominant trees) as a measure of lichen diversity at each plot.

RESULTS

- Lichen species richness ranged from 33 to 38 species in the six plots.
- The total number of lichen species sampled in the species inventory for all six plots was 69.
- The most frequently sampled lichen species were Sheild lichen species, Lungwort and *Cladonia* species.
- A lichen collection was developed to aid future monitoring and species identification.
- Recommendations for long-term monitoring of lichens at Kejimkujik are currently in development.

YEARS OF DATA

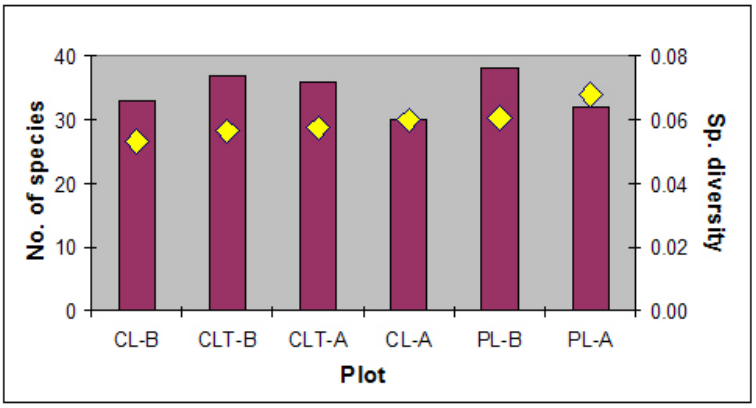
- Year 1 of an ongoing project

PARTNERS

- Parks Canada
- Dalhousie University

T. McMullin identifying lichens (Photo by M. Crowley)

Smooth lungwort (Photo by T. McMullin)



Lichen species richness and diversity (Simpson's Index) for epiphytic macrolichens in six mixed forest (maple-oak-birch-pine) plots at Kejimkujik (CL: Cobrielle Lake, CLT: Channel Lake Trail, PL: Pebbleogitch Lake).

CONTACTS

Darien Ure
Kejimkujik
PO Box 236, Maitland Bridge
NS, B0T 1B0
Ph. (902) 682-4003
Fx. (902) 682-3367
darien.ure@pc.gc.ca

Cindy Staicer, Biology Department
Troy McMullin, School for Resource and Environmental Studies
Dalhousie University
Halifax NS, B3H 4J1
Ph. (902)494-3533
Fx. (902)494-3736
cindy.staicer@dal.ca
troymcmullin@dal.ca

Rationale

The species composition of vegetation in forest ecosystems is an important measure of forest ecological integrity (EI). Forest species diversity is a measure of forest EI, as assessed from repeated sampling of forest vegetation in plots located in selected forest ecosystems. In addition to changes in native species richness, monitoring forest composition will also provide information on the colonization of forest plots by alien invasive or other invasive species. Forest species diversity data also provides valuable information related to shifts in ecological processes and succession associated with local, regional and global factors.

Sugar maple seedling (Photo by A. Lavers)

Monitoring

FLORISTIC INVENTORY OF FOREST MONITORING PLOTS

OBJECTIVES

- To sample long-term forest monitoring plots in Kejimkujik to generate baseline data on vascular plant and ground moss species composition and cover.
- To collect additional semi-quantitative data on species composition and occurrence for the ecosystems in which the plots are located.
- To develop protocols for monitoring and analyzing floristics in the future.

Unfurling Christmas fern (Photo by A. Lavers)

METHODS

- Vegetation plots were assessed using a method adopted by Canadian National Vegetation Classification. This method records a complete list of ground species with their percent cover in each of 7 possible layers on 20 x 20 m plots.
- A local ecosystem floristic list was also developed for the ecosystem encompassing each plot. This method records all ground species that can be found in a homogenous stand of vegetation during an hour survey by a botanist. Some rules apply to provide consistency of results. This is a quick method that can record local diversity of vegetation within individual ecosystems.

RESULTS

- Lists were developed of late summer vascular plant species in 21 forest monitoring plots representing seven different ecosystems.
- The lists resulted in a total of 572 records representing 149 different species.
- 19 Local Ecosystem Floristic Lists were recorded for the ecosystems around the plots.
- The total number of species records for the Local Ecosystem Floristic Lists was 681.
- Proposals were made for analysis of data and future monitoring activities.

Wood sorrel - herbaceous ground vegetation (Photo by A. Lavers)

YEARS OF DATA

- Ongoing Project: to be repeated every 5 years

PARTNERS

- Parks Canada
- Nature Serve Canada

Painted trillium - herbaceous ground vegetation (Photo by A. Lavers)

CONTACTS

Serguei Ponomarenko
NatureServe Canada
c/o: Ecological Integrity Branch
Parks Canada
Room 359a, 4th Floor
25, rue Eddy
Gatineau, QC K1A 0M5
sergei.ponomarenko@pc.gc.ca
Ph. (613) 565-5725, (819) 953-6464

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 as 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 Southern flying squirrel released from a live-trap in West Caledonia (Photo by A. Lavers, MTRI)

Monitoring

MONITORING FLYING SQUIRREL SURVIVORSHIP AND FECUNDITY

OBJECTIVES

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

A Northern flying squirrel in a live-trap (Photo by A. Lavers, MTRI)

METHODS

- Study grids were installed at six 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.
- Captured flying squirrels were implanted with PIT tags and released where they were caught.
- PIT tag receiving stations were placed within the grid to monitor survivorship.
- Volunteers from Lunenburg, Queens and Shelburne counties constructed squirrel boxes, which were installed in study grids for future fecundity work.

RESULTS

- Twenty-four flying squirrels (9 Southern and 15 Northern flying squirrels) were live-trapped at the West Caledonia study grid in 2005-06. Five of these animals regularly visited recording stations in the spring of 2006, three of them visited recording stations in January 2007. In 2007, fourteen flying squirrels (6 Southern and 8 Northern flying squirrels) were live-trapped and monitoring is ongoing.
- A total of 25 flying squirrels were live-trapped at Donnellan Lake, Low Landing, Grafton Lake and Jeremy's Bay.
- Study sites for future live-trapping and monitoring have been installed near Low Landing, Round Lake, Grafton Lake and Jeremy's Bay.

A flying squirrel released from a live-trap in West Caledonia gliding towards a cavity to take refuge for the day (Photo by A. Lavers, MTRI)

YEARS OF DATA

- 2005, 2006 and 2007

PARTNERS

- Parks Canada
- Mersey Tobeatic Research Institute
- Nova Forest Alliance
- Saint Mary's University
- Greater Fundy Ecosystem Group
- Acadia University

Volunteer squirrel box builders (Photo by P. Biddle)

K. Rowter and P. Kydd checking a flying squirrel live-trap (Photo by A. Lavers, MTRI)

CONTACTS

Amanda Lavers and Peter Kydd
Mersey Tobeatic Research Institute
9 Mount Merritt Road
PO Box 215
Kempt, NS, B0T 1B0
Ph: (902) 682-2371
Fx: (902) 682-2760
info@merseytobeatic.ca
www.merseytobeatic.ca

Rationale

Many incidental reports of food items for Southern flying squirrels have been made but few studies have quantified that species' diet. In South Carolina, one study found that acorn material was the most prevalent and other food items included pine seeds, holly fruit, tree moss, fungi, hickory nuts and insects. In New Brunswick, the Northern flying squirrel's diet includes plants, seeds, insects and many species of fungi including mycorrhizal truffles. In Nova Scotia where two species of flying squirrels coexist, their diet has not been researched but one might assume that Southern flying squirrels are limited to habitat with storable, protein-rich acorns and beechnuts for winter food while the Northern flying squirrels are able to survive on lower energy diets of fungi, lichens, and coniferous seed. Data showing the seasonal diets of these two species will help us understand their habitat requirements.

Young Northern flying squirrel eating fungus near Fisher Lake (Photo by J. Rowter)

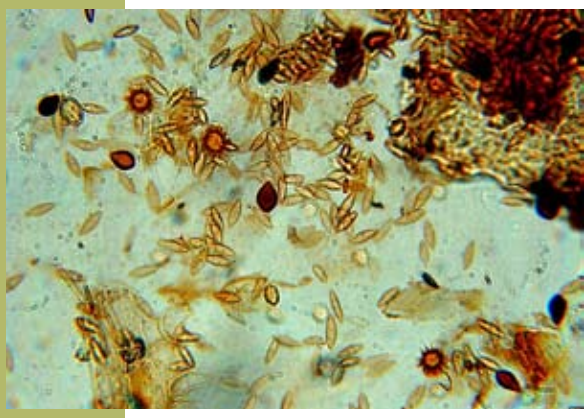
Research

DIET OF NORTHERN AND SOUTHERN FLYING SQUIRRELS

OBJECTIVES

- To determine the percent composition of fungi, insects, tree buds, seeds, nuts and other food items in stomachs and feces of Southern and Northern flying squirrels from Nova Scotia.
- To compare the diets of Southern and Northern flying squirrels.
- To look at seasonal trends in diets of Southern and Northern flying squirrels.

METHODS



Photomicrograph of summer fecal sample from a Northern flying squirrel showing fungal spores (Photo by A. Lavers)

- Flying squirrels were live-trapped at five sites in southern Nova Scotia (including sites at Kejimkujik, South Brookfield and Gaspereau) and feces were collected from traps and frozen for storage.
- Ten samples were chosen from each of three seasons (summer, fall, winter) for each species (Southern and Northern flying squirrel) although only six samples were available for Northern flying squirrels in the fall. For statistical independence, only one sample was used from an individual animal.
- Fecal samples were dried at 60°C for 48 hours.
- Fecal samples were analysed at Washington State University's Wildlife Habitat Lab with innovative microhistological techniques.

RESULTS

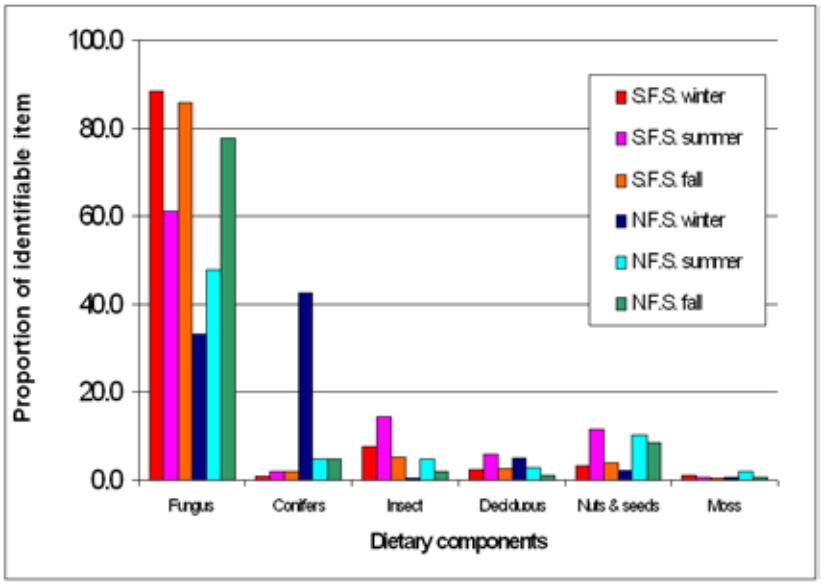
- The proportion of fungi and insects in the diet of Southern flying squirrels is higher and coniferous plant material is lower compared to the diet of Northern flying squirrels at the study sites.
- In summer, Southern flying squirrels consumed less fungi and more insects and deciduous material (including nuts) than they did at other times of year.
- In winter, Northern flying squirrels consumed more coniferous material and less fungi, nuts, deciduous seeds and insects than they did at other times of year.

YEARS OF DATA

- Ongoing project since 2001

PARTNERS

- Nova Scotia Habitat Conservation Fund
- Nova Scotia Department of Natural Resources
- Acadia University
- Parks Canada



Proportion of identifiable items for each dietarty component of Southern flying squirrel (S.F.S.) and Northern flying squirrel (N.F.S.) in winter, summer and fall (n=55)

CONTACTS

Amanda Lavers
Mersey Tobeatic Research Institute
9 Mount Merritt Road,
Kempt, NS
Ph. (902) 682-2371
Fx. (902) 682-2760
info@merseytobeatic.ca
www.merseytobeatic.ca

Rationale

Red oak is an integral component of the Acadian Forest and provides food and shelter for a wide array of wildlife. The greater Kejimkujik ecosystem was settled by Europeans in the mid-1700s and by the second half of the nineteenth century most of the virgin growth had been harvested. Past forestry practices and active suppression of forest fires have fundamentally changed the structure of Acadian forests in this area. Furthermore, data from two Smithsonian Institution Monitoring and Assessment of Biodiversity (SI/MAB) Forest Plots within Kejimkujik show a proportionately significant decline in Red oak stands. The aim of this project is to map the distribution of Red oak and to determine the age structure and health of the trees within the mapped stands. Understanding recruitment and population dynamics of Red oak will help to address the role of fire management in the maintenance of Acadian Forests.

Red oak leaf in late fall frost (Photo by A. Trant)

Research

DISTRIBUTION AND RECRUITMENT OF RED OAKS

OBJECTIVES

- To map and describe the distribution of Red oak in Kejimkujik.
- To determine the demography/age structure of these Red oak stands and measure the amount of recruitment between different size classes and in stands where historical fires have been documented.
- To establish monitoring plots that will be used to document future fire events and provide a long-term understanding of population dynamics.

METHODS

- Kejimkujik was surveyed with a helicopter and the proportion of Red oak in the canopy was estimated. GPS devices were used to delineate the perimeter of the stands.
- Twenty monitoring plots (400 m^2) were established in areas where fires are known to have occurred and in areas where fire history is not known.
- In each plot, all trees were identified, measured for diameter at breast height (DBH) and total height, and health of tree was determined. Five subplots (4 m^2) were used to record the number and size class of regeneration. Three transects (30 m) were conducted to determine the diversity, abundance and decay class of down woody debris.
- From these data, the following was explored: (i) the density of trees (using basal area), (ii) age structure (using proportional representation of age and size class), and (iii) population dynamics (using life-stages transition matrices).

Red oak stand as seen from above (Photo by K. Chin)

RESULTS

- Over the 3 days of flying the perimeters of 95 Red oak stands were mapped and the relative proportion of Red oak in each stand estimated.
- Red oak was the dominant species of downed woody debris at most sites.
- Though analysis of data is still in progress, overall there seems to be a lack of Red oak in the younger ages classes (seedling and sapling) and most sites seem dominated by regeneration of competing species (White pine and Red maple constituting a majority of these). Although mature Red oaks are abundant in these stands, the recruitment into older age classes appears to be limited by the paucity of Red oak regeneration.
- Preliminary results comparing stands on historical burn sites and those areas where fire history has not been documented suggest similar patterns of age structure but with significantly more oak seedlings in stands where there is evidence of fire.

Researcher A. Trant locating the perimeter of oak stands (Photo by K. Chin)

Red oak seedling (Photo by A. Trant)

YEARS OF DATA

- Year 1 of a 2+ year project

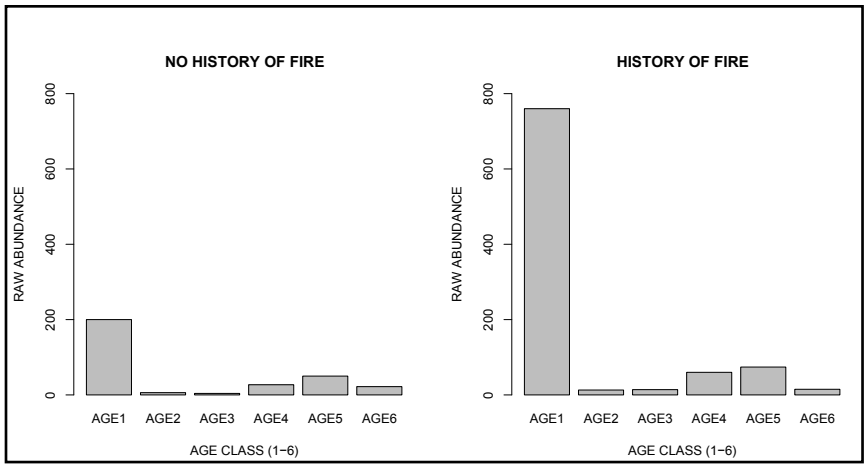
PARTNERS

- Parks Canada
- K.C. Irving Environmental Science Centre
- Acadia University

CONTACTS

Andrew Trant and Sara Good-Avila
Department of Biology
Acadia University
24 University Avenue
Wolfville, NS
B4P 2R6
Ph. (902) 585-1798
Fx. (902) 585-1059
andrew.trant@gmail.com
sara.good-avila@acadiau.ca
http://ace.acadiau.ca/~savila/webpage

Ian Morrison
Kejimkujik
PO Box 236, Maitland Bridge
NS B0T 1B0
Ph. (902) 682-4010
Fx. (902) 682-3367
ian.morrison@pc.gc.ca



Breakdown of age classes for Red oak with different fire histories

Rationale

An understanding of the disturbances that shaped the current forest composition in national parks is crucial for vegetation management. One of the most important natural disturbances in the interior areas of the Maritime region is fire. According to previous studies of the recent fire frequencies in Kejimkujik, the fire return interval in various ecosystems within the park was less than 20 years during the last 100 years (the fire return interval varied from 15 years for White pine to 19 years for Eastern hemlock). If indeed such fire frequencies represented natural processes in the past, fire management in the park should aim to conduct prescribed burning as often as every 15-19 years in order to preserve the existing forest ecosystems. However, extrapolation of these results to any longer time period (e.g., to the time of the establishment of the oldest tree stands in the park) is disputable, as fire frequency can significantly change through time, and the direction of the change is not immediately obvious. This two-year project aims to reconstruct pre-European fire frequency of Kejimkujik using soil charcoal and semi-coke.

Research

RECONSTRUCTION OF NATURAL FIRE DISTURBANCE HISTORY

2005 coastal barren fire at the Kejimkujik Seaside Adjunct (Photo by Ian Morrison)

OBJECTIVES

- To reconstruct historical fire history in the park.
- To determine past changes in fire frequencies.
- To determine the tree species composition associated with various levels of fire occurrence in the past, particularly for the period preceding the intensive European colonization and for the time of the establishment of the oldest tree stands in the park.

METHODS

- In 2006, the first stage of the project was implemented, which included the development of sampling strategy and criteria of site selection and field examination of 30% of the sites that will be used in the study.
- Soil sections were examined, photographed, and described using an ecosystem archaeology approach. Charcoal, semi-coke and charred forest duff were sampled from pyrogenic layers and morphons for further botanical identification and radiocarbon dating.
- The oldest tree stands were examined in order to provide the greatest depth of retrospective.
- Botanical identification of charcoal allowed for reconstructing the tree species composition and succession changes. Radiocarbon dating of charcoal determined the age of fires and their frequency.

Sectioned oak stump near Big Dam Trail(Photo by E. Ponomorenko)

RESULTS

- Fires recorded per site varied from three to five for the period from 250 to 8,000 years ago. Fire frequency changed during the last 8,000 years, reaching its maximum in the last millennium.
- Between AD1200 and AD1720, the average fire return interval in the area was 250 years. However, between AD 400 and AD 1200 no major fires were recorded in any of the studied sites, indicating that the fire return interval in the first millennium AD could be significantly lower than in the second millennium.
- Four large-scale fires affected several of the study sites approximately 1,500, 800, 500, and 250 years ago. These fires occurred shortly after hurricanes. Each of these combined fire-hurricane events affected tens of square kilometers in the eastern part of Kejimkujik, causing significant deforestation of the area.
- The area affected by a given fire was especially large during the fires that occurred about 800 years ago (AD 1220-1290) and 250-300 years ago (AD 1700-1764).
- The tree species recorded in pre-historic charcoal assemblages did not differ significantly from the species composition of the modern forests in the eastern part of Kejimkujik including: Eastern hemlock, White pine, Red pine, Spruce, Balsam fir, Red oak, Maple, American beech and Birch. Under-storey species included Canada yew, Hazelnut and Witch hazel.

Canning field site: lense showing the forest duff that was charred and then buried under uprooting mixture during the fire event of AD 1239-1261 (Photo by E. Ponomorenko)

YEARS OF DATA

- Year 1 of a 2 year project

PARTNERS

- Parks Canada
- ArchEco (Ecosystems Archaeology).

D. Ponomorenko examining forest duff in Kejimkujik's oldest Hemlock stand (Photo by J. Sheppard)

CONTACTS

Elena Ponomarenko
Canadian Museum of Civilization
20 Empress Ave
Ottawa, ON K1R7E8
Ph. (613) 565-5725
eponomarenko@yahoo.com

Rationale

Over the past four centuries, little of Nova Scotia's forested areas have escaped human influences. The outcome has been an increase in 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 land owners must be included in collaborative work to maintain landscape connectivity, conserve biodiversity and restore old forests in western Nova Scotia. The development of private land owner stewardship requires an understanding of land owner's knowledge and values about managing old forests and their active participation in research and management activities.

Large hemlocks and moss (Photo by K. Nickerson, MTRI)

Research

MANAGING OLD FORESTS FOR LANDSCAPE CONNECTIVITY

OBJECTIVES

- To find and characterize old forest features on small privately owned land in the Medway and Mersey watersheds.
- To conduct a local survey to better understand woodland owner values and attitudes towards old forests.
- To create a map and database in GIS for public and private old forests.
- To foster stewardship of old forests on private land utilizing research findings to design communication products and community outreach interventions.

METHODS

- Potential old forest sites in the Medway and Mersey watersheds were surveyed with GIS using Nova Scotia Department of Natural Resources (NSDNR) Forest Inventory database.
- Queries were developed in ArcMap to identify spruce, hemlock, pine and tolerant hardwood stands greater than one hectare with a minimum height of 15-18 m depending on the dominant species.
- Landowner information for each potential site was obtained at the Registry of Deeds so that they could be contacted by mail and phoned for permission.
- At each site, at least three sample points were randomly selected where tree species, age, height, coarse woody debris and other parameters were measured using NSDNR's Old Forest Scoresheet.
- Additional information recorded at each site incorporated methods used by other researchers at Dalhousie who recently studied old forests on Bowater Mersey freehold.
- A local survey of landowners was developed using recommendations by other researchers.

Private landowner hugging Red spruce on her land (Photo by K. Nickerson, MTRI)

Katie Nickerson measuring diameter at breast height of a Red maple (Photo by A. Lavers)

METHODS (Continued)

- Stewardship work with landowners has been undertaken in collaboration with the Nova Scotia Nature Trust, the Southwest Nova Biosphere Reserve Association and local forestry contractors.
- A GIS map and database for public and private old forests is being developed.

RESULTS

- Forty-five letters were sent to landowners with potential old forest to explain the project and ask permission to visit their woodlands. Fifty-three landowners were contacted by telephone to discuss potential old forests on their woodlands.
- Forty-two sample sites were investigated. Eighteen sites appeared to have potential old forests and were measured at fifty-four sample plots. Twenty-four sites had extensive cutting or did not have any trees older than 80 years of age.
- Sixty-three tree cores have been processed and analysed using the WinDendro system. Residual cores were donated to the Mount Allison Dendrochronology Lab. The average age of the oldest third of trees measured was 102 years old. The oldest tree found was an Eastern hemlock, 225 years of age which was only 50 cm in diameter.
- Sixteen land owners were engaged in discussions at their properties about old forests and will be surveyed about management plans.

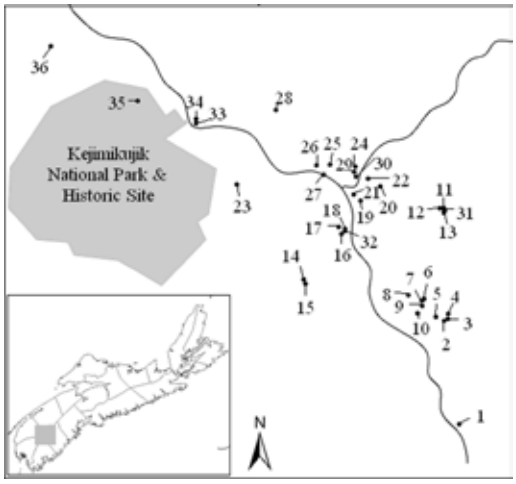
Coarse woody debris (Photo by A. Lavers)

YEARS OF DATA

- Ongoing project since September 2006

PARTNERS

- Mersey Tobeatic Research Institute
- Landowners
- Natural Resources Canada
- Bowater Mersey Paper Company
- Dalhousie University
- Nova Scotia Department of Environment and Labour
- Nova Scotia Department of Natural Resources
- Nova Scotia Nature Trust
- Parks Canada



Mersey River Watershed study sites (Map by K. Nickerson)

CONTACTS

Katie Nickerson and Amanda Lavers
Mersey Tobeatic Research Institute
9 Mount Merritt Road
PO Box 215, Kempt
NS B0T 1B0
Ph. (902) 682-2371
Fx. (902) 682-7263
info@merseytobeatic.ca
www.merseytobeatic.ca

Rationale

Old growth forests in Nova Scotia have declined significantly. The purpose of this study is to describe and prioritize old growth values of citizens and groups in Nova Scotia for integration in sustainable forest management (SFM) decision-making. The study is based on nine field trips to forest stands with 76 participants from Aboriginal groups, environmental organizations, forestry professionals and the rural and urban public. Diaries, group discussion and rating sheets were used to elicit information during trips. Thesis findings show that certain values are more often associated with old growth than others; some values associated with old growth are considered more important than others; some silvicultural treatments are perceived to compromise old growth values more than others; and demographic characteristics such as constituency group, gender and age can influence values priority. A framework specific to old growth values is presented, along with ideas on the incorporation of old growth values in SFM decision-making.

