Understanding implications of changing hydrology on the coastal biodiversity of Lakes Huron and Erie

Progress Report for 2011-2012

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This report is a progress report on the research funded by Sierra Club carried out from May to October in 2011. The three main projects share an overarching theme that examines threats to coastal biodiversity because of changes in the hydrologic regime of Lakes Huron and Erie. The first project provides an initial glimpse of how northern pike utilize wetland and nearshore habitat in Tadenac Bay and the surrounding region. The second is a comparison of home ranges of the Blanding's turtle (species at risk) in two protected areas (Beausoleil Island of Georgian Bay Island National Park and Rondeau Bay Provincial Park) that have very different landscape features and experience different stresses. Since this is the first documented study of a Blanding's population on an island, a sub-project has been carried out to determine if turtles select for specific habitats before, during and after nesting as has been suggested by the literature. The third project examines the effects of rain effects and agricultural practices on the water quality of first-order streams in the Beaver River watershed. In this report, students are associated with each project, and the names with an underscore are the primary researchers.

PROJECT 1

Tracking movement of Northern pike (Esox lucius) among coastal wetlands of eastern Georgian Bay using radio-tracking *(Graduates: Jon Midwood, JohnPaul Leblanc; Undergrads: Chris Biberhofer, Dallas Taylor)*

Background

Coastal wetlands throughout the Great Lakes must be protected from human development because of the ecosystem services they provide. Those that are designated as "Provincially Significant" under the Ontario Wetlands Evaluation System (OWES) are offered some measure of protection from human development, but in order to be evaluated, wetlands must be > 2 ha. This size criterion is an impediment to conservationists who want to protect the coastal wetlands of eastern Georgian Bay because majority of these wetlands are < 2 ha. The OWES makes a provision, however, that if there is a clear biological rationale, and if complexes are within 750-m of each other, smaller wetlands can be linked together to form larger complexes that qualify them for OWES. We hypothesize that in the convoluted shoreline of eastern Georgian Bay, wetland-dependent piscivores such as the Northern Pike (*Esox lucius*) must forage in multiple coastal marshes and that often, these wetlands are separated by more than a linear distance >750 m. If our hypothesis is supported, then a separate OWES manual should be created for coastal wetlands of Georgian Bay that provides a more appropriate rule-set for complexing coastal habitats.

Northern pike exhibit extreme individual variations with respect to their daily movements (total distance ranging from 0 to 8km over the course of a day) and these can be attributed to differences in habitat characteristics within each study. Therefore, movement patterns observed in other regions cannot be directly applied to eastern Georgian Bay without field validation. To avoid any confounding effects of human disturbance, we chose to conduct our study in Tadenac Bay, a large embayment (>400 ha) in eastern Georgian Bay with about 70 ha of total aquatic wetland habitat (**Figure 1**), where there is limited angling pressure and no development along most of the shoreline. This location was also desirable because there is only one access point to Georgian Bay, and this potentially allowed us to track when an individual entered or exited our study area.

Objectives

Our overall objective for 2011-12 was to use radio-telemetry to track the movement of 12 individuals of Northern pike among coastal wetlands of Tadenac Bay. Specifically we wanted to identify the core activity centres where pike spend the majority of their time. We will then determine the number of wetlands found within each activity centres. A secondary objective is to determine the thermal tolerances of Northern pike in Tadenac Bay and to model the amount of thermal habitat available to pike as a function of different water-level scenarios.

Methods

Twelve pike were captured in trap nets (2 m x 3 m) that were set perpendicular from shore in a minimum water depth of 2 m and left overnight. Captured pike were kept in the net to await surgery. Pike were placed in a 60-L bucket containing 20 L of 60 ppm clove oil. Once pike no longer responded to external stimuli, their length and weight were measured and the sex was determined as per Casselman (1974). Pike were placed supine onto a U-shaped foam surgical table (see **Photo 1**). A maintenance anesthetic dose of 30 ppm of clove oil was pumped over their gills to maintain their anesthetized state. A small incision (2-3 cm) was made mid-ventral and anterior to the pelvic girdle. We also made a small hole on the left side of the body using a 16-gauge needle, and the transmitter antenna was run through this hole with help of the needle. A MCFT2-3A radio-transmitter (manufactured by Lotek, Newmarket, ON) was then inserted into the body cavity through the incision (see **Photo 2**). Each transmitter weighed 16 g and was16 mm in diameter and 46 mm in length. In all cases, the tags comprised less than 2% of the fish' body weight (Rogers & White 2007). Incisions were closed with two interrupted 3-0 monofilament sutures and at least 2 throws of a surgeon's knot. Following surgery, fish were placed on top of the trap net so that their recovery could be monitored and they would be immersed in water from their natural environment. Similar procedures have been used in multiple studies with low mortality rates (Cooke *et al.* 2003; Koed *et al.* 2006).

Tracking did not begin until two weeks after surgery to ensure that pike had recovered and had resumed their normal movement patterns (Rogerts & White 2007; Kobler *et al.* 2008). We conducted four weeks of intensive (morning, afternoon, and evening) surveys spread monthly throughout the summer. Daily surveys were conducted opportunistically between these four weeks. Surveys consisted of driving a set route by boat through our study area. During this drive, we used a Lotek F150-3FB radio antenna and a Lotek SRX_400A/WX5G manual tracking radio receiver to identify the location of the pike. During the afternoon survey, the location of the pike was recorded with a standard triangulation method. For the morning and evening surveys, however, we did not have sufficient time to carry out a triangulation and just used radio signals to provide a rough approximation of the general location of each pike. All sample locations (from both triangulation and approximation) were entered into a Geographic Information System (GIS) for further analysis. To determine if pike had left our study area, we established a base-station that consisted of a receiver and antenna powered by a marine battery. This station monitored the entrance/exit to the Bay 24-hours a day and recorded all pike passing by. Unfortunately, we determined early on that the base-station had some blind spots that allowed pike to move past without detection. The base-station failed completely in early August. Although all observations of pike from the base-station are included, we will not discuss these data independently.

Tidbit thermal dataloggers were installed at meter intervals in the locations indicated in **Figure 1**. Bathymetric data were also obtained in the general vicinity of these dataloggers in September 2011.