Old growth forest moss
(Photo by R. Owen)

Research

OLD GROWTH FOREST VALUES OF CITIZENS

OBJECTIVES

- To determine the characteristics of an old growth forest.
- To determine what elements/attributes of forests and old forests are valued; what elements are more valuable than others and why.
- To determine if there is extra or added value of old growth as compared to non-old growth.
- To determine whether old growth values are compromised by silvicultural interventions.
- To determine if values differ by citizen constituency.

METHODS

- Nine one-day field workshops with citizen constituency groups in Nova Scotia were conducted in September and October 2005 and May 2006.
- Participants were selected to represent five citizen constituencies identified in the literature as groups whose values should be taken into consideration in forest decision-making.
- Seventy-six participants were recruited through organizations representative of the constituency groups, newspaper advertisements and posters.
- During field trips, each participant was given a diary to record personal thoughts during visits to young (40-60 years), mature (80-120 years) and old growth (120 years plus) cut and uncut forest stands in the morning.
- In the afternoon, a group discussion and rating sheet were used to elicit additional information.
- All text files were analysed using N6, a qualitative research software program, which was used to code information into theme areas.

Study participant (Photo by R. Owen)

RESULTS

- Many forest attributes were positively associated with old-growth values; green lush moss, large trees, rotting dead wood, canopy cover, overall ambience, naturalness, soft light, sound and unique habitat.
- Some values associated with young forests were also used to describe old growth forests but in a different context or with a different intensity. For example biodiversity and habitat were both important values for young and old growth forests.
- There were noticeable differences amongst the importance placed on certain old-growth values: *i.e.,* medicine (Mi'kmaw constituents), carbon sequestration (environmental representatives), heritage (Mi'kmaw constituents), majestic surroundings (urban and rural citizens) and fishing and hunting (Mi'kmaw and forestry representatives). Just as significant, there were major similarities amongst groups often related to key values such as habitat, peace, sacredness, beauty, water quality and quantity, education/research, wildlife appreciation and recreation/camping/hiking.
- Intrusive treatments such as scarification and higher-percentage tree removals were perceived as negatively affecting old growth values. Tending treatments and artificial regeneration were seen as more favourable as they could lead to enhancement and restoration in the stand which can positively add to old growth values. Still, some saw these treatments as negative. Protection treatments were viewed by some as having a negative impact on old growth values due to the uncontrollable, and often unintentional, effects on the ecosystem. Others viewed these as positive measures that could potentially save forests.
- With the exception of timber and firewood, all values were seen as more negatively affected by silvicultural treatments than positively. Aesthetic values were affected the most by silvicultural treatments, and economic values the least. Heritage, medicine, pristine, natural beauty, creative inspiration and untouched values were negatively affected by all treatments.
- The strongest recommendation was to preserve and protect the old growth forests of Nova Scotia. Over 20 suggestions were provided on areas such as education, planning, ethics, silviculture and policy and regulation.

Old hemlock with woodpecker holes (Photo by R. Owen)

YEARS OF DATA

- Single year study

PARTNERS

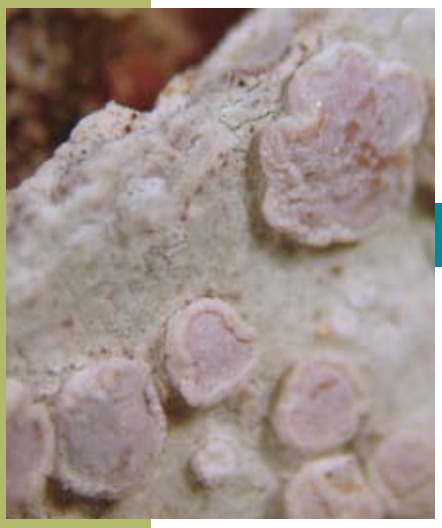
- Dalhousie University
- Bowater Mersey Paper Company
- Sustainable Forest Management Network
- Mersey Tobeatic Research Institute

CONTACTS

Rochelle Owen and Peter Duinker
School for Resource and Environmental Studies
Dalhousie University
6100 University Av., Suite 5010
Halifax, NS B3H 3J5
Ph. (902) 483-8179
rjowen@dal.ca
http://sres.management.dal.ca/

Rationale

Lichens are found in virtually all terrestrial environments but few habitats are as rich with lichen species as old growth forests. As a forest ages, its structural complexity increases, providing a progressively larger number of unique micro-habitats suitable for individual lichens. In Nova Scotia, however, only one study has focused on old forest lichens and it was confined to Cape Breton Island, demonstrating the need for further study in this area. Unharvested conifer-dominated forest stands were examined in southwestern Nova Scotia to determine lichen species unique to particular-aged stands. A further purpose of the lichen collection was to contribute information to a larger project focused on gaining a greater understanding of old growth forests, ultimately to develop conservation strategies for these forests.



Frosted rim-lichen
(Photo by T. McMullin)

Research

LICHENS IN OLD GROWTH FORESTS

OBJECTIVES

- To determine the lichen richness and uniqueness in coniferous old growth forests of southwestern Nova Scotia.

METHODS

- Fifty-one mature and unharvested coniferous forest stands were selected in southwestern Nova Scotia.
- A consistent plot design was established in each forest stand that avoided edge effects.
- The presence of all lichens growing on trees located within each plot was recorded.
- All tree species and snags were recorded.
- Each stand was aged using tree cores.

Bloody-heart lichen (Photo by T. McMullin)

RESULTS

Example of the large old Eastern hemlocks encountered at many of the study sites (Photo by T. McMullin)

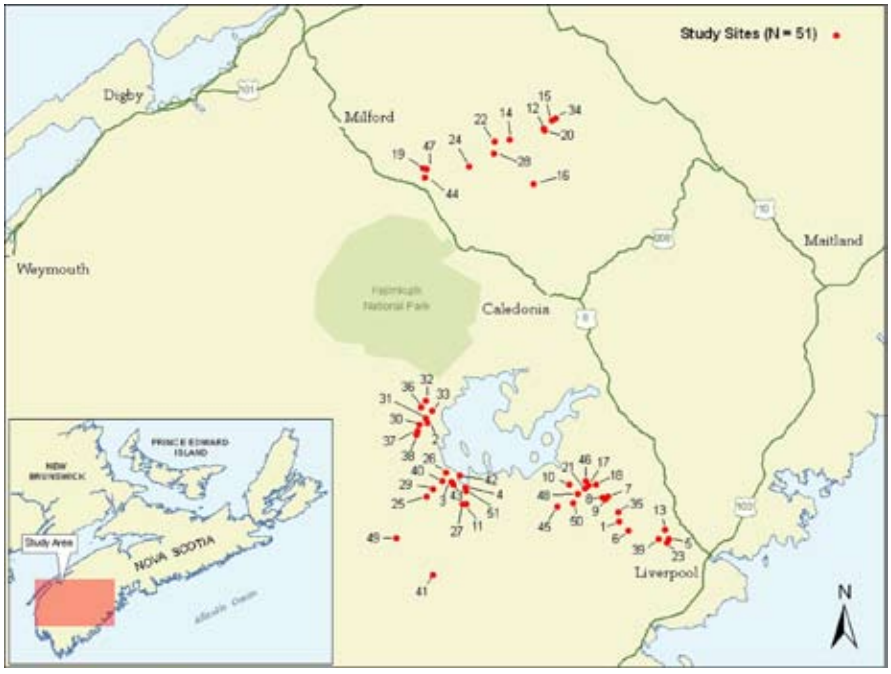
- The stand ages ranged from 52 to 292 years. One hundred and thirty-five lichen species and 60 genera were identified, of which 26 lichen species are new records for Nova Scotia and three may be new species to science. Using the Nova Scotia Department of Natural Resource's age thresholds, 12 of the 135 lichen species were found exclusively in 'early old-growth' and 16 were found only in 'advanced old growth' forest stands.
- This study revealed that the tree trunks of the mature, unharvested, conifer-dominated forests of southwestern Nova Scotia contain a diversity of lichens that include 8 genera and 21 species of cyanolichens. These taxa are at most risk from the effects of acid rain. In addition, the forests contain a range of large and uncommon green-algal lichens belonging to genera such as *Anzia, Cetrelia* and *Menegazzia*. These features emphasize the need to conserve and develop appropriate management strategies for the old growth forests in this part of Nova Scotia.
- Old growth forests are dynamic, complex, multi-faceted and difficult to characterise. It is clear, however, that they provide a unique and rich habitat for lichen species and other organisms.
- The development of a provincial checklist of lichen species in Nova Scotia would provide for easier reporting of new taxa and greater clarity about the changing status of particular species.

YEARS OF DATA

- 2005 and 2006

PARTNERS

- Dalhousie University
- Sustainable Forest Management Network
- Bowater Mersey Paper Company
- Mersey Tobeatic Research Institute



Location of study sites in southwestern Nova Scotia, Canada (Map by T. McMullin)

CONTACTS

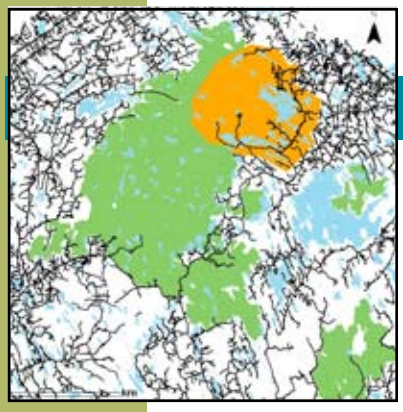
Troy McMullin and Peter Duinker
School for Resource and Environmental Studies
Dalhousie University
6100 University Ave. Suite 5010
Halifax NS B3H 3J5
Ph. (902) 494-1359
Fx. (902) 494-3728
troymcmullin@dal.ca
http://sres.management.dal.ca/

Rationale

Approximately 20,000 km of roads criss-cross the five counties of southwest Nova Scotia. Many of them are forest roads. This means that in much of the region critical habitat for species requiring large, undisturbed, roadless areas is scarce and fragmented. Despite recognition by landscape ecologists that roads penetrating forest ecosystems present a serious threat to habitats of many wildlife species and wilderness values, consequences of road building within the context of sustainable forest management are not well understood. Ecological impacts of roads can be hard to quantify. However, a growing body of research makes a compelling link between roads and ecological degradation. Understanding impacts of existing forestry roads and developing creative mitigation solutions provides opportunity for landowners, forest managers and protected areas planners to improve the status quo. Responsible road development and management of existing road networks are integral to sustainable forest management and complementary to an ecosystem-based approach to landscape level planning that is needed in Nova Scotia.

Research

ECOLOGICAL EFFECTS OF FOREST ROADS



Dense road networks (black) penetrate and isolate protected areas in southwestern Nova Scotia (Kejimkujik – orange, Provincial Wilderness Areas - green) (Map by C. Robinson)

OBJECTIVES

- To review analytical tools and common indicators for assessing ecological impacts of forest roads and field test a framework designed to verify human use and road presence effects.
- To critically assess and provide Nova Scotia Department of Natural Resources (NSDNR) partners with constructive feedback on their version of a road index tool designed to help integrate the influence of roads into an ecological landscape analysis process.
- To broaden knowledge of forest stakeholders on the importance of considering ecologically sensitive areas and areas important for connectivity in the planning and maintenance of forest roads.

METHODS

Bridges on old access roads eventually revert back to nature, like this one at Great Pine Lake (Photo by K. deGooyer)

- Common indicators and analytical tools used to quantify terrestrial and aquatic road impacts in forested ecosystems were compiled from a literature review. An assessment framework appropriate for this region was designed to catalogue effects in the field. A road index analysis was completed for southwest Nova Scotia.
- Field investigations were completed at three roaded sites on crown land with different management scenarios related to road presence and use (actively managed forest, forest not managed for decades, protected area). Written and photo observations of impact indicators were collected and georeferenced with a Global Positioning System (GPS). Results were compiled using a Geographic Information System (GIS) and compared to the road index analysis.
- Crown land-use managers and wilderness recreation groups were contacted for insight into the management challenges (maintenance, costs) and public use of forest roads at the study sites.

RESULTS

Roads fragment interior forest habitat (Photo by C. Robinson)

- Road presence and use affects all three forested areas investigated. Presence effects were primarily from fragmentation of interior forest habitat and roads that are irregularly maintained (clogged culverts, stream sedimentation). Use effects were related to resource development and recreational pressure in the forest ecosystem accessed by the road.
- In many cases the provincial digital road classification was overstated (*e.g.,* roads classified as "gravel" were suitable only for four wheel drive or all-terrain vehicle; many "trails" were overgrown). As the NSDNR road index tool relies primarily on road classification and road density information, digital information must be ground-truthed to ensure accurate analyses.
- The design of NSDNR's road indexing tool was generally consistent with coarse analytical approaches used elsewhere to measure landscape-level road influence. However, in addition to road features (density, class and distance of areas from roads) other tools included measures that indicate road use and ecological sensitivity to road effects (*e.g.,* proximity to wet areas and focal species habitat). These factors must be included in a thorough road impact analysis, within the context of landscape-scale, ecosystem-based, sustainable forest management.
- Regular maintenance and limited public access on roads necessary for management operations would mitigate some ecological impact. Decommissioning of redundant and unnecessary roads would help reduce road impact and maintenance costs and improve habitat for interior forest species sensitive to human interaction.

YEARS OF DATA

- Single year project

PARTNERS

- Dalhousie University
- Mersey Tobeatic Research Institute
- Natural Sciences and Engineering Research Council
- Nova Forest Alliance
- Nova Scotia Department of Natural Resources
- Parks Canada

CONTACTS

Clare Robinson and Peter Duinker
Dalhousie University
School for Resource and Environmental Studies
6100 University Ave., Suite 5010,
Halifax NS B3H 3J5
Ph. (902) 446-6603 and (902) 494-3632
Fx. (902) 494-3728
clare.robinson@dal.ca
peter.duinker@dal.ca
http://sres.management.dal.ca/

Old forest roads can provide easy vehicle access to otherwise remote ecosystems, like Sisketch Lake in the Tobeatic (Photo by C. Robinson)

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.

Vegetation type W20: Eastern hemlock forest near Medway Lake (Photo by P. Neily, NSDNR)

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

Vegetation type W13: Red pine forest located at Beaver Lake, Annapolis County (Photo by P. Neily, NSDNR)

- 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).
- Covertype 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.

RESULTS

A soil profile of Soil type 3: moist, moderately coarse textured soil commonly found in western NS (Photo by NSDNR)

- This project was initiated as a pilot from 2000-2003, and as a full scale provincial project from 2004 onward. To date 800 plots have been measured across the province, with about 225 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 will be produced in 2007. The final Provincial FEC is scheduled for completion in 2009.

YEARS OF DATA

- Field data collected since 2000
- Western Nova Scotia data mainly collected in 2004, 2005, and 2006

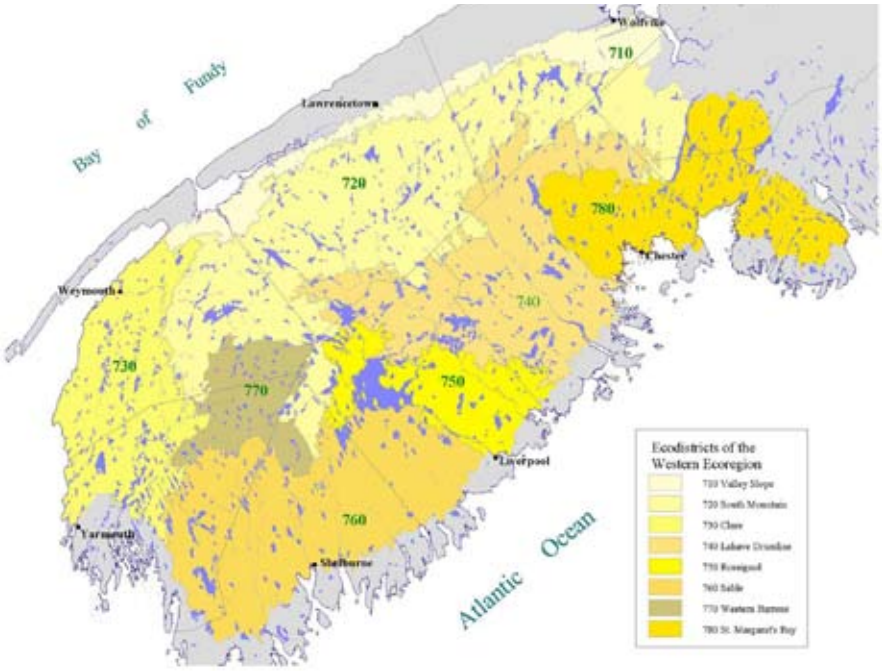
PARTNERS

- Nova Scotia Department of Natural Resources
- Nova Forest Alliance
- Bowater Mersey Paper Company
- Parks Canada
- Atlantic Canada Conservation Data Centre

Witch hazel in flower in Kejimkujik near Mountain Lake Portage (Photo by E. Quigley)

CONTACTS

Peter Neily, Kevin Keys, Bruce Stewart and Eugene Quigley
Nova Scotia Department of Natural Resources
PO Box 68
Truro, NS
B2N 5B8
Ph. (902) 893-5692
Fx. (902) 893-6102
pdneily@gov.ns.ca
kkeys@gov.ns.ca
bjstewar@gov.ns.ca
ejquigle@gov.ns.ca



Map of western NS showing the ecodistricts of the western ecoregion (from the provincial Ecological Land Classification) which is available on-line at the DNR Forestry Division web site (Map by NSDNR)

Rationale

The Pale-winged gray moth is native to Nova Scotia and distributed widely across eastern North America. Caterpillars of this species feed primarily on hemlock, but also eat alternate hosts in the understory at high densities. An outbreak of this insect has been occurring in the Kejimkujik area since 2002, causing widespread defoliation of Eastern hemlock trees and the death of the majority of understory hemlock in some mature hemlock stands. As there are no peer-reviewed, scientific articles on this insect, park managers and neighbouring woodlot owners did not possess monitoring tools to sample it nor ecological information to predict the impact of the outbreak on tree mortality and other ecosystem processes.

Research

ECOLOGY AND MANAGEMENT OF THE PALE-WINGED GRAY MOTH

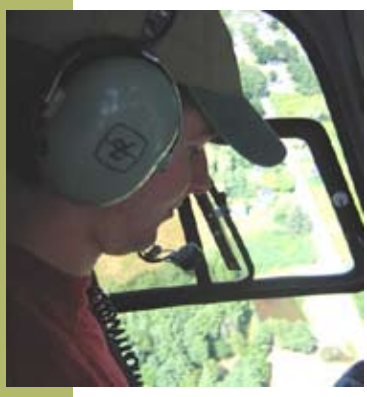
An adult Pale-winged gray moth (Photo by L. Pinault)

OBJECTIVES

- To determine defoliation patterns of the Pale-winged gray moth.
- To describe the daily patterns of adult behaviour.
- To develop sampling methods to monitor the different life stages of the Pale-winged gray moth and to relate insect densities to the percent of hemlock leaves that are eaten, in order to allow reliable prediction of tree damage in the future.

METHODS

- Feeding patterns within a tree were estimated from the ground using binoculars to compare defoliation of different foliage ages along a branch and between crown levels in a tree.
- Relative survival on different tree parts was determined by placing caterpillars in nylon mesh sleeve cages on different branch treatments.
- Adult behaviour was studied in the field during several evening observation sessions, allowing determination of the occurrence of mating and egg-laying.
- At many sites within and outside Kejimkujik: (i) foam oviposition substrates were placed on tree trunks to estimate relative egg densities, (ii) sticky traps were placed around the tree trunk to estimate first-instar caterpillar densities just after egg hatch, and (iii) beating sheets were used to sample older caterpillars on branches.
- Density estimates from the sampling procedures described above were correlated with subsequent levels of defoliation to produce predictive relationships between egg or caterpillar densities and subsequent defoliation.



Summer student R. Jameson observes hemlock defoliation from the Nova Scotia DNR helicopter (Photo by L. Pinault)

RESULTS

- Pale-winged gray caterpillars feed unevenly throughout a tree, defoliating the lower and middle crown more severely than the upper crown, and the current-year shoot more than the older ages of foliage, although all foliage ages are consumed.
- Survival of older caterpillars was lower in the sun than the full shade, which might explain, in part, why the lower and middle crowns are more heavily defoliated.
- Overall caterpillar survival was higher on a mixed diet of foliage ages than on the current-year shoot or older ages of foliage alone.
- Adult moths mate primarily between 2:00 – 4:00 am and lay eggs from 9:00 pm – 12:00 am. Flying, walking and resting behaviour was also studied.
- Egg densities in foam oviposition traps were not significantly correlated to defoliation, although they could be used to determine the presence or absence of the insect at a site. Densities of newly emerged caterpillars that were trapped on sticky tape were significantly related to defoliation and thus provide good predictions of future defoliation levels. Although caterpillar densities obtained using beating sheets were significantly related to defoliation of current-year shoots, they are not able to predict defoliation on older ages of foliage.

An older Pale-winged gray caterpillar (Photo by L. Pinault)

YEARS OF DATA

- 3rd year of a 3 year project

PARTNERS

- Parks Canada
- Nova Scotia Department of Natural Resources
- Canadian Forest Service
- Forest Protection Limited
- Natural Sciences and Engineering Research Council
- University of New Brunswick

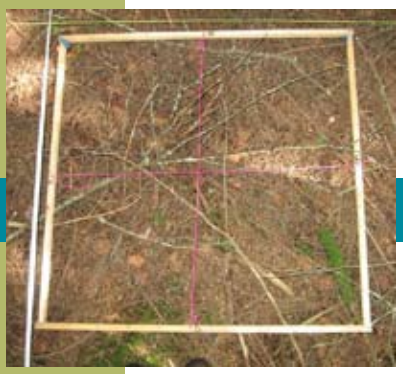
Graduate student L. Pinault estimates caterpillar densities on sticky tape at Mill Falls in Kejimkujik (Photo by L. Carrat)

CONTACTS

Lauren Pinault and Dan Quiring
Population Ecology Group
University of New Brunswick
28 Dineen Drive
Fredericton, NB E3B 6C2
Ph. (506) 452-6314 and (506) 453-4922
Fx. (506) 453-3538
p7tmb@unb.ca
quiring@unb.ca
www.unbf.ca/forestry/

Rationale

Mature hemlock forest in Nova Scotia exists only in small fragmented stands. In 2002, defoliation of hemlocks was detected in Kejimkujik and surrounding areas. It was determined that larvae of the native Pale-winged gray moth were the source of the defoliation. This study is intended to determine the impact hemlock defoliation has had upon understory plant species. This research will contribute to other studies regarding the moth's life history and its impact on trees. This native moth species has never before been observed to reach outbreak population levels or cause extensive defoliation and as such, the ecological consequences of the outbreak are unknown.



A 1x1 m quadrat in a site with low defoliation (Photo by S. Siblot)

Research

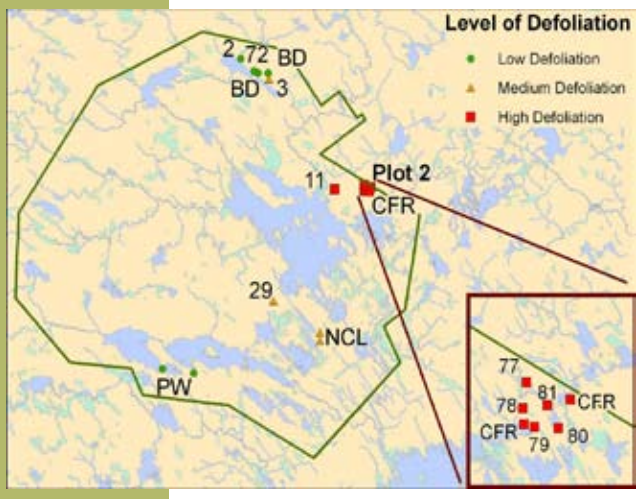
UNDERSTORY CHANGES IN HEMLOCK FORESTS

OBJECTIVES

- To examine changes in species composition and abundance of understory species within Eastern hemlock stands in Kejimkujik due to defoliation by the Pale-winged gray moth.
- To compare spatial variation of plants among stands with differing amounts of defoliation in 2006.
- To compare temporal variation in plant communities between sites sampled in 1997 and 2006.

METHODS

- Field work was conducted in July-August 2006 in Kejimkujik in stands dominated by Eastern hemlock.
- Vegetation and site characteristics were sampled within (i) 1 x 1 m quadrats in six 20 x 20 m plots, (ii) 12 10 x 10 m plots, and (iii) at 14 additional points within Forest Bird Plot 2.
- Eastern hemlock trees were randomly selected at each site and the amount of canopy defoliated (crown rating and percent), diameter at breast height (DBH), and percent defoliation of new growth on two randomly chosen branches was recorded.
- Multivariate statistics were used to analyze matrices of species.
- Regression analysis was used to determine relationships between species composition and environmental variables.
- Paired *t*-tests were used to temporally compare species abundance data between 1997 and 2006.



Map of Kejimkujik showing the location of sites sampled and level of defoliation at each site

RESULTS

Honours student Z. McKenna-Fuentes and graduate student M. Crowley assessing defoliation of Eastern hemlock trees in Plot 2 (Photo by C. Staicer)

- Defoliation of Eastern hemlock trees by the Pale-winged gray moth is increasing the amount of light reaching the forest floor. This increased light intensity is affecting understory plant communities.
- The highest amounts of Eastern hemlock defoliation occurred at Canning Field Road and in Forest Bird Plot 2. Medium defoliation occurred at Peskowesk and the lowest amount of defoliation occurred at Big Dam.
- In 2006, the mean number of tree seedlings was more abundant in sites with high defoliation (particularly shade intollerant seedlings).
- In Forest Bird Plot 2, in 2006, the number of tree seedlings was negatively related to the amount of Eastern hemlock defoliation and canopy density.
- Mean percent cover of bryophytes and trees was significantly higher in 2006 than 1997, while there was no significant difference in mean percent cover for shrubs and herbs.

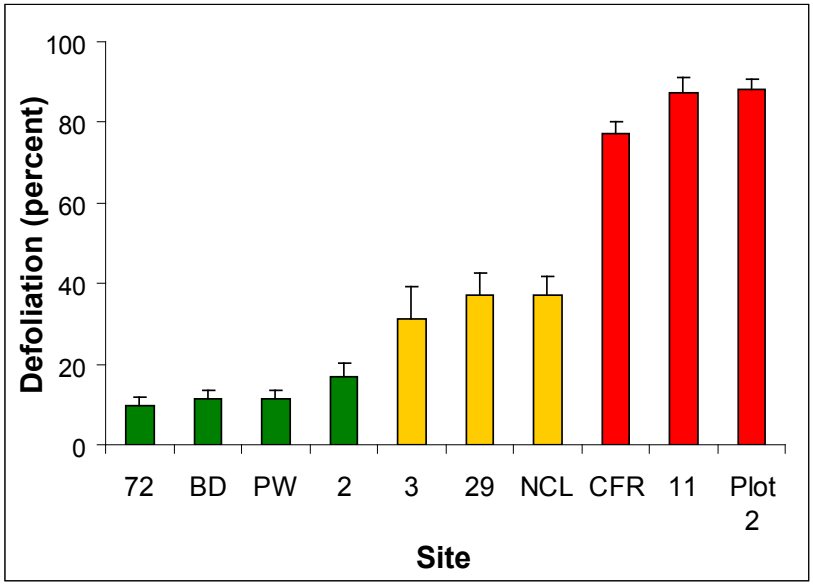
YEARS OF DATA

- Single year study

PARTNERS

- Dalhousie University
- Parks Canada
- Sarah Lawson Scholarship

Adult Pale-winged gray moth (Photo by NSDNR)



Percent of hemlock canopy defoliation at each study site: Big Dam (BD), Peskowesk (PW), North Cranberry (NCL), Canning (CFR)

CONTACTS

Zara McKenna-Fuentes and
Cindy Staicer
Biology Department
Dalhousie University
1355 Oxford St
Halifax, NS, B3H 4J1
Ph. (902) 494-3533
zmckenna@dal.ca
cindy.staicer@dal.ca

Rationale

Only small fragments of mature Eastern hemlock forest remain in Nova Scotia. Conservation of this rare forest type depends in part on understanding the ecology of hemlock forests, including how various ecosystem components interact with the trees. For example, some species of forest birds have a high affinity for hemlock forests, which provides unique structural characteristics for nesting and foraging. Also, many of the birds that inhabit hemlock forests eat insects that may be detrimental to the trees. In 2002, larvae of the native Pale-winged gray moth began to defoliate hemlocks near a long-term monitoring plot in hemlock forests of Kejimkujik. This outbreak provided an opportunity to study the response of forest birds to a natural disturbance, canopy defoliation. Monitoring data collected since 1996 was used to examine how bird populations have changed since the start of the outbreak. This research compliments studies undertaken to understand the life history of the moth and its effects on the trees.

Defoiliation of Eastern hemlock branch (Photo by C. McCarthy, Parks Canada)

Research

FOREST BIRD RESPONSE TO CANOPY DEFOLIATION

OBJECTIVES

- To determine how the abundance of individual forest bird species and foraging guilds have changed through time in areas of hemlock defoliation.
- To estimate the amount of hemlock defoliation in four areas of Kejimkujik.
- To relate changes in forest bird abundance to the amount of hemlock defoliation.

METHODS

- Forest birds were surveyed at hemlock sites in June 2005 and June 2006 using the standard techniques of point counts and spot-mapping.
- Point counts were conducted during two visits at 31 permanent monitoring sites in four areas of Kejimkujik: Big Dam, Indian Point, and at either end of Canning Field Road.
- The number of territories of each species were determined by spot-mapping for 10 visits at a 20-ha intensive monitoring plot near Canning Field Road.
- In July 2005, the height, diameter at breast height (dbh) and amount of defoliation of 20 randomly selected hemlock trees at each point count site were estimated.
- The 21 most abundant bird species and five foraging guilds were examined to determine whether there were changes in abundance since the Pale-winged gray outbreak began in heavily defoliated sites (Indian Point, Canning Field Road) as compared to less defoliated sites (Big Dam).
- A comparison of pre-outbreak (1997-2001) to post-outbreak (2003-2005) abundances for species or foraging guilds that were less abundant in 2005 in the more heavily defoliated sites was undertaken to determine whether they declined over time in the long-term intensive study plot.
- The contribution of tree height, dbh and amount of defoliation was examined to explain differences in the change in abundance of foraging guilds between sites.

C.Staicer surveying for birds (Photo by P.Hope, Parks Canada)

RESULTS

Black-throated green warbler (Photo by Parks Canada)

- As a group, the canopy foliage gleaners (*e.g.,* kinglets, vireos and wood-warblers) declined in the heavily defoliated sites but not in the less defoliated sites, suggesting canopy defoliation was a factor in their decline.
- In particular, five species of canopy foliage gleaners that are associated with mature coniferous forests declined: Blue-headed vireo, Bay-breasted warbler, Blackburnian warbler, Black-throated green warbler, and Yellow-rumped warbler.
- The Hairy woodpecker was the only species to significantly increase in abundance in the heavily defoliated sites.
- The granivores (*e.g.,* grosbeaks, finches and crossbills), declined in both the more heavily and the less heavily defoliated sites, suggesting their decline is likely due to factors other than canopy defoliation.
- Factors underlying declines in the heavily defoliated sites may include: (i) reduction in the quality of nesting habitat; and (ii) a decrease in food availability after the outbreak subsided.
- In the eastern United States, studies that assessed the impact of hemlock mortality caused by the hemlock woolly adelgid similarly found that bird species with an affinity for hemlock forest are negatively impacted by canopy defoliation.

YEARS OF DATA

- Ongoing project since 1997

PARTNERS

- Parks Canada
- Dalhousie University

Hairy woodpecker (Photo by M.Tarr)

CONTACTS

Cindy Staicer
Biology Department
Dalhousie University
1355 Oxford St
Halifax, NS, B3H 4J1
Ph. (902)494-3533
Fx. (902)494-3736
cindy.staicer@dal.ca
http://biology.dal.ca

Kyle Morrison
Biological Sciences
Simon Fraser University
Burnaby, BC V5A 1S6
Ph. (604)291-3988
kwmorris@sfu.ca

Rationale

Populations of many neotropical songbirds and several resident birds are declining throughout eastern North America. Of particular concern are declines in neotropical migrants that breed in mature forested landscapes. Increasing fragmentation and habitat alteration on breeding grounds is considered a major cause of these declines. Forested riparian areas may be especially valuable to breeding birds due to higher abundances and diversity of invertebrates, more diverse and complex vegetation and more favorable microclimates. These areas may also act as dispersal corridors for young and transient birds. Presently Nova Scotia's Wildlife Habitat and Watercourse Protection Regulations require that forested buffers no less than 20 m wide must be left on both sides of permanent watercourses.

Common yellow throated warbler (Photo by S.Leslie, Parks Canada)

Research

FOREST BIRDS AND RIPARIAN BUFFERS

OBJECTIVES

- To investigate the conservation value of riparian habitat and riparian buffers to breeding birds in the Acadian forest of Nova Scotia.
- To examine if riparian buffer width influences the abundance of species of conservation concern and to identify optimal buffer widths for these species.

METHODS

- Forty-five study sites, comprising three treatments (upland references, riparian references, and riparian buffers) were established in five main areas of mainland Nova Scotia.
- Breeding birds were surveyed in 2005 and 2006 using the line transect method.
- Vegetation and forest structure were measured at each site to quantify bird-habitat relationships.

Early morning at study site (Photo by G. Akerman)

RESULTS

- In general, riparian forests had higher basal areas (m^2/ha) of live trees and greater high canopy cover.
- Riparian buffers tended to have fewer birds of conservation concern than references with two species, Brown creeper and Ovenbird being completely absent from buffers. Buffers also tended to have higher numbers of ground nesting species and short distance migrants.
- Analysis is presently being done to assess the effects of riparian buffer width on bird communities.

Big RIver Run study site (Photo by A.Lavers, MTRI)

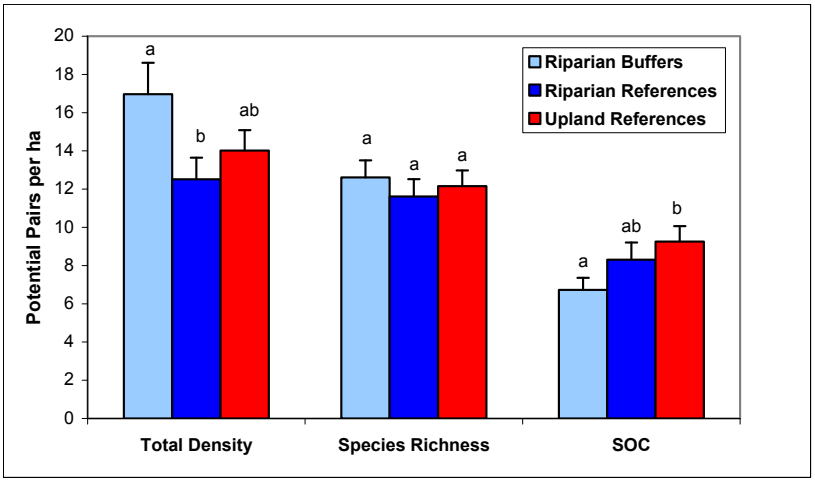
YEARS OF DATA

- Year 3 of a 3 year study

PARTNERS

- Mersey Tobeatic Research Institute
- Dalhousie University
- Nova Forest Alliance
- Bowater Mersey Paper Company
- J.D. Irving Ltd.
- StoraEnso
- NSDNR Habitat Conservation Fund
- Natural Sciences and Engineering Research Council
- Environment Canada Science Horizons
- Parks Canada

Field technician M. Crowley surveying birds (Photo by A. Lavers, MTRI)



Comparison of total pair density, species richness, and species of conservation concern among treatments based on greater than 30m truncation

CONTACTS

Gareth Akerman and Cindy Staicer
Biology Department
Dalhousie University
1355 Oxford St
Halifax NS, B3H 4J1
Ph. (902)494-3533
Fx. (902)494-3736
cindy.staicer@dal.ca
http://biology.dal.ca

Rationale

Males of most song bird species sing to attract mates and to defend territories. Population size estimates have traditionally counted every singing male as representing a breeding pair. This is potentially problematic because unpaired males may sing more often than paired males. The extent to which traditional population counts have over estimated population sizes is poorly known, but the conservation implications are clear. Trends calculated from song counts, like the Breeding Bird Survey, are used to determine conservation priorities at regional and national scales. Most wood warblers sing two functionally different types of songs: A and B. Previous studies have demonstrated that males of certain species sing A songs more often and at a higher and more consistent rate when they are unpaired. If the pairing status of song birds can be predicted based on singing behaviour, then field protocols can be developed to assess population sizes more accurately.

Yellow rumped warbler (Photo by P. Hope, Parks Canada)

Research

HONEST SIGNALING OF PAIRING STATUS IN WARBLERS

OBJECTIVES

- To test the hypothesis that singing behaviour accurately indicates pairing status.
- To test the accuracy of a preliminary sampling protocol in predicting pairing status from singing behaviour.

METHODS

- Between 10-30 song samples of eight wood warbler species were recorded in Kejimkujik during the 2006 breeding season.
- Shortly after the arrival of males to the breeding grounds, singing behaviour was recorded in 10 minute samples.
- The territory and pairing status of each sampled male was determined.
- During the latter part of the season, previously sampled males were sampled again and their pairing status was reassessed.
- The song rate for each sample was calculated for Type A and B songs separately. Pairwise Wilcoxon Signed-Ranks tests compared the song rates of the same male when unpaired and when later paired. Two sample Mann-Whitney *U*-tests were used to compare the song rates of paired males and of males who remained unpaired during the nesting period.

M. Jones recording data in the field (Photo by S. Siblot)

RESULTS

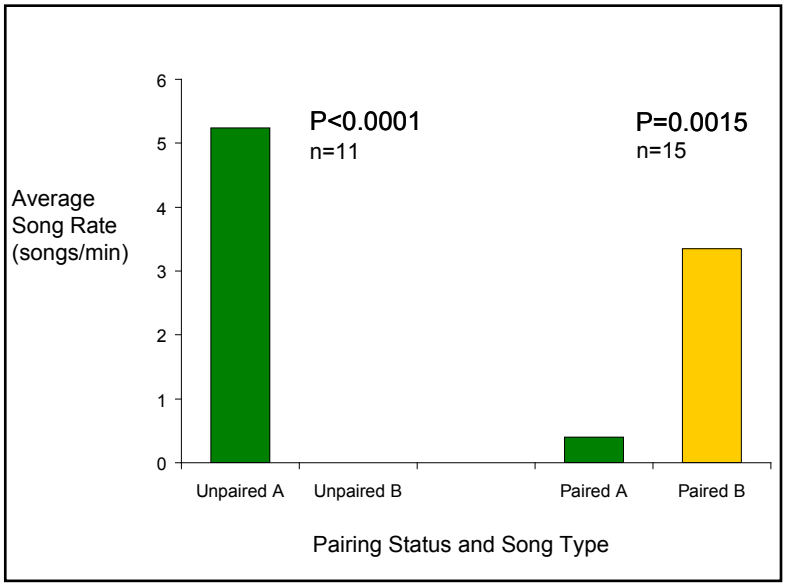
- Warblers tend to sing Type A songs at a higher rate when unpaired.
- Type A songs appear to function in mate attraction.
- Warblers switch from Type A songs to Type B songs as they become paired.
- The data collected in this study supports the hypothesis that the pairing status of male wood warblers can be predicted from their singing behaviour.
- Preliminary protocols have been established to predict the pairing status of males in the field from their singing behaviour alone.

YEARS OF DATA

- Single year study

PARTNERS

- Dalhousie University
- Parks Canada
- Mersey Tobeatic Research Institute



Average type A and type B song rates of paired (orange) and unpaired (green) Yellow-rumped warblers

CONTACTS

Matthew Jones and Cindy Staicer
Department of Biology
Dalhousie University
1355 Oxford St
Halifax, NS, B3H 4J1
Ph. (902) 542-9216 and (902) 494-3533
jonesmr@dal.ca
cindy.staicer@dal.ca

Rationale

During the breeding season songbirds are typically detected by their vocalizations and can be monitored using a method called point counts. The information gathered from these counts is used to calculate bird abundance and determine population trends. Point count duration is not standardized across monitoring programs and generally ranges from 3 to 20 minutes, with counts 10 minutes or fewer most common. Well known monitoring programs such as the Breeding Bird Survey and Breeding Bird Atlas conduct 3 and 5 minute point counts respectively. 10 minute long point counts have been conducted since 1996 for the Kejimkujik Forest Bird Monitoring and Research Program. In addition, singing rates generally decrease once the birds become paired and have young and this may affect point count detections later in the season. This study examines how point count duration and time of season affects the detection rates of bird species and individuals, and in turn the resultant bird population estimations.

Female Evening grosbeak (Photo by M. Crowley)

Research

SONGBIRD DETECTABILITY DURING POINT COUNTS

OBJECTIVES

- To determine the difference in detection rates of bird species and individuals in 3 and 10 minute point counts.
- To determine if point counts conducted earlier vs. later in the breeding season affect the number of species and individuals detected.
- To examine the suitability of detection probability models, which can improve population estimations by accounting for differences in detectability on the point count data collected over the past 11 years.

METHODS

Data sheet used during point counts (Photo by M. Crowley)

- The Kejimkujik Forest Bird Monitoring and Research Program has been conducting 10 minute point counts at 72 sites in the park twice per year since 1996.
- Detections during the first 3 minutes were distinguished from the remainder of the count to allow for comparison with the Breeding Bird Survey. For this study, this information was used to determine how detection rates vary due to count duration.
- Songs, calls and visual sightings were all recorded as detections.
- Data for 35 bird species was analysed from 1999-2006 to determine if detection rates of these species were higher in 10 minute counts, and to determine if detection rates varied between visit 1 and 2.
- Data from 2006 was analysed to determine if the total number of birds detected differed between 3 and 10 minute counts, and visit 1 and 2.
- Five models that estimate detection probabilities were examined to determine if the key assumptions of each model was met using the established methodology in Kejimkujik.

RESULTS

M. Crowley performing a bird survey in Kejimkujik (Photo by L. Pinault)

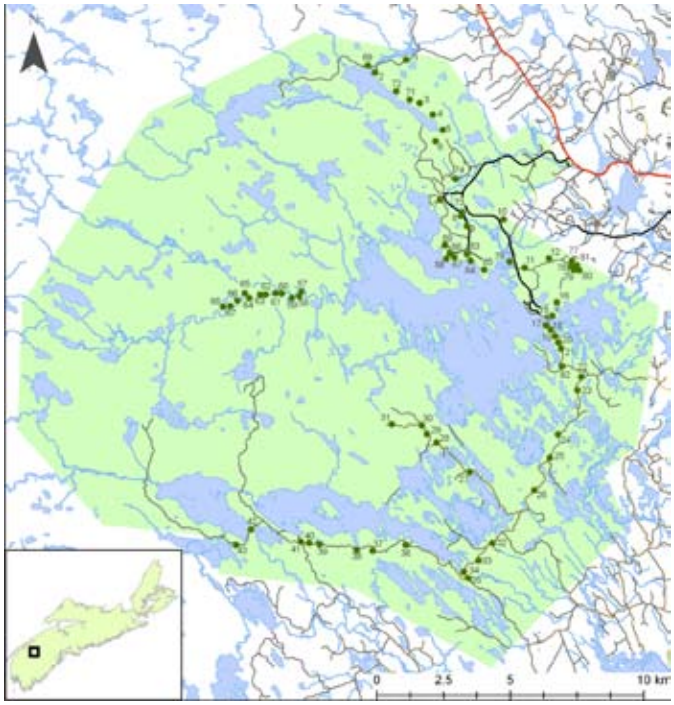
- The number of species and individuals detected significantly increases when point count duration is extended from 3 to 10 minutes. Longer point counts increased the number of species and individuals by 57% and 73% respectively. Species with low detection probabilities may be underestimated in 3 minute point counts.
- There was no difference in the total number of species detected in point counts over the course of the breeding season, although significant species specific seasonal trends in detectability were observed for 10 of the 35 species studied.
- Differences in detection rates among species appears to be the result of several factors such as singing rate, migration strategy, territory size, song frequency and song intensity.
- Since many factors can influence detection rates during point counts, the use of detection probability models would be beneficial to increase the reliability of population estimations.
- Repeated count, double sampling, distance sampling and removal modeling can be performed on all or part of the 11 year dataset. It would be beneficial to compare each of these techniques to determine whether similar estimations of abundance are produced.

YEARS OF DATA

- Single year research project associated with Year 11 of an ongoing monitoring program

PARTNERS

- Dalhousie University
- Parks Canada



Location of the point count sites in Kejimkujik

CONTACTS

Megan Crowley and Cindy Staicer
Biology Department
Dalhousie University
1355 Oxford St.,
Halifax, NS, B3H 4J1
Ph. (902) 494-3533
Megan.Crowley@dal.ca
Cindy.Staicer@dal.ca

Photos from top to bottom:
• Common loon 'Penguin dance' (Photo by G. Corbett, Parks Canada)
• Mountain Lake (Photo by A. Lavers)
• Exploring a beach on Grand Lake (Photo by B. Pentz)

FRESHWATER

Rationale

The Annapolis River Guardians volunteer monitoring program began collecting water quality data in the Annapolis River watershed in 1992. The Clean Annapolis River Project (CARP) initiated the program as a public awareness project, and has had numerous volunteer sample collectors over the years. It is one of the longest running and most extensive volunteer based water quality 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 3,500 water samples being collected and analyzed.

H. Grittith and P. Grittith of Kingston practice a dissolved oxygen titration at the annual training season for volunteers (Photo by D. Sullivan, CARP)

Monitoring

ANNAPOLIS RIVER GUARDIANS

OBJECTIVES

- To establish and support a regular observation system for water quality that provides an early warning of environmental problems in the Annapolis River.
- 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

T. Campbell collects a water sample from the bridge in Middleton (Photo by A. Sharpe, CARP)

- Volunteers at eight locations along the Annapolis River collected water samples every two weeks from spring through autumn.
- Information collected included the following: weather conditions, air and water temperature, dissolved oxygen content and fecal bacteria (*E. coli*) densities.

RESULTS

- Summer water temperatures in the Annapolis River frequently exceed 20 °C, which can cause stress to cold-water fish such as trout.
- In 2006, dissolved oxygen levels along the Annapolis River are satisfactory, with the exception of the lower tidal portion of the river.
- *E.coli* bacteria densities have been found to be highly variable in the Annapolis River. Densities observed in 2006 were significantly higher than those seen in 2004 and 2005.

YEARS OF DATA

- Ongoing project since 1992

PARTNERS

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

Signs at each of the water sample locations display the most recent water quality results (Photo by A. Sharpe, CARP)

CONTACTS

Andy Sharpe
Clean Annapolis River Project
151 Victoria Street
PO Box 395
Annapolis Royal, NS
Ph. (902) 532-7533
Fx. (902) 532-3038
andysharpe@annapolisriver.ca
www.annapolisriver.ca

Rationale

Long term fluctuations in stream flow can influence water quality, aquatic plants and animals and may be caused by deforestation, land use, ground water withdrawal and climate change (*e.g.* floods and droughts). There is a need to assess and understand hydrological measures as indicators of ecological condition and environmental change in aquatic ecosystems. Environment Canada maintains hydrometric stations and automated gauges throughout Canada that collect hydrological data (*e.g.* water level, flow, discharge) as part of the Water Survey of Canada program. The intent of this project is to examine trends in existing stream flow data from a hydrometric station on the Mersey River at Kejimkujik. Additionally, this project aims to identify the most sensitive hydrological measures for monitoring and reporting on the health of aquatic ecosystems in national parks.

Hydrometric sampling site on Mersey River, Kejimkujik (Photo by D. Ure, Parks Canada)

Monitoring

STREAM FLOW MONITORING

OBJECTIVES

- To identify the most sensitive measures for long-term monitoring of stream flow.
- To detect long-term trends in hydrology of the Mersey River (*i.e.*, stream flow, flashiness, droughts, floods).
- To understand how stream flow responds to natural and anthropogenic change.
- To provide recommendations for long-term monitoring and data analysis to detect trends in stream flow.

METHODS

- Existing stream flow data from the hydrometric station at Mill Falls on the Mersey River in Kejimkujik were acquired for analysis.
- Several measures were identified and used to examine data for trends including: (i) frequency and magnitude of floods; (ii) frequency and duration of low water events; (iii) variation in stream flow and flashiness (unit hydrograph analysis); (iv) ratio of total annual precipitation to total flow; and (v) rate of decline of flow after an event (base flow recession).
- Trends in stream flow in the Mersey River over the past 35 years were analysed (*i.e.*, changes in flooding and drought regime, variation in stream flow, flashiness, water retention).
- The most sensitive and meaningful measures for monitoring stream flow were identified.
- Recommendations were provided for long-term monitoring and data analysis to detect trends in stream flow.

Stream eddy, Tobeatic (Photo by A. Lavers, MTRI)

RESULTS

- Analysis of average flow per month in the Mersey River from 1968-2005 shows a slight trend towards lower average daily flows for most months in recent years.
- Minimum average flow for low flow periods (1, 3, 7, 30, 90 days intervals) has decreased in recent years.
- Maximum average flow for high flow periods (same intervals as above) does not show evident trends over time.
- Analysis of the remaining hydrological measures is currently in progress.

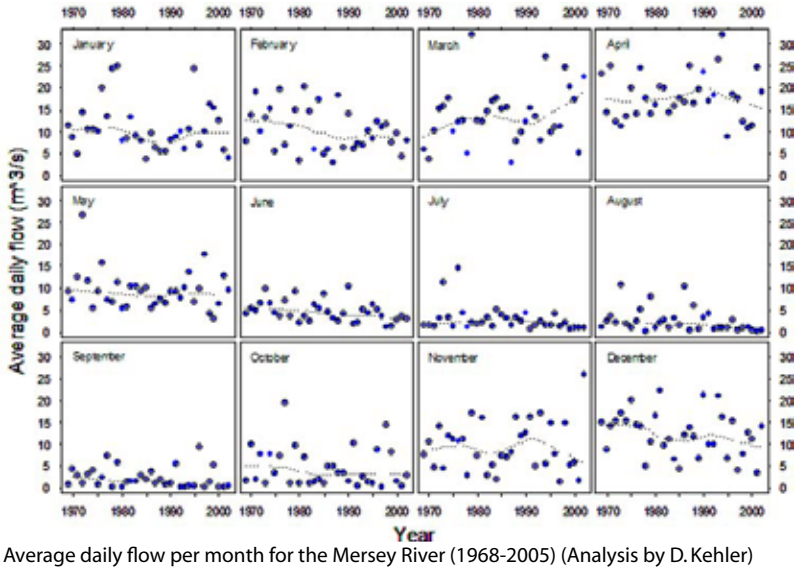
YEARS OF DATA

- Ongoing project: Daily stream flow data for the Mersey River has been collected by Environment Canada from 1968-present.

PARTNERS

- Environment Canada
- Parks Canada
- Dalhousie University

Sweeney Brook, Kejimkujik (Photo by D. Ure, Parks Canada)



Average daily flow per month for the Mersey River (1968-2005) (Analysis by D. Kehler)

Stream flow sampling cables (Photo by D. Ure, Parks Canada)

CONTACTS

Darien Ure
Kejimkujik
PO Box 236, Maitland Bridge
NS B0T 1B0
Ph. (902) 682-4003
Fx. (902) 682-3367
darien.ure@pc.gc.ca

David Hansen
Department of Civil Engineering
Dalhousie University
Sexton Campus
1360 Barrington St.
Halifax, NS B3J 1Z1
Ph. (902) 494-3115
Fx. (902) 494-3108
david.hansen@dal.ca

Rationale

The Common loon is a highly visible water bird inhabiting many of the lakes within the Southwest Nova Biosphere. It is an icon of the wilderness, captivating the public with its beauty and haunting call. A study by the Canadian Wildlife Service raised concerns about the health of loons when it revealed 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 the national park in 1996. In 2006, the program was expanded throughout the Mersey watershed where trained volunteers observe and record loon activity and breeding success on their assigned lake throughout the summer using a national protocol developed by Bird Studies Canada.

Monitoring

THE KEJIMKUJIK-MERSEY LOONWATCH PROGRAM

Common Loon (Photo by G. Corbett, Parks Canada)

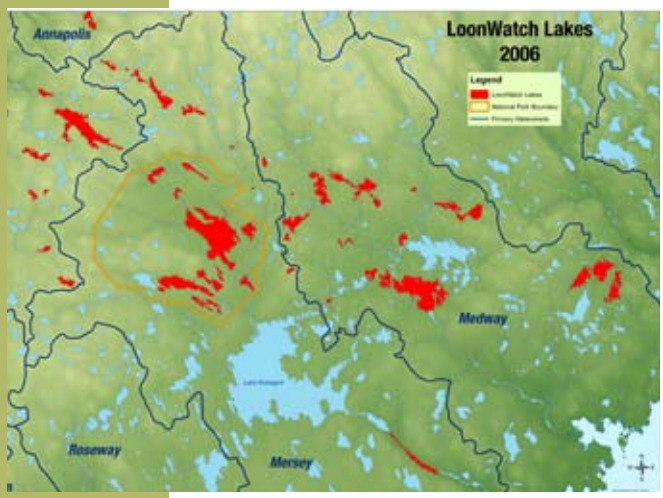
OBJECTIVES

- To observe Common loon abundance and breeding success on 16 lakes within Kejimkujik and at 25 lakes in 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 15 lakes being observed by LoonWatchers.

METHODS

Inside Kejimkujik:

- LoonWatch involved trained volunteers in a coordinated effort to simultaneously survey study lakes within a three hour observation period on two days in June and August.
- Data gathered from intensive LoonWatch days was combined with public observations and repeated surveys by Park staff.



LoonWatch lakes in 2006 are indicated in red (Map by S. O'Grady, Parks Canada

Outside Kejimkujik:

- Lakeside dwellers and cottagers with an interest in loons were recruited and trained 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, temperature, conductivity, dissolved oxygen and pH at one meter intervals.
- Volunteer data were collected, compiled and shared with Bird Studies Canada

RESULTS

- 2006 was a poor year for common loon nesting success due to flood conditions at nesting time.
- More than 80 volunteers participated in the LoonWatch Program observing loon activity and breeding success.

Volunteers observing loons in Kejimkujik (Photo by Parks Canada)

Inside Kejimkujik:

- Only two loon chicks fledged on the 16 lakes within the national park (Cobrielle and Big Dam East Lakes).

Outside Kejimkujik:

- Only five loon chicks were recorded (Fisher Lake, Charlotte Lake, Path Lake, Robertsons Lake and between dams three and four on the Mersey River near Milton).
- Loon activity and breeding success was observed on 40 lakes exceeding the project target of 25 lakes.
- The pH of surface water for 17 lakes varied from 4.4 to 6.9.
- Most of the 14 lakes surveyed were darkly coloured with Secchi disk measurements ranging from 0.4 to 2.5 m.
- Irving, Charlotte, Liverpool Head, Minard, Sand, Sandy Bottom and Tupper lakes exhibited some evidence of thermal stratification with August temperatures below 15 °C at a 6 m depth.

YEARS OF DATA

- Kejimkujik LoonWatch Program: Ongoing project since 1996
- Mersey LoonWatch Program: Year 1 of an ongoing project

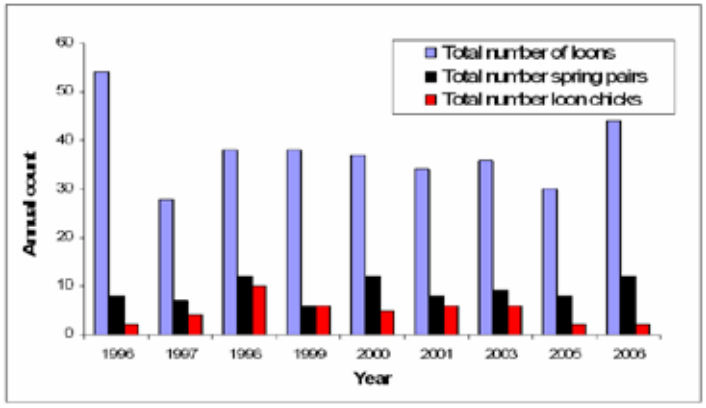
PARTNERS

- Parks Canada
- Mersey Tobeatic Research Institute
- Dedicated volunteers and community members
- Nova Scotia Go For Green Fund
- Shell Environmental Fund

CONTACTS

Chris McCarthy
Kejimkujik
PO Box 236,
Maitland Bridge, NS B0T 1B0
Ph. 902-682-4100
Fx. 902-682-3367
chris.mccarthy@pc.gc.ca

Amanda Lavers
Mersey Tobeatic Research Institute
9 Mount Merritt Road
PO Box 215
Kempt, NS B0T 1B0
Ph. (902) 682-2371
Fx. (902) 682-2760
info@merseytobeatic.ca
www.merseytobeatic.ca



Number of Common Loon adults and chicks recorded by the Kejimkujik LoonWatch Program (no survey in 2002 and no August survey in 2004)

Rationale

Mercury is an important environmental contaminant that can be harmful to fish, wildlife and humans. Mercury can be found in both air and precipitation and is capable of being transported globally in the atmosphere. Natural (volcanoes, forest fires) and manmade emissions (fuel combustion, incineration) and subsequent atmospheric deposition of mercury have been recognized as important sources of mercury in aquatic ecosystems. In response to concerns regarding mercury in the environment, the Canadian Atmospheric Mercury Measurement Network (CAMNet) was established in 1996 by Environment Canada (EC). EC initiated CAMNet to provide a better understanding of levels and trends in atmospheric mercury and air-surface exchange processes in the environment.

Environment Canada's air chemistry site at Kejimkujik (Photo by Environment Canada)

Monitoring

MERCURY IN AIR AND PRECIPITATION

OBJECTIVES

- To measure levels of mercury in air and precipitation.
- To examine the changes in mercury levels over time.

METHODS

- Measurements of atmospheric mercury are made every five minutes using a Tekran™ Mercury Vapour Analyser and have been measured since 1996.
- Precipitation is collected weekly and sent to a lab where the levels of mercury are measured. Measurements of mercury in precipitation have been measured since 1996.

Mercury in precipitation collector (Photo by Environment Canada)

RESULTS

Clouds at Brookfield Mines (Photo by J. McKinnon)

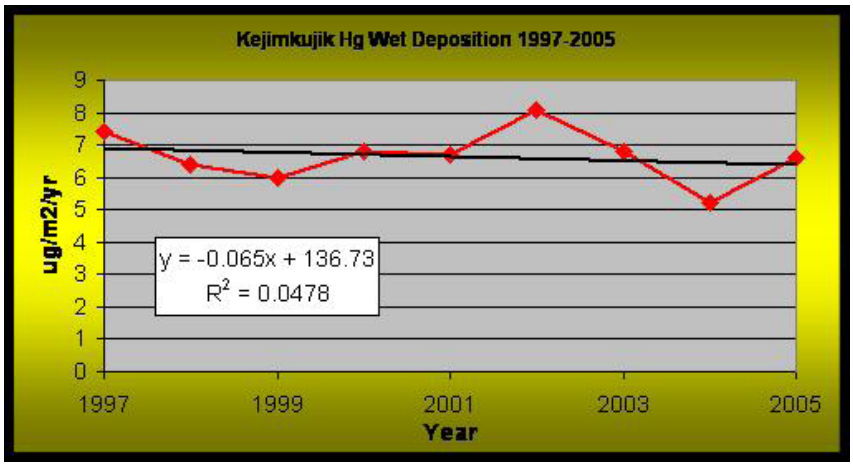
- Despite reductions in mercury use and regulations on waste disposal, mercury in the environment continues to be an issue.
- Atmospheric mercury at Kejimkujik has shown no significant annual trend in terms of increasing or decreasing concentrations since 1996.
- Mercury in precipitation has not shown any significant change from year-to-year at Kejimkujik since 1996. Deposition values for mercury in precipitation at Kejimkujik are similar to values found at other sites in northeastern United States.
- More info on mercury can be found at http://www.ec.gc.ca/MERCURY/EN/bf.cfm
- More info on CAMNet can be found at http://www.msc.ec.gc.ca/arqp/camnet_e.cfm
- More info on mercury in precipitation can be found at http://nadp.sws.uiuc.edu/mdn/

YEARS OF DATA

- Ongoing project since 1996

PARTNERS

- Environment Canada
- Parks Canada



Mercury deposition in Kejimkujik

CONTACTS

Robert Tordon
Environment Canada
45 Alderney Drive,
Dartmouth NS
B2Y 2N6
Ph. (902) 426-4780
Fx. (902) 426-9158
rob.tordon@ec.gc.ca

Rationale

Most freshwater lakes in Nova Scotia are small, shallow and are infilling with sediment. Some lakes, however, are deep enough for their waters to stratify and develop pockets of cold water protected by a layer of water where there is a sharp temperature change called a thermocline. Lakes with thermoclines are important because they provide Brook trout with cold water in the summer (p. 86). There is some evidence, however, that lakes in the Mersey watershed may be losing their thermal structure (p. 84). A model of thermal sensitivity to regional climate change for stratified lakes in southwestern Nova Scotia is required to develop appropriate management strategies for activities such as shoreline development and forest harvesting. The Upper Mersey watershed is well suited for long term monitoring because it is relatively remote and therefore many of the lakes are directly linked with their catchment area and regional climate.

Rain on Mountain Lake (Photo by A. Lavers, MTRI)

Monitoring

LAKE THERMAL SENSITIVITY

OBJECTIVES

- To monitor lake temperature at 2 m depth intervals.
- To understand how both short and long term climate change will affect the thermal structure of two study lakes.
- To determine how morphometric variability influences the impact of both short term and long term climate change.

METHODS

- Each lake was surveyed by sonar and sounder to describe water depth and lake bottom sediment distribution.
- Water quality data were collected to determine pH, temperature, conductivity and dissolved oxygen.
- A suite of datalogged thermistors was installed in each lake at its maximum depth and in the tree canopy on shore to begin monitoring thermal response.
- Local meteorological data were collected from nearest weather stations.
- Datalogged thermistors were retrieved and data downloaded biannually.

B. Lennox and I. Spooner pulling thermistors out of Menchan Lake (Photo by A. Lavers, MTRI)

RESULTS

P. Martel and K. Rowter downloading thermistor data in 2006 (Photo by A. Lavers, MTRI)

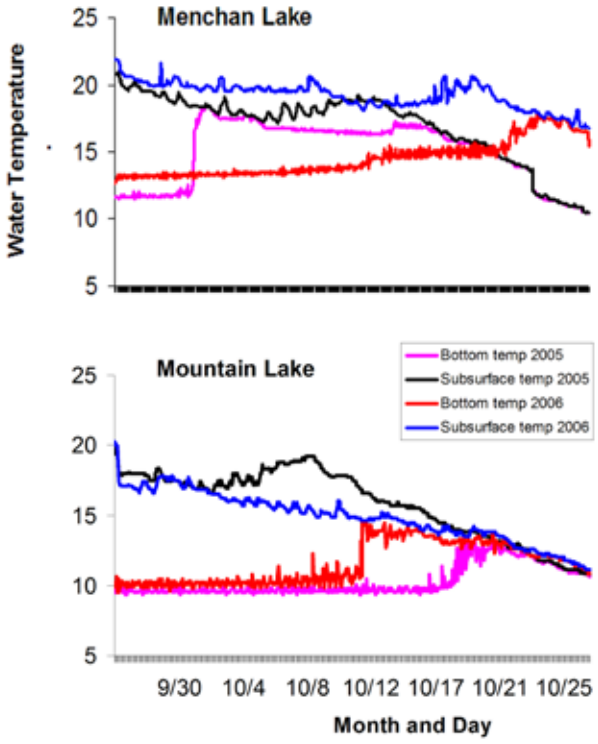
- Menchan and Mountain lakes react uniquely and strongly to short duration climate events.
- Data from 2005 indicate that Menchan Lake had rapid temperature changes at depth that were most likely in response to wind turbulence associated with low pressure systems. Of particular note is the gradual weakening of stratification that developed in September and the very rapid increases in deep water temperatures in mid and late September.
- In 2005, Menchan Lake had become completely mixed by Sept 26 with a temperature of about 17˚C indicating a complete loss of cold water habitat. During the same time period, however, Mountain Lake experienced little change. Lake morphometry may strongly influence the efficiency of storm related heat transfer.
- Data from Mountain Lake indicate that lake stratification is strongly maintained throughout the summer months with little change in profundal water temperatures. Turnover in 2006 occured almost a month earlier at Mountain Lake than at Menchan Lake.
- 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.

YEARS OF DATA

- Ongoing Project since 2005

PARTNERS

- Mersey Tobeatic Research Institute
- Acadia University
- Atlantic Centre for Global Change and Ecosystems Research
- Parks Canada



Thermistor data for Menchan and Mountain Lakes 2005 and 2006

CONTACTS

Ian Spooner
Geology Department
Acadia University
Wolfville, Nova Scotia
Ph. 902-585-1312
Fx. 902.585-1816
ian.spooner@acadiau.ca
http://ace.acadiau.ca

Amanda Lavers
Mersey Tobeatic Research Institute
9 Mount Merritt Road
PO Box 215
Kempt, NS
Ph. 902-682-2371
Fx. 902-682-2760
info@merseytobeatic.ca
www.merseytobeatic.ca

Rationale

Cold water fish species such as Brook trout are limited by the presence of summer refugia that have cold water and adequate dissolved oxygen. The extent of well-oxygenated, cold water refugia present in deep stratified lakes in Nova Scotia is not well known. Although considerable data have been collected over the last several decades as part of the Lake Survey Program carried out by the Nova Scotia Department of Fisheries and Aquaculture, it has not been adequately analyzed to determine how many and which of the approximately 1,600 lakes surveyed contain cold water habitat suitable for Brook trout. Recent studies of stratified lakes in southwestern Nova Scotia revealed that, over the past 20 years, many lakes have experienced a decrease in suitable cold water habitat.

Mike Brylinsky collecting water samples in Kejimkujik Lake (Photo by A. Lavers, MTRI)

Sunset over McGowan Lake (Photo by J. McNeil)

Research

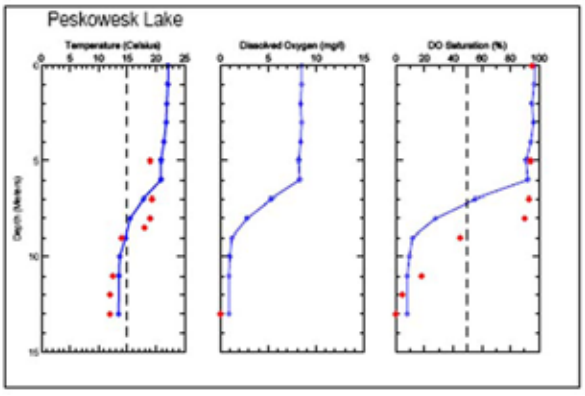
COLD WATER LAKE HABITAT

OBJECTIVES

- To survey lakes within the upper Mersey and Medway watersheds to determine the current level of existing cold-water lake habitat.
- To determine if there has been any change over time in the extent of cold-water habitat present in these lakes.

METHODS

- Six lakes were identified that had (i) a maximum depth greater than 6 m to ensure sufficient hypolimnetic volume to serve as cold-water habitat and (ii) historical survey data collected during either July or August when water column stratification is strongest and hypolimnion dissolved oxygen concentrations are the lowest.
- Secchi disk depth, chlorophyll *a* concentration, colour, total phosphorous and dissolved inorganic nitrogen concentration were collected from each study lake at the deepest part of the lake.
- Depth profiles of specific conductivity, temperature, dissolved oxygen concentration and percent dissolved oxygen saturation were collected.



Temperature, dissolved oxygen and percent dissolved oxygen profiles for Peskowesk Lake collected on 17 August 2006 (blue) and 1 September 1971 (red)

RESULTS

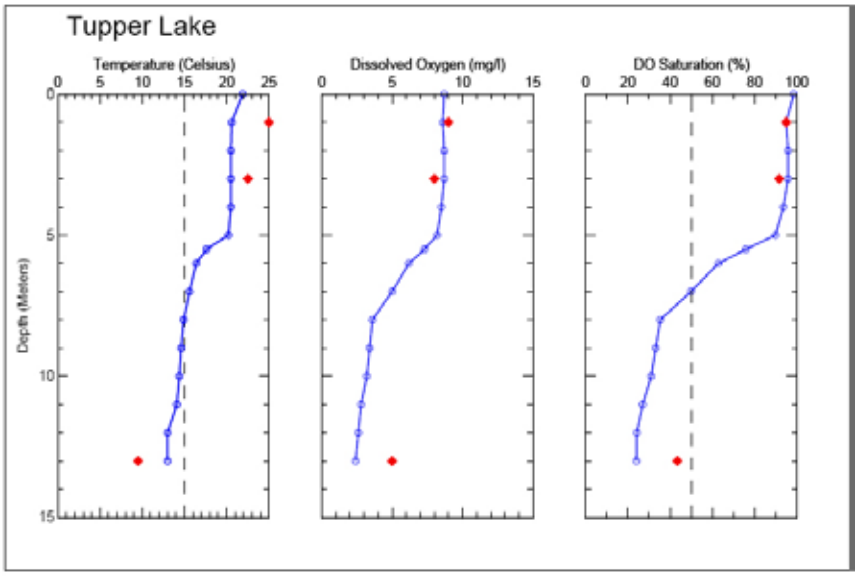
- All of the lakes exhibited thermal stratification but the degree of stratification was not very strong. In most cases the thermocline extended over several meters and its separation from the hypolimnion was poorly defined.
- The spring of 2006 was not likely a typical year and results were quite different in 2006 from the 2005 survey. Unusually warm air temperatures and windy spring weather tends to prolong the time over which the thermocline develops leading to a warmer and less well-oxygenated hypolimnion which occurs deeper in the water column.
- Of the six lakes surveyed this year, five lacked cold-water habitat during August that would be suitable for salmonids, and the remaining lake only contained suitable cold-water habitat within a small area of the thermocline.

YEARS OF DATA

- Molega Lake: August 1982 and August 2006
- Little Ponhook Lake: May 2002 and August 2006
- McGowan Lake: July 1982 and August 2006
- Tupper Lake: July 1982 and August 2006
- First Christopher: August 1982 and August 2006
- Peskowesk Lake: September 1971 and August 2006

PARTNERS

- Acadia Centre for Estuarine Research, Acadia University
- Mersey Tobeatic Research Institute
- Nova Scotia Department of Fisheries and Aquaculture
- Parks Canada



Temperature, dissolved oxygen and percent dissolved oxygen profiles for Tupper Lake collected on 16 August 2006 (blue) and 15 July 1982 (red)

CONTACTS

Mike Brylinsky
Acadia Centre for Estuarine Research
Acadia University
Wolfville, NS B4P 2R6
Ph. (902) 585-1509
Fx. (902) 585-1054
mike.brylinsky@acadiau.ca

Rationale

Brook trout are important indicators of aquatic health because they require cool, clean and well-oxygenated water. They may, however, need to travel across political boundaries to meet these needs. Mark and recapture studies in Kejimkujik over the past two decades have shown that trout move in and out of the park and appear to make seasonal migrations. This radio telemetry study can help identify summer thermal refuges and fall spawning areas both inside and outside Kejimkujik for the long term management of Brook trout in the watershed and help inform the development of a monitoring program for the watershed.

Trout at Kejimkujik (Photo by Parks Canada)

Research

BROOK TROUT MIGRATION

OBJECTIVES

- To identify Brook trout feeding areas, summer refugia, spawning areas and overwintering sites in the Upper Mersey watershed.
- To assess Brook trout movement and migration patterns using marked trout and radio-tagged trout.
- To measure depth profile, substrate, flow, temperature, pH, nitrogen, dissolved oxygen, calcium, phosphorous, conductivity of feeding areas, summer refugia, spawning areas and overwintering sites, using standardized provincial classification for fish habitat.
- To identify the presence of site-specific stressors on identified Brook trout feeding areas, summer refugia, spawning areas and overwintering sites (*e.g.,* roads, dams, acidity, pollutants, sedimentation, riparian coverage, water temperature, land use).
- To provide recommendations for the conservation of important Brook trout habitat throughout the Upper Mersey watershed.

Brook trout (Photo by Parks Canada)

METHODS

- Brook trout were captured in nets and by angling when water conditions were acceptable. Each fish was measured, weighed and examined externally for general health, condition, presence of external parasites and injuries.
- Scales were collected for aging and each fish was marked with a serial numbered tag.
- Trout that were age 4 or 5 and weighed over 275 grams were considered for radio transmitters which weighed 7.7 grams (to keep transmitter at less than 3% of body weight).
- Radio-tagged trout were actively tracked by truck, foot, canoe and aircraft. Monitoring of all tags was done as often as possible and often daily during the ice free season and once per month during the ice cover season.

METHODS (Continued)

- Once radio-tagged trout were located, GPS position, date, time and habitat type (pool, riffle, run, etc) were recorded.
- M. Townsend from AGRG calculated distances travelled between known locations using ArcGIS.

RESULTS

- Thirteen trout in the Mersey River watershed were radio tagged (6 in May 2006, 2 in November 2005, 5 in October 2006).
- Tracking of these fish indicates that Brook trout feed actively in the rivers and larger brooks of the watershed in May and June.
- In the summer months, some move to Kejimkujik Lake to deeper, cooler water where there is sufficient oxygen. Some trout spend the summer in small thermal refuges in the Mersey river or other smaller lakes where cold groundwater provides suitable conditions throughout the summer.
- In the fall when river water cools, some trout re-enter the river to spawn and some spawn in the lake. After spawning some trout move back into the lake to overwinter while some winter in the river.
- Brook trout depend on the availability of thermal refuges to survive the summer months when river water temperatures soar and oxygen levels are depleted.
- The average known distance traveled by radio-tagged trout between summer and fall was 43 ± 19 km (n=11) with a maximum of 72 km and minimum of 19 km.

Reg Baird holding a Brook trout (Photo by P. Hope, Parks Canada)

YEARS OF DATA

- Year 2 of an ongoing project

PARTNERS

- Parks Canada
- Mersey Tobeatic Research Institute
- Trout Nova Scotia
- Inland Fisheries Division of Nova Scotia Fisheries and Aquaculture
- Applied Geomatics Research Group

CONTACTS

Gary Corbett and Chris Mc Carthy
Kejimkujik
Maitland Bridge, N.S.
Ph. 902-682-4100
Fx. 902-682-3367
gary.corbett@ns.sympatico.ca
chris.mccarthy@pc.gc.ca

Reg Baird
Trout Nova Scotia
Clementsvale, N.S.
Ph. 902-467-3126
Reg.Barb@ns.sympatico.ca
www.troutnovascotia.ca

G. Corbett and R. Baird searching for radio-tagged Brook trout (Photo by A. Lavers, MTRI)

Rationale

The land surrounding Kejimkujik in southwestern Nova Scotia is used primarily by the forest industry and because of geological conditions specific to the area it is sensitive to the impacts of acid precipitation. This area also tends to have warmer water conditions than the rest of the province. The spawning success of salmonids in many southwestern Nova Scotian rivers has been reduced by the combined impacts of these factors. Past studies have shown that terrestrial invertebrates constitute a significant portion of the diet of drift feeding fish, especially during the summer months. Despite the importance of terrestrial invertebrates to fish diet there has been very little research conducted in the maritimes to examine how logging activities affect riparian terrestrial invertebrate communities. Understanding these interactions is important for proper management of fragile riparian areas and the conservation of Brook trout populations.

Riparian vegetation and drift nets at Cole Brook (Photo by C. Macdonald)

Research

RIPARIAN VEGETATION AND INVERTEBRATE RELATIONSHIPS

OBJECTIVES

- To determine the magnitude of terrestrial subsidies to nine streams in and near Kejimkujik in central southwestern Nova Scotia.
- To determine how riparian vegetation affects terrestrial and aquatic invertebrate communities in and around streams.
- To provide baseline data on invertebrate communities and riparian vegetation for future research initiatives.

METHODS

- Nine streams were selected as study sites from the Mersey and Medway watersheds, three located in Kejimkujik, and six near the northern and eastern borders of the park. Logging activities of varying intensities occurred on the banks of three of the streams.
- Terrestrial and aquatic invertebrates were collected from June to August 2005, using three methods: (i) Pan traps (5/stream) were deployed once a month for a 24 hour period to collect terrestrial invertebrates falling into the streams; (ii) Drift nets (2/stream) were also deployed once a month for 24 hour to assess the terrestrial and aquatic composition of the drift; (iii) Emergence traps (4/stream) were deployed continuously along the reach of six of the streams and invertebrates collected bimonthly.
- Invertebrates were stored in a 70% ethanol solution and sorted to order, counted and weighed in the lab. Measurements of canopy cover, substrate size, riparian vegetation, pH, temperature and stream flow rates were taken for all nine streams.
- The data were analyzed using regression procedures to determine the relationships between environmental variables and invertebrate biomass and composition.

RESULTS

- Terrestrial invertebrate biomass input into pan traps and stream drift varied among streams.
- The average contribution of terrestrial invertebrates to the total drifting invertebrate biomass from June to August ranged from 10% to 55%.
- Quantity and type of terrestrial input varied with characteristics of the riparian vegetation. Input of terrestrial invertebrate biomass was higher in the streams with riparian vegetation dominated by deciduous trees than in streams bordered by coniferous trees.
- Streams in forests with a high deciduous content, and especially oak-birch forests, had higher proportions of terrestrial invertebrate biomass in the drift.
- Biomass of aquatic invertebrates in the drift was also higher in streams running though forests dominated by deciduous riparian vegetation. Emergence of aquatic invertebrates was less affected by riparian vegetation than by physical factors such as water temperature, pH and proximity to lake outlets.

Emergence trap (left) and pan trap (right) at Thomas Meadow Brook (Photo by C. Macdonald)

YEARS OF DATA

- Single Year Project

PARTNERS

- Dalhousie University
- Mersey Tobeatic Research Institute
- Parks Canada

C. Macdonald (left) and J. Parks (right) collect invertebrate samples (Photo by J. Sircom)

CONTACTS

Sandra Walde and Christina Macdonald
Department of Biology
Dalhousie University
1355 Oxford St.,
Halifax, NS, B3H 4J1
Sandra.Walde@dal.ca
cmbmacdo@yorku.ca

Rationale

Human activities such as forestry are affecting the health of aquatic ecosystems in the Upper Mersey watershed. To understand, communicate and mitigate the impact of these stressors, it is important to assess aquatic health throughout the region and monitor how it is changing over time. Benthic macroinvertebrates are useful indicators of aquatic health because they are sensitive to a variety of stressors; they stay in the same area, and are long-lived and diverse. Environment Canada, through their Canadian Aquatic Bio-monitoring Network (CABIN) provides a nationally standardized and robust program for assessing aquatic health using benthic macroinvertebrates. This project provides reference and test sites to monitor aquatic health and assess the effect of silviculture treatments on benthic invertebrate communities in the upper Mersey and Medway watersheds.

Uhlman Meadow Brook (Photo by A.Lavers, MTRI)

Research

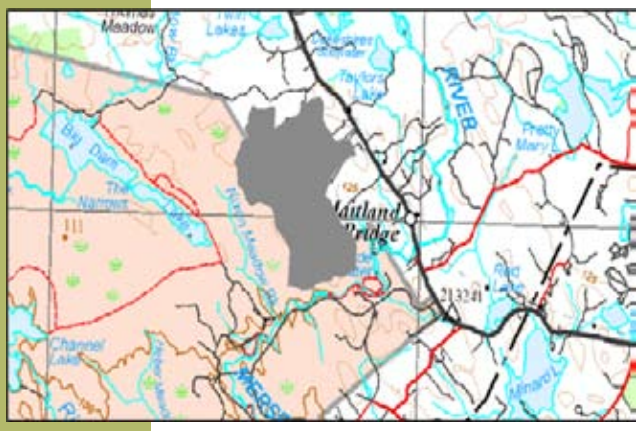
ASSESSING AQUATIC HEALTH USING INVERTEBRATES

OBJECTIVES

- To assess aquatic health in the upper Mersey and Medway watersheds.
- To determine the effect of silviculture treatments on aquatic health in the upper Mersey and Medway watersheds.
- To establish reference condition sites for long-term monitoring in Kejimkujik and the Tobeatic Wilderness Area.
- To contribute to the Environment Canada (EC) national reference database on benthic invertebrates for Canada.

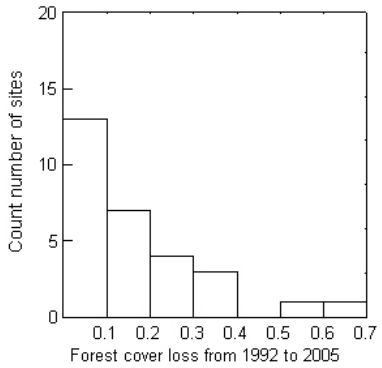
METHODS

- The standardized CABIN protocol was used for data collection and processing to assess benthic macroinvertebrate communities, habitat and water quality. Water samples were analyzed by Environment Canada.
- To measure human activity and the extent of deforestation at study sites, the stream catchment area was calculated using depth-to water table mapping and satellite imagery of the area from 1992-2006 was analyzed. Eighteen sites were chosen along a gradient of forestry operation intensity and data from eleven sites inside Kejimkujik were analyzed.
- Indices of diversity and sensitive species were calculated and statistical analyses were conducted to look at correlations, multivariate models and correspondence.



McBride Brook showing transboundary catchment (Map by A.Smith, Bowater)

RESULTS



Number of study sites with proportion of cover loss in stream catchments ranging from 0.10 to 0.70 (N=29)

- Streams were typically acidic, nutrient-poor, narrow and shallow with small, unembedded substrate.
- All streams included a minimum 20 m riparian buffer with mixed-wood and complete canopy cover. Although most sites had no road crossings, the number of road crossings ranged from 0-19.
- Forest cover loss of catchments studied ranged from 0 to 70%.
- In total, 83 families of benthic macroinvertebrates were identified; the mean number of families per site was 21.
- There was no significant internal structure or clustering to the data and no significant correlations between environmental parameters (benthic invertebrates or water quality) and the proportion of a catchment that was deforested.
- This research suggests that aquatic health in streams is currently not impaired by silviculture in the Upper Mersey Watershed where there are vegetated riparian buffers at least 20 m wide and where forest cover loss is low (usually less than 20 % of a stream's catchment area).

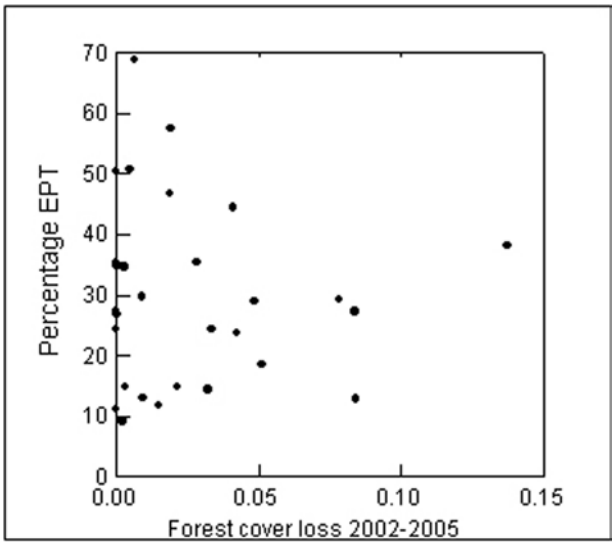
YEARS OF DATA

- Single year project

PARTNERS

- Mersey Tobeatic Research Institute
- Parks Canada
- Applied Geomatics Research Group
- Bowater Mersey
- Ecological Monitoring and Assessment Network (EC)
- Canadian Aquatic Bio-monitoring Network (EC)

P. Martel at study site with cutting to riparian buffer (Photo by A. Lavers)



Percentage of mayflies, stoneflies and caddisflies (EPT index) in samples in relation to the forest cover loss in each stream catchment between 2002 and 2005 (N=29)

CONTACTS

Pierre Martel and Amanda Lavers
Mersey Tobeatic Research Institute
9 Mount Merritt Road
PO Box 215
Kempt, NS B0T 1B0
Ph. (902) 682-2371
Fx. (902) 682-2760
info@merseytobeatic.ca
www.merseytobeatic.ca

Photos from top to bottom:
• Bog Cotton grass (Photo by Parks Canada)
• Grasses in flower at Roger's Brook (Photo by J. Brownlie, Parks Canada)
• Lily pad (Photo by M. Wood, Parks Canada)
• Kejimkujik Lake meets mouth of Grafton Brook (Photo by J. Steeves, Parks Canada)

WETLAND

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. Of the 64 species, 11 are extremely rare and listed nationally 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.

Golden crest (Photo by NSNT)

Monitoring

RARE PLANT MONITORING

OBJECTIVES

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

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.
- Volunteer Rare Plant Monitors were trained to identify coastal plain plant species, observe changes and threats to habitat and record information using Nature Trust data sheets.
- Monitors 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 coastal plain plants.

Plant identification training (Photo by NSNT)

RESULTS

Plymouth gentian (Photo by NSNT)

- A National Recovery and Conservation Plan for Atlantic Coastal Plain Flora was finalized in 2005 with input from the Nature Trust's monitoring program.
- Although Nature Trust volunteers were anxious to get out in field, several training and monitoring sessions had to be cancelled in 2006 due to the atypically wet field season. Exceptionally high lake levels throughout the summer curtailed plant growth to the point where flowering and/or vegetative growth for many species was restricted, and greatly hindered identification.
- Despite poor growth for some species, Nature Trust volunteers still were able to carry out monitoring on 5 lakes, at 24 sites, providing key data towards future planning efforts. Thanks to volunteers for their participation and efforts under very trying weather circumstances!

YEARS OF DATA

- Ongoing 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
- Habitat Stewardship Program for Species at Risk
- Endangered Species Recovery Fund
- Aveda
- Beautiful Gaia Project
- Parks Canada

Virginia meadow-beauty (Photo by NSNT)

Volunteer plant monitor training (Photo by NSNT)

CONTACTS

Patti Green
Nova Scotia Nature Trust
PO Box 2202
Halifax, NS B3J 3C4
Ph. (902) 425-LAND or 1-877-434-LAND
Fx. (902) 429-LAND
patti@nsnt.ca
www.nsnt.ca

Rationale

The initial Atlantic Coastal Plain Flora (ACPF) assessment for Kejimkujik, carried out in mid-1970's by Dr. A.E. Roland, noted 34 ACPF species. Twenty-seven of the original species listed by Roland are on the current ACPF Recovery Plan including one species listed by the Committee on the Status of Endangered Wildlife in Canada (Water-pennywort). The ACPF Recovery Plan has listed 64 species for the province. This project updates the distribution of coastal plain flora within Kejimkujik by providing accurate coordinate data collected by GPS, detailed site data compiled to current standards and information about population, distribution, development, reproduction and habitat. This will provide baseline data to measure change over time and to manage this suite of species. This report is for the second year of a two-year survey of Kejimkujik and includes the Lower Lakes (15 lakes) in the southwest corner of the park from North Cranberry Lake west as far as Liberty Lake and south to Hilchemakaar Lake and Mud Lake.

Small swollen bladderwort at Puzzle Lake (Photo by H. Stewart)

Monitoring

ASSESSMENT OF COASTAL PLAIN FLORA

OBJECTIVES

- To revisit documented occurrences and determine the present distribution of ACPF within Kejimkujik.
- To collect site and field data at these locations with protocols designed by Parks Canada for species at risk inventories.
- To determine new site occurrences for target species.
- To develop a database for all ACPF found in Kejimkujik for future population monitoring.
- To provide data to assist Kejimkujik resource management. decisions concerning ACPF.

METHODS

- Within the study area, using information from historic observations, sites were set up along the shorelines and ACPF occurrences were documented.
- Site characteristics recorded included: GPS coordinates, habitat type, substrate type and cover, shoreline width (water line to shrubline where shorelines occurred), dominant plant species within the habitat type and measured slope and aspect of the site.
- Within each site, occurrences of each ACPF species were subjected to detailed assessment (patches). Patch size, ACPF distribution, habitat type, phenology (rough counts) and element occurrence observations were documented.
- All data were entered into a Microsoft Access database for query by species, habitat type, substrate, etc. Structured queries were set up to enable continuous update and query.
- All spatial data collected for sites, habitat types and species were downloaded into a geodatabase and will allow for comparison with other digital datasets in the future.

Purple bladderwort along shoreline at Beaverskin Lake (Photo by H. Stewart)

RESULTS

H. Stewart doing shoreline site at Peskawa Lake (Photo by S. Monette)

- Ninety-nine sites were surveyed on the lower lakes where 413 patches were described for 24 ACPF species. Sites had between one to three ACPF patches. Marsh St. John's-wort (in 57 patches) was the most common ACPF species. Shrub species such as Water willow and Inkberry were more common on the lower lakes than around Kejimkujik Lake.
- Substrates of the lower lakes sites were dominated by organic soils (90 sites with mean coverage of 76%) followed by boulder and then cobble. Very little gravel and sand was encountered. Mean beach width was 3 m compared to 24 m for Kejimkujik Lake in 2005.
- Eight habitat types were documented with the upper zone (134 patches) being the most often encountered followed by middle zone (73 patches). A notable increase was the number of aquatic ACPF occurring in Lower Lakes (30 patches). The aquatic species in Bladderwort family had thirty patches on the lower lakes.
- The mean number of habitats at each site was 1.5 with a maximum of 4 at several sites. The mean ACPF species (richness) at each site was 4 with a maximum of 13 ACPF species at one site. Shannon Diversity was calculated as 1.2 and the Simpson's index of diversity was 0.62.
- Rarity ranking for species encountered on the lower lakes was lower for S1 and S2 species (1 patch) than on Kejimkujik Lake (16 patches).

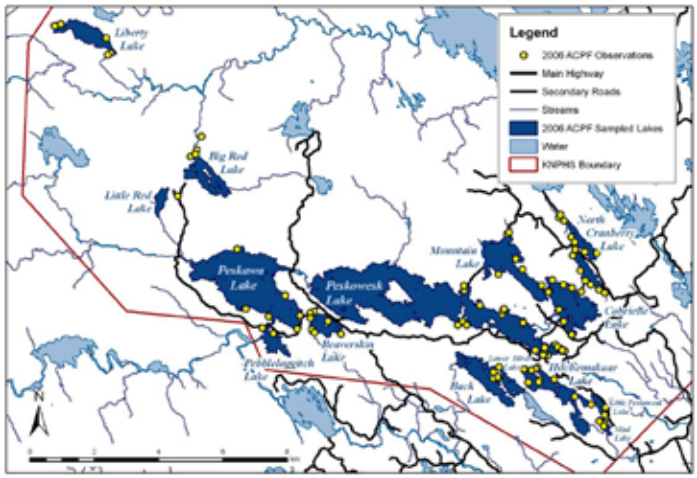
YEARS OF DATA

- Year 2 of a 2 year project

PARTNERS

- Parks Canada
- Applied Geomatics Research Group
- Natural Sciences and Engineering Research Council of Canada

Dwarf chain fern at Big Red Lake (Photo by H. Stewart)



Lower Lakes Surveyed in 2006 (Map by Suzanne Monette, AGRG)

CONTACTS

Heather Stewart
Applied Geomatics Research Group
Nova Scotia Community College
50 Elliot Road, RR#1
Lawrencetown, NS
Ph. (902) 825 - 1056
Fx. (902) 825 - 5479
heather.stewart@nscc.ca
http://agrg.cogs.ns.ca

Rationale

Water-pennywort is a small, clonal macrophyte that grows along freshwater lakeshores in southern North America and South America. Its distribution in Canada is limited to two regions in Nova Scotia: Wilson's Lake and Kejimkujik National Park and National Historic Site. The species was designated as 'Endangered' by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1985 due to its limited range and threats to its habitat. Water-pennywort is currently listed as 'threatened' by COSEWIC and a recovery plan was developed in 2003. (As a federal agency, it is the responsibility of Parks Canada to protect species at risk). Water-pennywort populations are monitored at Kejimkujik to detect changes in species distribution and abundance and to better understand the influence of environmental variables and human impacts on the species to inform management and ensure protection.

Water-pennywort (Photo by R. Davies)

Monitoring

WATER-PENNYWORT MONITORING

OBJECTIVES

- To monitor Water-pennywort population abundance and density.
- To monitor spatial distribution of Water-pennywort at Kejimkujik (*i.e.,* stand surface area and locations).
- To survey potential habitat at Kejimkujik for the establishment of new stands of Water-pennywort.
- To assess water levels at Water-pennywort stands.
- To assess stem height and percent damage within Water-pennywort stands.

METHODS

- Water-pennywort surveys have been conducted annually on Kejimkujik and George Lakes within Kejimkujik. Surveys were conducted at known populations in both shoreline and aquatic habitats.
- Extensive surveys have also been conducted every 3 years to search for new stands.
- Population abundance, density, stem height, water depth and percent damage of individual Water-pennywort stands are assessed by systematic transect surveys in early August. Stand surface area is also measured. Survey results are compared to historic data in order to determine population size fluctuations.

J.Dick and D.Thexton monitoring Water-pennywort at Indian Point (Photo by D. Ure, Parks Canada)

RESULTS

- Water-pennywort distribution and stand locations have remained fairly consistent over the period of sampling.
- Spatial distribution analysis demonstrates the ability of stands to recover. In 2000, a new stand established within the George Lake population. This population existed until the 2005 survey, when no ramets were observed. One of the Meadow Beach populations was lost in 2004 but re-established in 2005.
- Both the Merrymakedge and Indian Point populations have expanded significantly in size over time.
- Stand area and ramet density are highly variable from year to year, most likely in response to water level. Despite this variability, historic surveys indicate stable to increasing populations of Water-pennywort within Kejimkujik.

Water-pennywort (Photo by D. Ure, Parks Canada)

YEARS OF DATA

- Ongoing project since 1999

PARTNERS

- Parks Canada
- Atlantic Coastal Plain Flora Recovery Team

Water-pennywort near Meadow Beach (Photo by Parks Canada)

CONTACTS

Darien Ure
Kejimkujik
PO Box 236
Maitland Bridge
NS B0T 1B0
Ph. (902) 682-4003
Fx. (902) 682-3367
darien.ure@pc.gc.ca

Rationale

The number of fens and bogs (6987) in the Annapolis, Mersey, Medway and the LaHave watersheds occupy an area of approximately 25,816 ha and yet very little research has been done on how silvicultural practices and associated road networks affect adjacent peatlands. Are there changes in the water chemistry and water quantity of these peatlands and connecting waterways, and if so, what is the duration of these changes? Following clear-cutting, the effect of "watering-up" in the cut as well as adjacent wetlands has been documented in forestry literature. This study attempts to establish the conditions in these mapped peatlands prior to cutting and after cutting to compare water quantity and quantity to nearby peatlands under conservation management. The managed wetlands were used as reference sites for the "treatment" peatlands.

Researcher cutting pipe for piezometer (Photo by AGRG)

Monitoring

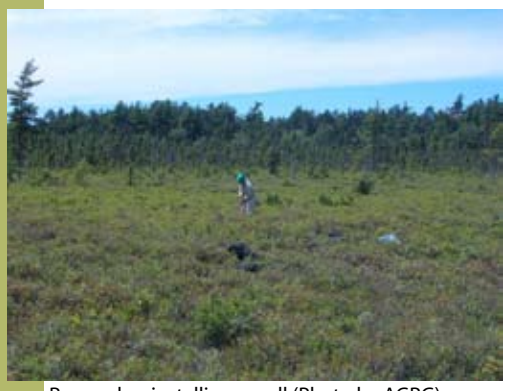
SILVICULTURE IMPACTS ON PEATLANDS

OBJECTIVES

- To determine effects of varying silvicultural practices on adjacent peatlands (fen and bog type) in a "working landscape" by setting up a series of plots along a transect with increasing distance from a proposed cut and measuring water quality variables, water quantity and vegetation cover.
- To set up similar plots measuring the same variables within nearby areas managed for conservation such as Kejimkujik and Cloud Lake Wilderness Area, to serve as reference plots.

METHODS

- Site selection criteria included fens or bogs with greater than 40 cm peat adjacent to proposed silvicultural treatments. Reference sites were selected inside areas managed for conservation.
- Piezometers were installed in each plot to measure water quality and quantity. Measurement was completed using in-situ probe and water was pumped into 250 ml bottles for lab analysis for standard anions and cations. Well depth at installation and water depth at each visit was recorded. Several new sites were installed this year and were visited twice during the season, once at installation and once at the end of the season.
- Nested plots were set up to assess vegetation cover for 5 strata within the plot. All species were assessed using strata-appropriate sized plots and recorded by percent cover.
- Trees above 5 m were assessed using forest mensuration methods. Site characteristics such as microhabitat, were noted for mosses.



Researcher installing a well (Photo by AGRG)

RESULTS

White-fringed orchid (Photo by H. Stewart)

- Despite record setting precipitation for May and June (445 mm), additional sites were set up for both the reference and treatment plots. Reference plots installed last year were revisited (17 plots from 2005). Treatment plots were not cut in 2006.
- New reference sites were established in Cloud Lake Wilderness Area (NSDEL) at three sites; Big Bog, Hanley's Meadow and Cloud Lake Brook (7 plots) and additional treatment plots were located along West Dalhousie road at Medicraft Lake (2 plots) and Township Brook (2 plots). This represents a total of 28 plots for the two years.
- Mean well depth at installation was 2 m with maximum well installation at 2.5 m. High early summer precipitation facilitated water measurement during July and August.
- Within plot vegetation was very similar (0.80) compared to (0.70) between plot similarity. Peatland type varied between shrub bog and poor shrub fen.
- Cloud Lake mean water values were highest for temperature(18), pH (5.0), dissolved oxygen (30% Saturation) and chloride (8 ppm). Kejimkujik sites had highest mean conductivity (56 uS/cm Actual Conductivity). This may be an instrument error as a very high value occurred at one site.

YEARS OF DATA

- Year 2 of a 2 year pilot project for ongoing monitoring

PARTNERS

- Applied Geomatics Research Group
- Natural Sciences and Engineering Research Council
- Mersey Tobeatic Research Institute
- Bowater Mersey Paper Company
- Parks Canada
- Nova Scotia Department of Environment and Labour

Shrub bog (Photo by AGRG)

CONTACTS

Heather Stewart
Applied Geomatics Research Group
Nova Scotia Community College
50 Elliot Road, RR#1
Lawrencetown, NS
Ph. (902) 825 - 1056
Fx. (902) 825 - 5479
heather.stewart@nscc.ca
http://agrg.cogs.ns.ca

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.

Volunteers S. Green and N. Green, checking on protected turtle nest (Photo by D. Smith, Parks Canada)

Monitoring

BLANDING'S TURTLE NEST MONITORING

OBJECTIVES

- To protect Blanding's turtle nests from predation to bolster 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.
- At 8 pm, 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.

Reducing Threats via Road Signs

- Road signs and speed bumps were implemented in Kejimkujik in 2006 to raise awareness of turtle nest sites on roadsides and reduce traffic speeds during periods of turtle nesting and hatchling emergence.

Protective measures for Blanding's turtles include road signs and speed bumps (Photo by Parks Canada)

RESULTS

Volunteer gardening around Blanding's Turtle nest enclosure in Plesant River (Photo by B. Caverhill)

Nest Protection

- In 2006, 59 volunteers and researchers logged 1470 hours in Kejimkujik and located 19 Blanding's turtle nests.
- Volunteers also collected 28 eggs to be incubated as part of the captive rearing (headstarting) program.
- An additional 18 nests were protected at McGowan Lake and Pleasant River (the other two populations). In Pleasant River, 10 families (25 individuals) contributed 352 hours to help protect 10 nests on or near their properties.

Nest Monitoring

- In Kejimkujik, 14 volunteers helped monitor Blanding's turtle nests and radio track hatchling turtles over an 8 week period, contributing over 600 hours.
- A total of 73 hatchlings emerged in Kejimkujik and 18 of these were tracked (see p. 104). Volunteers also helped excavate eggs from nests that were overdue. These were incubated in captivity.
- At McGowan Lake, only 10 hatchlings emerged from the eight protected nests; reasons for this low success are unknown. More than 30 hatchlings emerged in Pleasant River where 10 volunteer families (25 individuals) monitored the 10 protected nests over a six week period and invested 280 hours.

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 and in September and October for emerging hatchling turtles. These signs drew attention to the turtles and the bumps reduced driving speeds.

YEARS OF DATA

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

CONTACTS

PARTNERS

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

Duncan Smith
Parks Canada
PO Box 236, Maitland Bridge
NS B0T 1B0
Ph. (902) 682-2770
Fx. (902) 682-3367
duncan.smith@pc.gc.ca
www.speciesatrisk.ca/blandings
www.friendsofkeji.ns.ca

Eric Alcorn
Acadia University
24 University Avenue
Wolfville, NS B4P 2R6
Ph. (902) 585-1721
Fx. (902) 585-1069
eric.alcorn@acadiau.ca

Rationale

The Nova Scotia population of Blanding's turtle is listed as Endangered under the Species at Risk Act due in part to its restricted range, uneven age structure and low recruitment of juveniles and young adults. Currently, very little is known about the earlier life stages of this species, and particularly about the ecology and behaviour of hatchling Blanding's turtles. Use of radio telemetry allows researchers to track hatchlings following emergence from their nests and collect information on hatchling behaviour, activities and habitat use. Detailed description of hatchling habitats can also reveal patterns in habitat use and preference. A better understanding of the behaviour and ecology of hatchling Blanding's turtles will help in identifying potential threats and risks to hatchlings and in defining and protecting critical habitats, thus leading to more effective conservation of this species.

Hatchling Blanding's turtle from Pleasant River with radio-transmitter attached, basking on land (Photo by A. Camaclang)

Research

RADIO-TRACKING HATCHLING BLANDING'S TURTLES

OBJECTIVES

- To study the behaviour and movement patterns of hatchling Blanding's turtles following emergence from the nest.
- To determine habitat use and preferences of hatchlings during fall and winter.
- To identify potential threats and risks to hatchlings in their habitats.
- To aid in the identification and protection of critical habitats for this species.

METHODS

- Following emergence from the nest, small radio-transmitters (0.3 – 0.6 g) were attached to the shell of hatchling Blanding's turtles from the three distinct populations in Nova Scotia.
- Hatchlings were tracked manually every 1 – 3 days throughout the fall using a hand-held antenna and receiver.
- UTM coordinates of hatchling locations were recorded, along with weather conditions, hatchling activity and position, and information about the microhabitat.
- Characteristics of the habitats were measured and recorded, including habitat type, water depth and width, velocity, bank type, substrate type, shape of the shoreline, evenness of terrain, vegetation type and structure and percent vegetation cover.

P. Kydd tracking hatchling turtles in Kejimkujik (Photo by A. Camaclang)

RESULTS

Example of hatchling habitat: small pond behind a roadside nest near McGowan Lake (Photo by A. Camaclang)

- Hatchling emergence began on 15 September 2006 and continued until 27 October 2006. Twenty-nine hatchlings were equipped with radio transmitters, although nine radio transmitters were lost due to technical issues (transmitter or attachment failure).
- Of the remaining 20 hatchlings that were radio tracked, 50% died due to predation by small mammals. Another 30 % died from other causes. Only four hatchlings were still alive by the end of the study period in mid-December.
- Preliminary observations suggest that hatchlings move towards protected wetlands near the nest. Hatchlings from inland nests moved towards small ponds, ditches, bogs and/or swamps near the nest, while hatchlings from beach nests tended to avoid the open water and moved inland towards the forest and the wet meadows beyond.
- Upon arrival at these sites, hatchlings spent all of their time in and around these sites, often remaining within a very small area. Hatchlings remained relatively active throughout the remainder of the study period and were often observed basking and/or active on warmer days.

YEARS OF DATA

- Year 1 of an ongoing project

PARTNERS

- Blanding's Turtle Recovery Team
- Dalhousie University
- Parks Canada
- Habitat Stewardship Program for Species at Risk
- Endangered Species Recovery Fund
- Natural Sciences and Engineering Research Council of Canada
- Environment Canada's Science Horizons Youth Internship Program
- Friends of Keji Cooperating Association
- Mersey Tobeatic Research Institute

Hatchling turtle crossing the road in Kejimkujik (Photo by A. Camaclang)

CONTACTS

Abbey Camaclang
School for Resource and Environmental Studies
Dalhousie University
6100 University Avenue, Suite 5010,
Halifax, NS B3H 3J5
abbey.camaclang@dal.ca

Tom Herman
Acadia University
24 University Avenue
Wolfville, NS B4P 2R6
Ph. (902) 585-1469
Fx. (902) 585-1059
tom.herman@acadiau.ca
http://ace.acadiau.ca/science/biol

Rationale

Nova Scotia's Blanding's turtles are designated both nationally and provincially as Endangered. This small peripheral population complex is disjunct from the main species range, centered around Ontario's Great Lakes. Blanding's turtle distribution is primarily limited to wetlands. A habitat model is being developed based on the physical and biotic characteristics of wetlands that will predict the species' presence or absence. Data used include on-site measurements, remote sensing data (provided by the Nova Scotia Department of Natural Resources) and previous Blanding's turtle trapping data. This model contributes to concrete recovery actions by identifying: (i) key features of critical habitat; (ii) wetlands containing sub-populations at high risk, for which conservation actions can be targeted; and (iii) suitable wetlands where turtles are not known to occur at present, but may support populations in future.

Blanding's turtle in typical habitat (Photo by G. Bourque)

Research

BLANDING'S TURTLE HABITAT MODELLING

OBJECTIVES

- To describe wetlands used by Blanding's turtles in Nova Scotia.
- To identify key habitat features critical to Blanding's turtle in Nova Scotia.
- To develop a user-friendly predictive model of Blanding's turtle presence to inform future distribution studies and management actions.
- To identify wetlands containing sub-populations of Blanding's turtles at high risk for which conservation actions can be targeted.
- To identify suitable wetlands where Blanding's turtles are not known to occur at present, but may support populations in future.

METHODS

Researcher Guillaume Bourque working on habitat models (Photo by G. Bourque)

- On-site measurements were taken simultaneously by two independent observers during July-August 2005, and again by two different observers in 2006. The 2006 data will be used to validate and improve the model developed from 2005 data; 2006 data have not yet been analyzed.
- The wetland characteristics recorded included vegetation, wetland morphometrics (water depth, stream width, bank slope, etc.), habitat type according to the Canadian Wetland Classification system and occurrence of features potentially important to turtles, such as basking areas.
- Water samples were taken from each wetland and were analyzed in the lab for pH and water color.
- Landscape features were measured from remote sensing data in a Geographic Information System (GIS) environment; data were provided by the Nova Scotia Department of Natural Resources. Landscape features included site area and area of wetland habitat within specific radii around each site.

METHODS (Continued)

- Blanding's turtle presence/absence in each studied wetland was assessed from the Blanding's Turtle Recovery Team database trapping records, using data from 1995-2005.
- Habitat and landscape variables were first investigated individually for effects on Blanding's turtle presence/absence. The significant variables were then used to build a series of models. The best models were identified according to the model predictive power when assessing the species presence at sites not included in the first analysis.

RESULTS

Typical Blanding's turtle habitat: a stream fen in North Brookfield (Photo by G. Bourque)

- 160 wetlands were characterized in 2005, and 71 in 2006, encompassing all three known Blanding's turtle populations in Nova Scotia as well as areas outside these populations. 76% of previously trapped wetlands have been characterized including both wetlands with and without known presences of Blanding's turtles.
- Blanding's turtle presence/absence has been determined for most sites characterized in 2005, and landscape variables have been measured in GIS. Sites from 2006 have not yet been analysed.
- Models were developed using the 2005 data. The most important variables affecting Blanding's turtle presence in wetlands appear to be: (i) a high minimum distance from the edge of the water body to the forest edge; (ii) a bank vegetation of sedge and/or sweet gale in opposition to grass and/or leather leaf;(iii) a predominance of sedges in terrestrial parts of the wetland; and (iv) a low incidence of rocks as aquatic substrate.
- Occupied sites predicted to be unsuitable and unoccupied sites predicted to be suitable for Blanding's turtles were identified for conservation purposes.

YEARS OF DATA

- Ongoing project since 2004

PARTNERS

- Natural Sciences and Engineering Research Council of Canada
- Endangered Species Recovery Fund
- Government of Canada Habitat Stewardship Program for Species at Risk
- Blanding's Turtle Recovery Team
- Acadia University
- Nova Scotia Department of Natural Resources
- Parks Canada
- Acadia Center for Estuarine Research

CONTACTS

Guillaume Bourque and Tom Herman
Acadia University
Biology Department
Acadia University
Wolfville, NS B4P 2R6
Ph. (902) 585-1469
Fx. (902) 585-1059
074051b@acadiau.ca
tom.herman@acadiau.ca
www.speciesatrisk.ca/blandings

Rationale

Blanding's turtles in Nova Scotia are listed as Endangered by both the Federal Species at Risk Act and the Nova Scotia Endangered Species Act. They are currently only known to occur in three distinct populations in the southwestern region of the province. To recover this species, there is a need to both monitor known populations and search unknown areas for additional populations. Blanding's turtles are long-lived (80+ years) and slow to mature (20+ years) so long-term data are necessary to determine changes in abundance, trends in age-related survival, changes in habitat use and the effect of our recovery actions. Searching unknown areas will allow us to determine the extent of the species' range in Nova Scotia and to locate additional populations to target recovery actions.

Blanding's Turtle at Little Kempton Meadow (Photo by J. McNeil)

Research

ASSESSING BLANDING'S TURTLE POPULATIONS

OBJECTIVES

- To trap and visually survey areas in and around the three known Nova Scotia populations to monitor individual turtles, assess abundance and determine age-related survival and movement patterns.
- To radio-track turtles throughout the season to locate important seasonal habitats (*e.g.,* nesting, overwintering).
- To trap and visually survey areas beyond the three known populations, especially where Blanding's turtle sightings have been reported, to determine the extent of the range in Nova Scotia.

METHODS

- Live trapping was conducted using hoop traps baited with sardines. Traps were set for 2–5 days and were checked daily by trained staff and volunteers.
- Visual surveys were conducted by slowly searching the area by canoe or on foot.
- All new turtles captured were given a unique notch code so that they can be individually identified on subsequent captures. Turtles were handled by trained personnel in accordance with the standard procedures developed by the Blanding's Turtle Recovery Team.
- Select turtles were outfitted with radio transmitters to allow researchers to track their seasonal movements.
- Data on turtles and their habitats were entered into the long-term Blanding's turtle database, which has records on some individuals as far back as 1969.

Volunteers checking turtle traps in Kejimkujik (Photo by D. Smith, Parks Canada)

RESULTS

- Trapping in and around the three known populations (>2100 trap nights) yielded 35 new individuals and 68 previously marked individuals.
- All captures occurred in previously known areas; however, the presence of turtles at several new sites was confirmed within those areas.
- Turtles captured ranged in age from 2-year-old juveniles to adults over 60 years old, providing information on age-related survivorship and habitat use.
- Seasonal movements were monitored in all three populations. New nesting and overwintering sites were located in the Barren Meadow area of the Pleasant River population.
- With the aid of volunteers, additional trapping was conducted in areas beyond known populations, including Tobeatic and Rossignol Wilderness Areas and the Weymouth area. No Blanding's turtles were captured in these areas.

Volunteers setting turtle traps
(Photo by B. Caverhill)

YEARS OF DATA

- Ongoing project since 1996

PARTNERS

- Blanding's Turtle Recovery Team
- Parks Canada
- Government of Canada Habitat Stewardship Program
- Endangered Species Recovery Fund
- Mersey Tobeatic Research Institute
- Nova Scotia Department of Natural Resources
- Nova Scotia Department of the Environment
- Acadia University
- Friends of Keji Cooperating Association

CONTACTS

Tom Herman
Acadia University
Biology Dept
Wolfville, NS B4P 2R6
Ph. (902) 585-1469
Fx. (902) 585-1059
tom.herman@acadiau.ca
www.speciesatrisk.ca/blandings

Jeffie McNeil
Kejimkujik
PO Box 236
Maitland Bridge, NS
Ph. (902) 682 2770
Ph. (902) 682 3367
jeffie.mcneil@ns.sympatico.ca

Volunteers surveying for turtles in Kejimkujik (Photo by D.Smith, Parks Canada)

Rationale

Blanding's turtle, a nationally and provincially endangered species, aggregates in the fall, winter and early spring in common overwintering locations. These aggregations are potentially vulnerable to local disturbance. Little is known about the site characteristics or the requirements of wintering turtles. Understanding the conditions these turtles need to survive and how they move during the winter within these sites will give the Blanding's Turtle Recovery Team a better framework for conserving critical habitat for this species in Nova Scotia.

This turtle overwintered under a layer of soft organic mud in winter 2005-2006 while other turtles overwintered above the mud layer (Photo by E. Newton)

Research

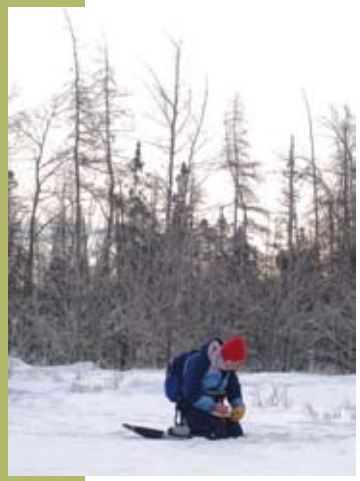
OVERWINTERING OF BLANDING'S TURTLES

OBJECTIVES

- To characterize the range of physical and chemical attributes experienced by overwintering turtles in eight sites in three populations.
- To document the winter movements of Blanding's turtles to more effectively manage winter critical habitat.

METHODS

- Sites were characterized in the fall to gain an understanding of the ecological and physical characteristics of Blanding's turtle overwintering sites.
- All sites were visited biweekly during the winter to assess water chemistry (dissolved oxygen and pH) and movement of 25 individual turtles by radio telemetry and additional turtles by visual survey.
- At each site, three locations were equipped with digital loggers that recorded temperature at 4-hour intervals.



As researcher E. Newton recorded movement of turtles every two weeks in Pleasant River it was apparent that during very cold periods, turtles' activity decreases drastically (Photo by P. Newton)

Researcher E. Newton radio tracks turtles in McGowan Lake to determine their time of emergence from overwintering sites in spring 2006 (Photo by B. Caverhill)

RESULTS

- Blanding's turtles overwinter in a variety of wetland types, from discrete bog and fen holes to anthropogenic trenches to flooded woodlands.
- In terms of site structure and vegetation, there was considerable variation among overwintering sites, but sites shared important features such as shallow, still water, undercut banks and common flora (Sweet gale, Leatherleaf, sphagnums and sedges).
- Blanding's turtles can successfully overwinter in a wide range of temperatures (from 0°C to 7°C) and dissolved oxygen (10-100%). The pH in overwintering sites ranged from 4.6-5.5, which is typical of wetlands in Nova Scotia.
- Movement to overwintering sites was gradual, but departure was rapid. Several moderate movements (< 7.4 m) occurred at water temperatures below 1.5 °C, but most movements during the winter were under 2 m every two weeks. Activity increased with increasing temperatures.
- Blanding's turtles have been observed overwintering under a layer of organic substrate, resting on the bottom of the site and positioned directly beneath the ice among submerged vegetation.
- Data suggest that overwintering Blanding's turtles in Nova Scotia can tolerate a wide range of environmental conditions, but that suitable overwintering sites could be limited because of communal, regular use of several overwintering sites.

Researcher E. Newton records dissolved oxygen, pH, snow cover and ice thickness in Pleasant River (Photo by P. Newton)

YEARS OF DATA

- Ongoing project since 2004

PARTNERS

- Blanding's Turtle Recovery Team
- Acadia University
- Parks Canada
- Natural Sciences and Engineering Research Council
- Species at Risk Recovery and Education Fund

Turtles came up periodically over the winter if air holes were available; however, turtles were able to tolerate periods of about 3 months submerged under the ice (Photo by E. Newton)

CONTACTS

Erica Newton and Tom Herman
Department of Biology
Acadia University
Wolfville, NS B4P 2R6
Ph. (902) 585-1469
Fx. (902) 585-1059
065355n@acadiau.ca
tom.herman@acadiau.ca

Rationale

The Eastern ribbonsnake (Atlantic Population) is the rarest snake in Atlantic Canada and is found only in southwestern Nova Scotia. Its autecology, including where it hibernates, how it knows when to emerge from hibernation (cues) and when and where it breeds remain largely unknown. The goal of this project is to collect that information and apply it to the development and implementation of a Recovery Plan for the Eastern ribbonsnake in Nova Scotia. Previous research has provided basic information on population size, sex ratio and seasonal movement of the snakes in a well-defined area on the shores of Grafton Lake (Kejimkujik). However, the behavioural ecology of the snake during its active season needs to be established in order to understand its environmental requirements for successful growth and reproduction. Similarly, the characteristics of successful hibernation sites also need to be established to know what habitats to protect to assure the animal safe places to overwinter.

Eastern ribbonsnake at Cobrielle Lake (Photo by J. Todd)

Research

EASTERN RIBBONSNAKE ECOLOGY

OBJECTIVES

- To identify habitat preference and spatial distribution of the Eastern ribbonsnake at Grafton Lake in Kejimkujik.
- To more precisely identify and characterize hibernacula used by the Eastern ribbonsnake at Grafton Lake and seek other hibernacula sites.
- To learn more about this rare species' autecology, including seasonal movement patterns, feeding, mating, parturition, growth, demography and basking behaviours.
- To determine if temperature gradient, water level rise or circannual rhythm cause emergence from hibernation in this species.

METHODS

Eastern ribbonsnake in a researchers hand (Photo by R. Marotte)

- Habitat was visually surveyed and observed snakes were hand captured. Data were collected on physical condition (*i.e.,* length, weight, age class and injuries), behaviour when first seen, environmental conditions and GPS location.
- Animals were photographed for the ribbonsnake database and assigned a ventral scale clip code to help interpret seasonal and individual movements.
- The use of PIT tags were piloted for this species by inserting them under the skin and monitoring tag loss using ventral scale clip codes as a reference marking.
- Movement patterns were observed using fluorescent powder.
- Other areas of high ribbonsnake concentration were examined for potential hibernacula.
- Ribbonsnakes were collected from outside Kejimkujik and subjected to winter conditions in artificial hibernacula in a laboratory setting to record where they choose to hibernate. In spring, animals were subjected to reversing thermal gradient, a rise in water level, or no change and observed to see if any treatment caused them to come to the surface of the artificial hibernacula.

RESULTS

- Public awareness of the Eastern ribbonsnake was expanded through pamphlet distribution both inside and outside Kejimkujik and with a presentation to the South Shore Naturalists Club.
- Basking, swimming (including fully submerged), foraging, eating and predator avoidance were observed.
- The confirmed active season was extended into March. Previously the earliest recorded sighting of a ribbonsnake was April 7th.
- All sightings were documented and are pending analysis with GIS technology.
- Neonates were born in captivity in August and September. Litters ranged from five to ten young (average eight).
- Some ribbonsnakes in hibernation chose to hibernate underwater (laboratory observations), either partially or fully submerged. Emergence results are pending.

PIT tagging at Grafton Lake (Photo by R. Marotte)

YEARS OF DATA

- Ongoing project since 2001

PARTNERS

- Dalhousie University
- Acadia University
- Parks Canada
- Friends of Keji Cooperating Association
- Mersey Tobeatic Research Institute

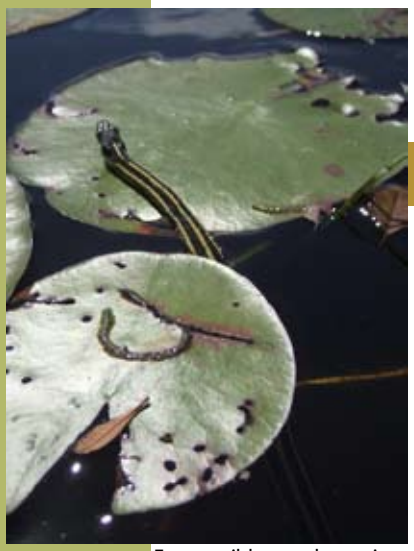
Animal photographed for Eastern ribbonsnake database (Photo by R. Marotte)

CONTACTS

Josie Todd and Richard Wassersug
Dalhousie University
5850 College St
Halifax, NS B3H 1X5
Ph. (902) 494-2244
Fx. (902) 494-1212
josephine.todd@dal.ca
tadpole@dal.ca
www.anatomy.dal.ca/

Rationale

The population of Eastern ribbonsnakes in Nova Scotia is listed as Threatened under Species At Risk Act and the Nova Scotia Endangered Species Act. Many threats to this species were outlined by the Committee On The Status Of Endangered Wildlife In Canada Status Report in 2002, but one of the largest threats is our lack of knowledge. The cryptic nature of this snake allows for infrequent observations, which also appear to be highly dependant on weather conditions, habitat and behaviour of the researcher. The snake also appears to occur in low densities throughout most of its range. A greater understanding of ribbonsnake distribution in Nova Scotia will allow for more accurate population estimates and potential metapopulation dynamics. Location of additional high-density sites will improve our ability to detect population structure through genetic analysis and movement studies. Work in the summer of 2006 was the continuation of an ongoing project to determine the extent of Eastern ribbonsnake distribution in Nova Scotia through visual surveys.



Eastern ribbonsnake resting on the surface of Molega Lake (Photo by J. Todd)

Research

EASTERN RIBBONSNAKE DISTRIBUTION

OBJECTIVES

- To survey wetlands and determine the extent of Eastern ribbonsnake distribution in Nova Scotia.
- To locate previously unknown high-density sites of ribbonsnakes for future research and stewardship efforts.
- To increase public awareness of this species by the distribution of pamphlets and to solicit sightings from the public.

METHODS

- Several high priority sites for survey were identified based on sighting reports (both historic and recent) or their location at the periphery of the known range. Blanding's turtle researchers also recorded ribbonsnake sightings.
- Visual surveys, by foot or canoe, were conducted with a minimum of two observers. Effort exerted during each survey was recorded. Attempts were made to capture all snakes observed.
- Weather conditions, behaviour of the snake and the microhabitat within a 2.5 m radius were recorded for each observation. Additional information was recorded on the physical characteristics and morphology of all captured snakes. Photographs and a DNA sample were obtained from each individual. All snakes were released at the site of capture with an individual identification mark (ventral scale clipping or a PIT tag).

T. Imlay, J. Brunt, J. Todd, and R. Marrotte processing a ribbonsnake caught at Grafton Lake (Photo by S. Siblot)

RESULTS

- Sightings were confirmed in several locations throughout southwestern Nova Scotia. Many previously unsurveyed wetlands were surveyed and additional sightings were recorded.
- Four new high density sites were located – Cobrielle Brook, McGowan Lake, Molega Lake and Barren Meadow.
- PIT tags were used to mark adult snakes at Grafton Lake and Cobrielle Brook. A protocol was developed for safe implementation.
- Over 50 DNA samples were collected for future genetic analysis.
- Over 200 information pamphlets were distributed to outdoor organizations, outfitters and the general public. More than 10 ribbonsnake sightings were reported through the Species at Risk toll free number or when conversing with community members.

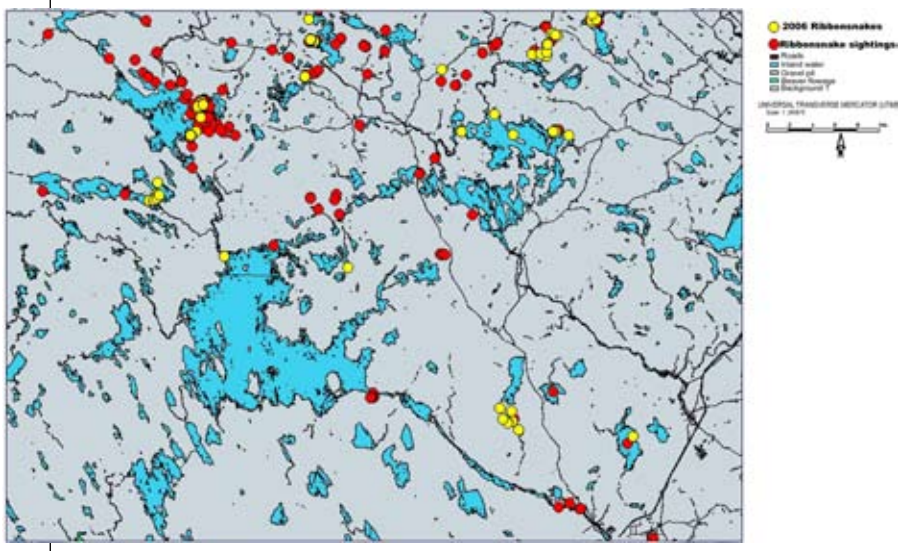
Eastern ribbonsnake attempting to evade capture at Grafton Lake (Photo by T. Imlay)

YEARS OF DATA

- Ongoing project since 2004

PARTNERS

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



Known distribution of the Eastern ribbonsnake in Nova Scotia as of August 25, 2006 (Compiled by J. McNeil)

CONTACTS

Tara Imlay and Tom Herman
Acadia University
Wolfville NS B4N 2R6
Ph. (902) 585-1469
Fx. (902) 585-1069
057259i@acadiau.ca
tom.herman@acadiau.ca
www.speciesatrisk.ca/ribbonsnake

Rationale

This study will contribute to an evaluation of the need to amend Nova Scotia buffer regulations to protect treed bogs from forestry impact. At present, the Nova Scotia Wildlife Habitat and Watercourses Protection Regulations do not require foresters to leave buffer zones around treed bogs as is the case with other wetlands. In fact, where conditions permit, trees can be harvested within the peatland. Treed bogs contain a significant portion of Nova Scotia's biodiversity, hosting species that are highly specialized, rare, and/or at risk, and forestry activity may result in biodiversity loss, community shifts, or habitat degradation in sensitive areas. The goal of this research project was to determine how adjacent forest harvesting influences treed bog biodiversity and to make appropriate recommendations for modification of regulations if needed. The results of this study will enhance the ability of land managers at all levels to make responsible decisions regarding wetlands and biodiversity, leading to more sustainable forestry that is attentive to non-timber forest values.

Aerial view of a treed bog (Photo by D. Hurlburt)

Research

INVERTEBRATES AS INDICATORS OF BOG HEALTH

OBJECTIVES

- To evaluate Nova Scotia Wildlife Habitat and Watercourses Protection Regulations to protect treed bog biodiversity and make recommendations for improved regulations if necessary.
- To determine diversity patterns for odonates and tabanid flies in treed bogs relative to type and intensity of forestry.
- To evaluate tabanids and odonates as indicators of wetland health and landscape integrity for long-term monitoring.

METHODS

- In 2005-2007, 28 treed bogs were sampled in Bowater's Southshore-Rossignol and Medway districts and adjacent protected areas, including Kejimkujik.
- Surveys for dragonflies, damselflies and tabanid flies were conducted within each bog using free-standing Manitoba fly traps and/or hand netting.
- Physical characteristics were described for each bog and quantification of adjacent forestry activity within 20-500 m radii surrounding each peatland was calculated using GIS.
- Species diversity and evenness were determined in relation to physical characteristics and forestry activity to assess the impact of forestry on treed bog biodiversity.

Trap installation for deerflies and horseflies (Tabanid flies) (Photo by D. Hurlburt)

RESULTS

Treed bog with moderately dense Black spruce cover and ericaceous shrub understory (Photo by D.Hurlburt)

- 1754 dragonflies and damselflies of 54 species were captured, representing 47% of Nova Scotia's species. Several rare and specialized species were found, including Elfin skimmers, Little bluets, Delicate emeralds and Incurvate emeralds.
- Thirty-six species of horse and deer flies were identified, representing approximately 72% of Nova Scotia's species (n~50). Three species were extremely rare and disjunct, including *Merycomyia whitneyi, Chrysops pudicus* and *C. delicatulus*. Only 20 specimens of *M. whitneyi* have been reported in North America; this is the first record (n=3) for Atlantic Canada.
- Fly and odonate diversity were dependent on the proportion of poor fen, bog openness and pH. Odonate diversity was also responsive to amount of road within 500 m and proportion of forestry within 100 m. Flies were mostly affected by bog characteristics, with three species having a negative response and two species having a positive response to forestry.
- Most bogs had only 0-20 % adjacent forest harvest within 100 m over a 30 year period (1975-2005). Most sites were associated with up to 2400 m of road regardless of the site being in a forestry or protected area.
- Analyses of the relationship among species diversity, bog characteristics and forestry are ongoing.

YEARS OF DATA

- Year 2 of a 2 year project

PARTNERS

- Bowater Mersey Woodlands
- Nova Scotia Department of Natural Resources, Wildlife Division
- Acadia University
- Mount Allison Dendrochronology Lab
- Nova Forest Alliance
- Nova Scotia Habitat Conservation Fund
- Mersey Tobeatic Research Institute
- Natural Sciences and Engineering Research Council
- Parks Canada
- Nova Scotia Department of Environment and Labour, Protected Areas Branch
- Atlantic Dragonfly Inventory (Paul Brunelle)

Meadowhawk dragonfly, a common treed bog species (Photo by D.Hurlburt)

Microscopic identification of Tabanid flies (Photo by D.Hurlburt)

CONTACTS

Donna Hurlburt
Bowater Mersey Woodlands;
Acadia University
RR#1 Annapolis Royal, NS B0S 1A0
Ph. 902-532-1341
Fx. 902-532-1341
donna.hurlburt@ns.sympatico.ca

Rationale

Wetlands provide critical habitat for aquatic and semi-aquatic species, as well as for many terrestrial species at key points in their life cycle. In Nova Scotia, a large proportion of species at risk occur in inland wetlands. These populations represent a rich biodiversity heritage whose natural history has been shaped by past environmental changes and will be vulnerable to future changes in climate and human activity. Understanding the impacts of past environmental changes on the distribution and abundance of these species is essential to predict vulnerability to future environmental change. Nova Scotia has a long history of intensive forestry, especially in its southern regions. Forestry-related activities often required the flooding of wetlands, the effects of which may have been profound for resident wildlife populations. This project is an initial effort to examine these effects by documenting post-European contact changes in species at risk populations of southwestern Nova Scotia. Specifically, the history of water impoundments ("dams") throughout this region for the past 200 years will be obtained.

Research

EFFECTS OF DAMS ON WETLAND SPECIES AT RISK

This dam remnant, located in the southern end of Tobeatic Lake, is typical of dams left over from the days of log driving in Mersey watershed (Photo by K. McKendry)

OBJECTIVES

- To locate all dams and dam remnants in the Mersey and Medway watersheds.
- To determine the effects of dams (historic and present) on the distribution of select wetland-dependent species as risk in southwestern Nova Scotia.

METHODS

- Historic literature, maps and local informants were used to estimate approximate locations of dams (past and present).
- Dam coordinates were recorded using GPS (digital photos also taken).
- A map was constructed using GIS software overlaying the water bodies of the Mersey and Medway watersheds, dam locations, and distribution data for select species at risk.
- Geostatistical analyses were performed to examine the effects of dams on species at risk population distributions.

Some of the best clues to the location of old dams are found onshore, as is the case with this spike protruding from an old spillway (Photo by B. Caverhill)

RESULTS

- Over 90 dams and dam remnants were located in the study area during the summer of 2006. Most were located thanks to the directions given by local informants.
- GIS analysis are expected to be complete by summer of 2007.

YEARS OF DATA

- Year 1 of a 2 year project

PARTNERS

- School for Resource and Environmental Studies (Dalhousie University)
- Acadia University
- Atlantic Centre for Global Change and Ecosystems Research
- Mersey Tobeatic Research Institute
- Parks Canada
- Bowater Mersey Paper Company
- Nova Scotia Department of Environment and Labour

This hydroelectric dam, owned by Nova Scotia Power, plays an important role in providing electricity to local communities (Photo by K. McKendry)

CONTACTS

Karen McKendry
School for Resource and Environmental Studies
Dalhousie University
6100 University Av., Suite 5010
Halifax, NS B3H 3J5
Ph. (902) 483-8179

Tom Herman
Biology Department
Acadia University,
Wolfville, NS B4P 2R6
Ph. (902)585-1469
Fx. (902) 585-1059
tom.herman@acadiau.ca
http://ace.acadiau.ca/science/biol/

Rationale

Soils that are frequently wet or moist pose significant challenges to land managers. These areas are often associated with important ecological flows (e.g., water, nutrients, dissolved organic carbon, water colour, sediment), as well as unique flora and fauna (e.g., wetland perimeters, stream side riparian zones, vernal pools). At the same time, these areas are highly susceptible to damage from management actions that do not recognize their inherent hazards (e.g., rutting and/or compaction, erosion, flow channel alteration, change in soil drainage, loss of habitat). Until recently, land managers and land-use planners have had no tools to systematically locate potential wet areas and habitats across the landscape with sufficient resolution for operational planning. The capability now exists, however, to develop such a tool for the entire province of Nova Scotia, based on proven technology. This tool is a digital, high-resolution map, which will identify areas that are potentially wet and/or subject to water inundation and flow.

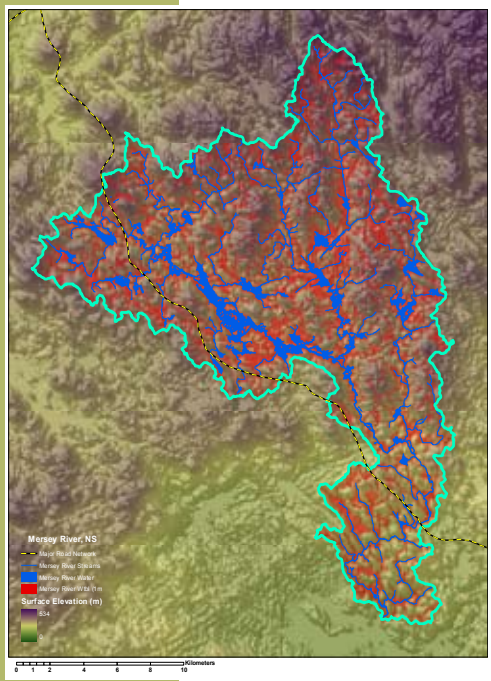
Small stream in Mersey watershed (Photo by A. Lavers, MTRI)

Research

WET AREA AND FLOW CHANNEL MAPPING

OBJECTIVES

- To produce a digital map (10 m resolution) showing potential water retention areas and flow channels associated with perched watertables and surface water bodies across Nova Scotia.
- To refine and update the potential wet areas map based on extensive ground verification work. Verification and updated map production will take place during year two of this project.
- To interpret the high-resolution wet areas features in terms soil, site, wetland and habitat classification, from physical, chemical and biological perspectives (*e.g.,* assessment of terrain trafficability, soil resistance to tree blow-down, relation between stream colour and wet area percent per watershed, distribution of bryophytes and other wetland-obligate species).



Mersey River wet area and flow channel map

METHODS

- An ArcView-based mapping methodology was used.
- Flow accumulation was charted based on digital elevation model (DEM) data and water bodies.
- Watershed boundaries (flow areas) were delineated.
- Likely depth to water during wet seasons was automatically derived and displayed based on local DEM data and locations of water bodies within the topographic grid. The process was further refined by considering the likely area needed to produce surface water flow within accumulation zones, as dictated by local depressions and soil substrate permeability.

RESULTS

- A map displaying ephemeral channels and the probable depth to surface water at the high water mark at any location in NS was developed in the fall of 2005
- In the summer and fall of 2006, a verification process was conducted to compare derived flow accumulation patterns with known locations of flows based on field checks and/or comparisons with more detailed maps and aerial photos.
- An improved wet areas map is anticipated for the spring of 2007.

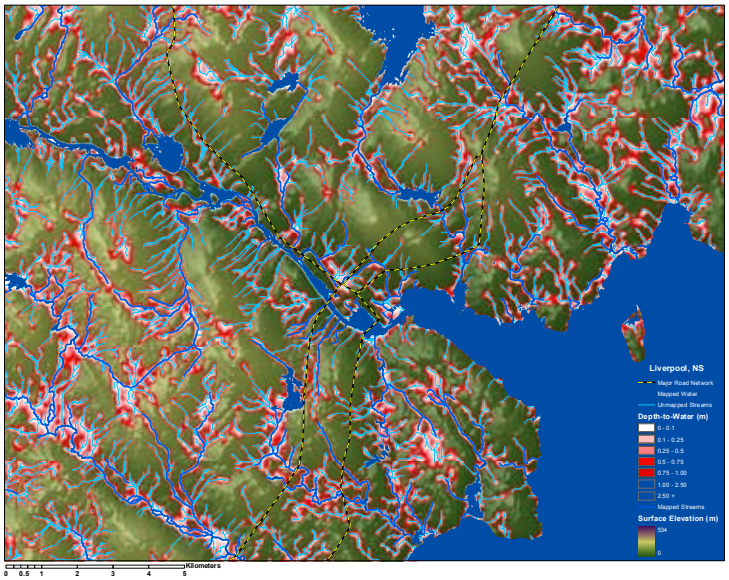
YEARS OF DATA

- Year 2 of a 3 year project

PARTNERS

- Nova Scotia Department of Natural Resources
- University of New Brunswick
- Nova Forest Alliance
- Bowater Mersey Paper Company Ltd.
- J.D. Irving Ltd.
- Stora Enso
- Neenah Paper
- Agriculture Canada
- Nova Scotia Department of Environment and Labour
- Parks Canada
- Pockwock/Bowater Watershed Research Project

Ephemeral wet area with fungi (Photo by A. Lavers)



Liverpool wet area and flow channel map

CONTACTS

Paul Arp
Faculty of Forestry and Environmental Management
University of New Brunswick
PO Box 44555
Fredericton, NB E3B 6C2
Ph. (506) 453-4931
Fx. (506) 453-3538
arp2@unb.ca

Photos from top to bottom:
• Kayaker with Great blue heron (Photo by P. Hope, Parks Canada)
• Child smelling wild flowers (Photo by L. Maurice, Parks Canada)
• Skiing under old hemlock on Hemlock & Hardwoods trail (Photo by Parks Canada)

HUMAN DIMENSIONS

Rationale

Southwest Nova Scotia is one of Canada's "Biodiversity Hot Spots". It is home to many rare and endangered species, including reptiles, mammals, birds, fishes and plants. Researchers, managers and staff from Kejimkujik, Acadia University, Bear River First Nations, MTRI and other partners are working together in the Southwest Nova Biosphere Reserve (SNBR) to help recover the Species at Risk (SAR) that live there. Together, they are learning interesting and useful information about SAR in this region of Nova Scotia. This information is shared with the public and serves to excite, engage and guide interested individuals, families and communities to become stewards of these species and the habitat in which they live. This three year project is funded by the Parks Canada's Priority Investment Fund for Species at Risk Recovery and is one of the most targeted efforts in Canada to recover SAR by involving public volunteers and stewardship.

Park warden working with park visitors on ribbonsnake monitoring at Kejimkujik (Photo by B. Caverhill, Parks Canada)

Monitoring

SPECIES AT RISK STEWARDSHIP IN THE SNBR

OBJECTIVES

- To help recover SAR in the SNBR, focusing on Blanding's turtle, Eastern ribbonsnake, Piping plover, Southern flying squirrel, Monarch butterfly and Water-pennywort.
- To engage Kejimkujik visitors and residents of the SNBR in the research and recovery of SAR.
- To promote environmental stewardship in southwest Nova Scotia, and increase public awareness regarding SAR conservation.

METHODS

- Engaging outreach strategies and activities were developed and delivered to increase public awareness by, for example, visiting major community fairs in southwestern Nova Scotia with an interpretive booth, bicycling to high schools around the SNBR in fall 2006, visiting elementary schools in southwestern Nova Scotia with North Queens Elementary Enrichment Program students presenting "Species at Risk in Our Backyard", a film they developed last year.
- Simple, useful and fun volunteer opportunities were 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 were established with individuals and organizations (school, government, NGO, Mi'kmaw and industry) that work with SAR in Nova Scotia to enhance communication and collaboration and ultimately the recovery of SAR.

RESULTS

R. Baird, receiving his "Lifetime Achievement Award" from Kejimkujik superintendent H. Delong at Volunteer Celebration 2006 (Photo by D. Smith, Parks Canada)

- 2500 individuals were reached during summer 2006 exhibition tour; 250 expressed interest in participating in activities; more than 25 of those are already engaged in several volunteer activities.
- 800 high school students participated in presentations during fall 2006 bike tour around SNBR; over a dozen schools participating in "The SAMPAA challenge: linking art & science in the SNBR."
- Over 3000 Kejimkujik visitors learned about SAR, issues SAR face and how they can help during the summer through onsite and evening theatre programs; many individuals were inspired to get actively involved in a recovery activity.
- In August, three headstarted hatchlings were released at Grafton Lake in Kejimkujik. More than 250 volunteers, community members, local Mi'kmaw and park visitors came out to celebrate their release. Bear River First Nation helped celebrate their release with prayer, traditional music and dance as well as sweet grass and naming ceremonies. Members of the local, volunteer and Mi'kmaw communities released the three turtles.
- Close to 700 individuals directly contributed to SAR Recovery Initiatives through activities designed and delivered by the Kejimkujik stewardship coordinators. These individuals contributed to one or more of the following activities: Blanding's turtle trapping, visual surveys and radio tracking, nest protection and monitoring, Piping plover Habitat Restoration, Atlantic Coastal Plain Flora monitoring and Eastern ribbonsnake surveys.
- 100 Nova Scotians attended a volunteer banquet in December 2006 to celebrate the 47,000 hours of volunteering that have been recorded in these (and other) programs in the Greater Kejimkujik Ecosystem since 2000.

YEARS OF DATA

- Year 1 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

CONTACTS

Brennan Caverhill & Duncan Smith
Kejimkujik
PO Box 236
Maitland Bridge, NS
Ph. (902) 682 2770
Fx. (902) 682 3367
brennan.caverhill@pc.gc.ca
duncan.smith@pc.gc.ca
www.speciesatrisk.ca
www.friendsofkeji.ns.ca

S. Moore working with her SAR Enrichment Elementary Students on Atlantic Coastal Plain Flora Monitoring at Kejimkujik (Photo by B.Caverhill, Parks Canada)

Rationale

Historically, the rivers and lakes of southwest Nova Scotia have provided the easiest routes for traveling through the interior. Mi'kmaw oral history and French records as early as 1686 indicate that the Allains and Mersey Rivers formed an important portage route between the Bay of Fundy and the Atlantic coast. Previous archaeological research from Kejimkujik, Lake Rossignol and the lower Mersey River has revealed 4000 – 7000 years of occupation by the Mi'kmaq and their ancestors in this area. However, prior to last summer, archaeological studies had not been conducted on the upper Mersey, north of Kejimkujik Lake, and only limited investigations had been conducted on the Allains River, near Annapolis Royal. The goal of this research was to identify new sites along the upper Mersey River, which would bridge the gap between the 200 known sites along the lower Mersey River and the sites from the Lequille area.

Volunteers D. Pentz and R. Marotte excavate at Fisher Lake (Photo by B. Pentz)

Research

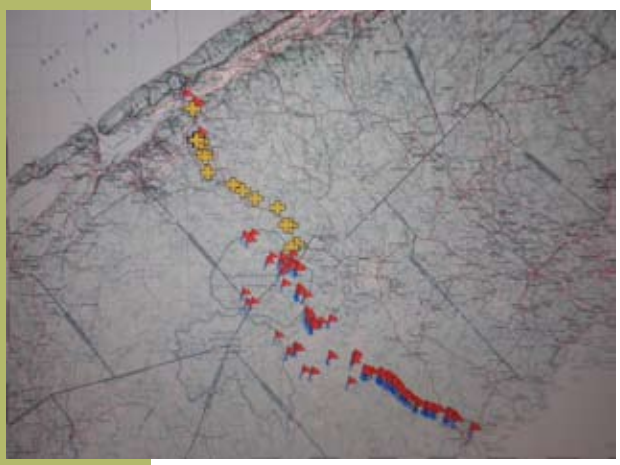
UPPER MERSEY RIVER ARCHAEOLOGICAL SURVEY

OBJECTIVES

- To identify and record new archaeological sites along the upper Mersey and Allains River drainages.
- To determine the age and cultural affiliation of sites identified.
- To demonstrate the movement of people and trade goods along the Mersey/Allains Corridor.
- To establish archaeological evidence to support the written and oral histories that describe the Mersey and Allains Rivers as important portage routes between the Bay of Fundy and Atlantic coast.

METHODS

- A spring canoe trip through the study area provided a first hand appreciation of the landscape.
- The route was divided into nine regions with the goal of identifying at least one site in each region.
- Areas with the highest potential for archaeological evidence of early Mi'kmaw occupation were prioritized. Shovel-test samples were placed at these high potential areas to identify cultural material. When a site was identified, additional shovel-tests were placed to determine the extent of the site.
- Several 1 x 1 m evaluative units were carefully excavated at three of the larger sites to recover additional cultural materials and to better understand the soil horizons and vertical distribution of artifacts at the site.



Map of southwest Nova Scotia showing the distribution of Mi'kmaq sites along the Mersey and Allains Rivers. Yellow crosses represent the new sites identified during the 2006 field season.

RESULTS

Quartz point from Fisher Lake (Photo by B.Pentz)

- During the 2006 field season, 12 new Mi'kmaw sites (campsites, portage trails and stone fish-weirs) were recorded in the field and three additional sites were identified from artifacts held in local private collections. Three sites of European origin were also recorded, including a lumber mill built ca. 1825.
- At least one site was found in each of the nine regions of the study area, establishing a continuous line of archaeological sites between Liverpool and Annapolis Royal.
- Many sites featured artifacts made from non-local materials, such as agate/jasper, chalcedony and quartzite, which are sourced from the Minus Basin area of the Bay of Fundy. These artifacts were found in a cultural context and some were made into tools, indicating that these materials were transported and deposited at the sites by people, as opposed to natural processes. Many artifacts made from these same materials have been found all along the lower Mersey, demonstrating that the Mersey/Allains Corridor was an important trade and travel route between the Fundy and Atlantic coasts.
- Decorated Mi'kmaw pottery and the base of side-notched arrowheads from three sites along the upper Mersey revealed that these sites are between 500 – 1600 years old. Artifacts examined in private collections indicate that the Allains River drainage has been used for at least 5000 years.

YEARS OF DATA

- Single year project

PARTNERS

- Minus Basin Archaeological Survey
- Saint Mary's University – Summer Student Employment Program
- Social Sciences and Humanities Research Council
- Kwilmuk Maw-klusuaqn: Mi'kmaq Rights Initiative
- Parks Canada
- Nova Scotia Museum
- Bowater Mersey Paper Company
- Mersey Tobeatic Research Institute

Historic fish weir near Maitland Bridge (Photo by B. Pentz)

CONTACTS

Ben Pentz and Michael Deal
Department of Anthropology,
Memorial University of Newfoundland
St John's, NL A1C 5S7
Ph. (709) 737-8864
b_pentz@hotmail.com

Rationale

By expanding the learning experience of students outside of the school building, children can explore, connect to and develop a deep knowledge of place. In this way, learning will be connected to the socio-cultural and ecological aspects of place, putting the environment and human knowledge of it at the core of the curriculum. To date, learning projects have been centered on forests, species at risk and fish.

DVD created by North Queens Elementary students

Research

PLACE-BASED EDUCATION

OBJECTIVES

- To enhance the learning of students through educational experiences in the local area.
- To connect students with the ecological research and monitoring that is taking place in the SNBR, particularly the Kejikujik area.
- To consider local ecological knowledge, Mi'kmaw teachings and scientific perspectives regarding aspects of the area in order to understand the socio-cultural context of knowledge.
- To develop critical thinking skills regarding knowledge systems.

METHODS

- Cross-curriculum, cross-grade environmental projects were initiated within the community.
- An action research model of education based in inquiry, experience and evaluation of the learning was developed and employed.
- Students worked with community members to learn about aspects of the local environment and then produced educational resources that reflect that learning.
- Teachers critically evaluated the relation of knowledge systems and the assumptions of learning as they were reflected in each project.

Forests of southwest Nova Scotia (Photo by S. Moore)

RESULTS

- Participants produced multimedia/print-based education resources that will, in turn, enrich the learning of other students. In this way students are both learners and teachers.
- Learning has been assessed on the basis of students' understanding of the social construction of knowledge and recognition of the impact of socio-cultural values on the environment.

Student studying trees (Photo by S. Moore)

YEARS OF DATA

- Ongoing project since 2005

PARTNERS

- Parks Canada
- Nova Scotia Teacher's Union
- Mersey Tobeatic Research Institute
- North Queens School

CONTACTS

Sylvia Moore
North Queens Schools and
Lakehead University
RR#4, Annapolis Royal, NS
Ph. (902) 682-3500
sdmoore@staff.ednet.ns.ca

Rationale

Lake Rossignol Wilderness Area has had little ecological research in the past. As a result, little is known about the biota (flora and fauna) that occur there. In order to manage this protected area effectively and ensure that ecological integrity is maintained, more information about the organisms that live there is needed. An effective way to acquire information very quickly is to do intensive inventories on a variety of groups of organisms over a short period of time.

Indian pipe is one of many vascular plants recorded and collected during the Bio-Blitz (Photo by R. Cameron, NSDEL)

Research

BIO-BLITZ: INTENSIVE, SHORT DURATION, BIOLOGICAL INVENTORY

OBJECTIVES

- To document as many species as possible living in the Lake Rossignol Wilderness Area.
- To identify rare or threatened species occurring there.
- To provide a forum for biologists from a variety disciplines to interact.

METHODS

- Thirty-eight scientists and volunteers from 10 disciplines were invited to Lake Rossignol Wilderness Area between 26 and 29 July, 2006.
- Inventories occurred in the following groups: aquatic invertebrates, bryophytes, flying squirrels, lichens, vascular plants, Eastern ribbonsnakes, Blanding's turtle, fungi and fish.
- Scientists also did tree ring aging and inventoried native medicinal plants.

Scientists and volunteers relax at camp during a potluck supper the first night (Photo by R. Cameron, NSDEL)

RESULTS

- Although species are still being identified, it is estimated that well over 200 species will be documented.
- Sightings of rare species include several orchids, mosses and the nationally threatened Eastern ribbonsnake.
- Trees over 250 years old were found in the Bowater Mersey-Nature Conservancy of Canada conservation easement adjacent to the Wilderness Area.

YEARS OF DATA

- Single year project

PARTNERS

- The following institutions participated:

  Acadia University, Dalhousie University, L'sitkuk Environment, Mersey Tobeatic Research Institute, Mount Allison University, Nova Scotia Museum of Natural History, Nova Scotia Environment and Labour, Nova Scotia Youth Conservation Corps, Saint Francis Xavier University.

- The following individuals participated:

  Frances Anderson, Robert Cameron, Brennan Caverhill, Diane Clapp, Harold Clapp, Bethany Coulthard, Crystal Doggett, Sarah Hart, Leif Helmer, Scott Hubley, Donna Hurlburt, Tara Imlay, Shalan Joudry, Peter Kydd, Amanda Lavers, Sarah MacPhee, Robby Marrotte, Katie Marshall, Pierre Martel, Will Meuse, Melanie Meuse, Sean Mitchell, John Mitchell, Chris Morton, Tom Neily, Katie Nickerson, Natasha O'Neill, Jeremy Peck, Ben Philips, Catherine Pross, Lisa Proulx, Gini Proulx, Carolyn Rearden, Kyle Rowter, Christopher Taylor, Josephine Todd, Julie Towers, Ron Williams.

Mount Allison University Dendrochronolgy Lab researchers core an old growth hemlock to determine tree age (Photo by R. Cameron, NSDEL)

Scientists and volunteers set live traps for flying squirrels (Photo by R.Cameron, NSDEL)

CONTACTS

Robert Cameron
Nova Scotia Environment and Labour
Protected Areas Branch
PO Box 697, Halifax, NS, B3J 2T8
Ph. (902) 424-2176
Fx. (902) 424-0501
camerorp@gov.ns.c
www.gov.ns.ca/enla/paareas

Rationale

It has long been recognized that protected areas do not exist in isolation from their surrounding regions. Ecological, economic and socio-cultural interactions between protected areas and their surrounding regions occur on a regular basis within the context of a politicized environment, a lack of knowledge and a great deal of complexity. A regional, multi-stakeholder and co-operative approach to protected area management is needed. The term 'regional integration' means the integration of a protected area into its surrounding region in order to address the challenges that exist in the context of its interaction with its surrounding region. Regional integration initiatives can involve building partnerships, collaborating and cooperating with actors within a protected area's surrounding region; increased public participation in protected area management and planning; or engaging in ecological integration initiatives such as joint monitoring programs.

Research

EXPLORING THE REGIONAL INTEGRATION OF PROTECTED AREAS

OBJECTIVES

Peskowesk Lake, Kejimkujik (Photo by J. McCleave)

- To develop the theory and improve the practice of the regional integration of protected areas.
- To answer the following four primary research questions:

  (i) What are the critical interactions between national parks and their surrounding regions and what management challenges do they raise?

  (ii) How have the interactions between national parks and their surrounding regions been addressed by protected area managers and other actors?

  (iii) How is the concept of regional integration currently defined and practiced within the context of national parks in Canada?

  (iv) How can the regional integration of Canada's national parks be improved?

METHODS

- Four case studies were selected: Kejimkujik National Park and National Historic Site of Canada; Gros Morne National Park, Waterton Lakes National Park; and Mount Revelstoke National Park.
- Qualitative research methods were used.
- Semi-structured interviews were conducted with Parks Canada staff, biosphere reserve board/committee members, provincial and local government representatives, local business owners and other relevant stakeholders.
- 25-35 people were interviewed at each case study site.

RESULTS

- Interviews in the Kejimkujik region were conducted during the spring and summer of 2006.
- Analysis is currently underway.
- Preliminary results indicate that national parks in Canada have different approaches to 'doing' regional integration. There are examples of innovative ways to move regional integration from an issue-based, reactionary approach to a more regular, structured approach.
- There seems to be a correlation between the physical geography and history of a national park and its region and its approach to regional integration.
- Biosphere reserve boards and programs can be important mechanisms in which national park employees can communicate with regional stakeholders, although they are not always used to their full potential.
- For more information, please visit http://www.juliamccleave.ca

Conducting an interview (Photo by J. McCleave)

YEARS OF DATA

- Year 1 of a 3 year project

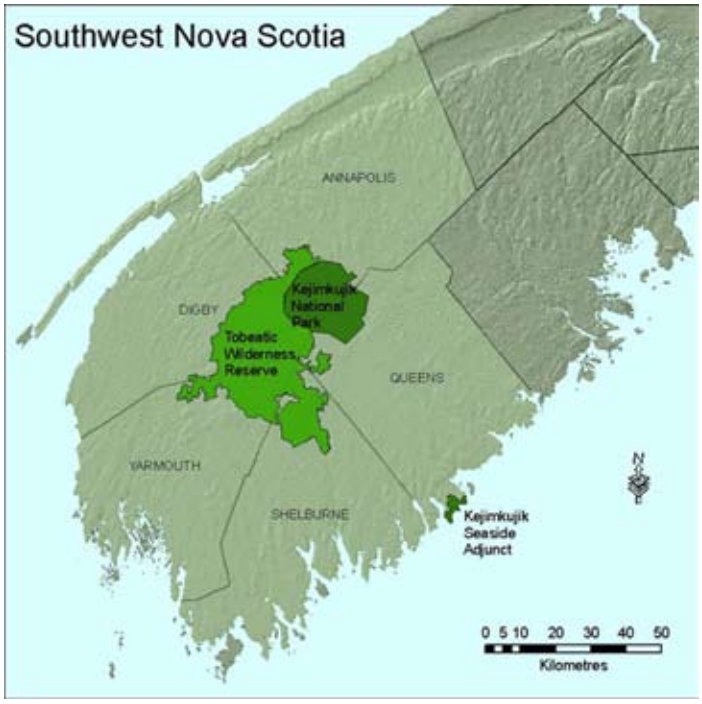
PARTNERS

- University of Waterloo
- Canon National Parks Science Scholars Program
- Social Science and Humanities Research Council of Canada
- Parks Canada
- Southwest Nova Biosphere Reserve Association
- Mersey Tobeatic Research Institute

CONTACTS

Julia McCleave
Department of Geography
University of Waterloo
PO Box 8635
Revelstoke, BC V0E 2S2
Ph. (250) 837-3665
Fx. (250) 837-3675
j2mcclea@fes.uwaterloo.ca
http://www.juliamccleave.ca

Scott Slocombe
Department of Geography and
Environmental Studies,
Wilfrid Laurier University
75 University Ave. W.
Waterloo, ON N2L 3C5
Ph. (519) 884-0710 x 2781
Fx. (519) 725-1342
sslocomb@wlu.ca
http://www.wlu.ca/~wwwgeog/facstaff/slocombe.htm



Map of Southwest Nova Biosphere Reserve (Map courtesy of the SNBRA and the Nova Scotia Geomatics Centre)

Rationale

Protected areas affect local communities' access to and use of local natural resources and consequently, conflict can arise between local communities and government with respect to protected areas management. The biosphere reserve program may offer opportunities for place-based governance, which involves formal and informal arrangements with multiple stakeholders engaged in long-term planning, integrative decision-making and resource management. Increased public engagement can contribute to a democratic, regionally legitimate, well-informed decision-making process. Improving the effectiveness of public participation in place-based governance for socio-ecological sustainability requires implementing a strategic, inclusive, transparent process, having enabling, respectful, constructive engagement and delivering efficient, meaningful and instrumental outcomes. Examining the challenges, opportunities and real-life experiences from implementing regional land-use planning and comparing them against the scholarly discourse are an important part of understanding and improving place-based governance and socio-ecological sustainability.

Research

PLACE-BASED GOVERNANCE IN TWO PROTECTED AREAS

White pine tree in Kejimkujik (Photo by S.Rehman)

OBJECTIVES

- To answer the research question: How can stakeholders participate in the implementation of conservation planning and how has participation contributed to decision-making processes in Southwest Nova Biosphere Region, NS and Burnt Cape Ecological Reserve region, NL.
- To examine the usefulness of the selected public participation criteria through field research and the role of public participation to place-based governance.
- To assess the actual level of public participation in two case studies by applying public participation criteria.
- To explore the challenges to and opportunities for participation faced by communities engaged in conservation projects in two Atlantic Canada sites.

METHODS

Pond south of MTRI (Photo by S. Rehman)

- A purposive sampling technique was used to select the two case studies: Burnt Cape Ecological Reserve region (BCER), NL, and the SNBR region.
- Methodology included literature review, participatory observation, document analysis and semi-structured interviews. Preliminary participant observation, document analysis and key stakeholder identification determined the initial interview participants and subsequent selection was through snowball sampling (a sampling technique that subsequent individuals are identified by the preliminary participants).
- Data collection efforts focused on direct stakeholders: local scientists, local residents, local business representatives, park staff, government representatives, educators, members of community development agencies, non-government organizations and local decision makers.
- Data analysis used a sequence of coding techniques, including open coding, axial coding and selective coding for developing grounded theory.

RESULTS

- The selected criteria offered a useful guide to assess effective public participation because the criteria assign fair attention to public engagement, the process and the outcomes, presenting a flexible and comprehensive list of qualities to examine.
- Meeting the public participation criteria should contribute to an accessible, fair and legitimate decision-making system. At the same time, fulfilling these criteria may not ensure political equity or develop a shared sense of purpose and engage relevant stakeholders unless efforts are made to map and incorporate local values, stories and interests that define, distinguish and turn a space into "place".
- Public participation during BCER's designation process exemplified the best contributions to decision-making processes because public input and information flowed between stakeholders but less so during the management phase. Because SNBR is still in its formative years, public participation remains limited to current stakeholders and mostly focuses on research and monitoring activities around the core area.
- BCER's designation stage was an example of effective public participation because it was strategic, inclusive, enabling, instrumental and meaningful. Participation during BCER's management stage is less effective because it does not fully meet any of the criteria and fails to be transparent. SNBR's public participation can be considered inclusive because many key stakeholders are engaged with a high level of respect. SNBR's substantial efforts to gaining formal endorsements from regionally important stakeholders and inadequate financial support have limited the initiative's full implementation.
- All stakeholders and sponsoring agencies need to recognize and accept the long-term commitment and economic support needed to produce sustainable and positive changes.

Mersey River (photo by S. Rehman)

YEARS OF DATA

- Single year project

PARTNERS

- Southwest Nova Biosphere Reserve
- Mersey Tobeatic Research Institute
- University of Waterloo's Biosphere Reserve Sustainability Project

CONTACTS

Sami Rehman
Environment and Resources Dept.
University of Waterloo
rehmans@hotmail.com

Scott Slocombe
Department of Geography and
Environmental Studies,
Wilfrid Laurier University
75 University Ave. W.
Waterloo, ON N2L 3C5
Ph. (519) 884-0710 x 2781
Fx. (519) 725-1342
sslocomb@wlu.ca
http://www.wlu.ca/~wwwgeog/facstaff/slocombe.htm

Criterion	Burnt Cape Ecological Reserve		SW Nova Biosphere Reserve
	Designation	Management	
Strategic timelines; objectives, goals			
Inclusive fairness; involving stakeholders			
Transparent clear process; how & who?			
Enabling accessible to all; valuable input			
Respectful good relationships; trust			
Constructive exchange and feedback			
Instrumental meeting goals & objectives			
Meaningful relevant; influential			

Met Criterion | Somewhat met criterion | Did not meet criterion

Comparative summary of project results with respect to eight selection criteria

Rationale

A patterns of visitor use study is underway at Kejimkujik to document and describe how visitors move through and identify patterns in visitors' movements and activities. Seven methods of surveying were undertaken including: an intercept interview, visitor information program survey, trip diary, visitor employed photography, trackstick research on waterways and in backcountry areas and trail, traffic partition study/traffic counter, and traffic counters in locations throughout the park. The information gathered by this study will describe what areas of the park are most popular and whether changes such as promotion or de-emphasis is necessary to increase usage or protect the ecological integrity of different park areas.

GPS data logger in bow of canoe (Photo by Parks Canada)

Research

PATTERNS OF VISITOR USE

OBJECTIVES

- To estimate the number of visitor arrivals to Kejimkujik by month.
- To calculate the number of visitors arriving by category of vehicle.
- To evaluate visitors' satisfaction with specific activities, facilities and services and determine visitors' understanding of key heritage themes
- To document the travels and whereabouts of visitors within Kejimkujik's boundaries including main roads, secondary roads, trails and waterways.

METHODS

- Intercept interviews were conducted near the main traffic counter at the entry gate. A staff member collected information including the number of visitors and the vehicle type.
- First-time entry visitors were given an extensive interview and offered either: (i) a visitor information program survey to evaluate satisfaction with activities, facilities and services, and to determine visitors' understanding of key heritage themes; (ii) a trip diary booklet to record their travels, activities and general trip patterns over the course of their visit to Kejimkujik; (iii) single-use cameras and a booklet, to visually document their park visit memories.
- A number of tracksticks (GPS data logger) were deployed with visitors to backcountry areas to record the travels of visitors while traveling on the waterways found within Kejimkujik's boundaries.
- Trail and traffic counters were installed in various locations throughout the park to monitor the use of Kejimkujik's main roads, secondary roads and trails.

Trail counter installed on the Farmlands trail (Photo by Parks Canada)

RESULTS

C. Brigley installing a trail counter during bug season (Photo by Parks Canada)

- At Jake's Landing 127 tracksticks were deployed, recording approximately 400 – 500 of over 5000 rentals over the season or approximately 10 % of rentals.
- Results of the trackstick study will be used to identify areas that require additional interpretation efforts or additional protection and to create a human use layer to existing Kejimkujik GIS data.
- Preliminary analysis indicates that because tracksticks are issued at the entrance gate, the tracksticks record data as people drive to Jakes Landing. The data is useful to measure compliance with park initiatives including the Blanding's turtle speed bumps and caution signs (see pp. 102-103).
- 107 sets of back country travel log sheets were returned from trip diaries (there were approximately 5000 back country person visit site nights in the 2006 season).
- On average trip diaries indicated 30 activities per sheet.
- Detailed results will be available next year and will be used to guide similar programs at other Canadian National Parks.

YEARS OF DATA

- Single year project

PARTNERS

- Nova Scotia Community College, Centre of Geographic Sciences
- Parks Canada

Example of a camera used for the visitor employed component of the study (Photo by Parks Canada)

Surveying park visitors at park entrance (Photo by Parks Canada)

CONTACTS

Alain Boudreau
Parks Canada
1869 Upper Water St.
Halifax, NS B3J 1S9
Ph. (902) 426-2746
Fx. (902) 426-9199
alain.boudreau@pc.gc.ca

APPENDIX

	Kejimkujik	Greater Kejimkujik Ecosystem	Monitoring	Research
Coastal				
Piping Plover Monitoring Program	X		X	
Piping Plover Habitat Management Project	X			X
Dissolved Oxygen Levels in Lower Annapolis River		X		X
Soft-shell Clam Survey, Annapolis Basin		X		X
Projects not included in this report:				
Validating the Occurrence of Ramalina in Maritime Canada	X			X
Delineating Critical Habitat for Piping Plover using Remote Sensing	X	X		X
Forest				
Caledonia Christmas Bird Count		X	X	
Nocturnal Owl Surveys	X	X	X	
Southwestern Nova Scotia Marten Distribution	X	X	X	
Small Mammalian Predator Detection	X		X	
Distribution of the Eastern Pipistrelle Bat	X	X	X	
Salamander and Decomposition Monitoring	X		X	
Keji Quest: Involving Youth in Ecological Monitoring	X		X	
Air Quality Monitoring with Lichens		X	X	
Lichen Monitoring	X		X	
Floristic Inventory of Forest Monitoring Plots	X		X	
Monitoring Flying Squirrel Survivorship and Fecundity		X	X	
Diet of Northern and Southern Flying Squirrels		X		X
Distribution and Recruitment of Red Oak	X			X
Reconstruction of Natural Fire Disturbance History	X			X
Managing Old Forests for Landscape Connectivity		X		X
Old Growth Forests Values of Citizen Constituencies in Nova Scotia		X		X
Lichens in Old Growth Forests		X		X
Ecological Effects of Forest Roads		X		X
Forest Ecosystem Classification		X		X
Ecology and Management of the Pale-winged Gray Moth	X			X
Understorey Changes in Hemlock Forests	X			X
Forest Bird Response to Canopy Defoliation	X			X
Forest Birds and Riparian Buffers		X		X

	Kejimkujik	Greater Kejimkujik Ecosystem	Monitoring	Research
Honest Signaling of Pairing Status in Warblers	X			X
Songbird Detectability During Point Counts	X			X
Projects not included in this report:				
Ground Vegetation Monitoring	X		X	
Coarse Woody Debris Monitoring	X		X	
Forest Bird Point Count Surveys	X		X	
Invasive Plant Trail Monitoring	X		X	
White-tailed Deer Roadside Survey	X		X	
Hemlocks and Hardwoods Trail Use Monitoring	X		X	
Bedrock Mapping of the South Shore	X	X		X
Acadain Forest Restoration at Jeremy's Bay Campground	X			X
Freshwater				
Annapolis River Guardians		X	X	
Stream Flow Monitoring	X		X	
The Kejimkujik - Mersey LoonWatch Program	X	X	X	
Mercury in Air and Precipitation	X		X	
Lake Thermal Sensitivity	X	X	X	
Cold Water Lake Habitat	X	X		X
Brook Trout Migration	X	X		X
Riparian Vegetation and Invertebrate Relationships	X	X		X
Assessing Aquatic Health Using Invertebrates	X	X		X
Projects not included in this report:				
Lake Water Chemistry Monitoring	X	X	X	
Cobrielle Dam Removal Monitoring	X		X	
Mersey Riparian Area Conservation	X	X		X
Wetland				
Rare Plant Monitoring		X	X	
Assessment of Coastal Plain Flora	X		X	
Water-pennywort Monitoring	X		X	
Silviculture Impacts on Peatlands	X	X	X	
Blanding's Turtle Nest Monitoring	X	X	X	
Radio-tracking Hatchling Blanding's Turtles	X	X		X
Blanding's Turtle Habitat Modeling	X	X		X
Assessing Blanding's Turtle Populations	X	X		X
Overwintering of Blanding's Turtles	X	X		X
Eastern Ribbonsnake Ecology	X	X		X
Eastern Ribbonsnake Distribution	X	X		X
Invertebrates as Indicators of Bog Health	X	X		X
Effects of Dams on Wetland Species at Risk	X	X		X
Wet Area and Flow Channel Mapping	X	X		X
Human Dimensions				
Species at Risk Stewardship in the Southwest Nova Biosphere Reserve	X	X	X	
Upper Mersey River Archaeological Survey	X	X		X
Place-based Education		X		X
Bio-Blitz: Intensive, Short Duration, Biological Inventory		X		X
Exploring the Regional Integration of Protected Areas	X			X
Place-based Governance in Two Protected Areas		X		X
Patterns of Visitor Use	X			X
Projects not included in this report:				
Biosphere Reserves and Community-based Ecosystem Management	X	X		X

Annual Report of Research and Monitoring in the Greater Kejimkujik Ecosystem 2006

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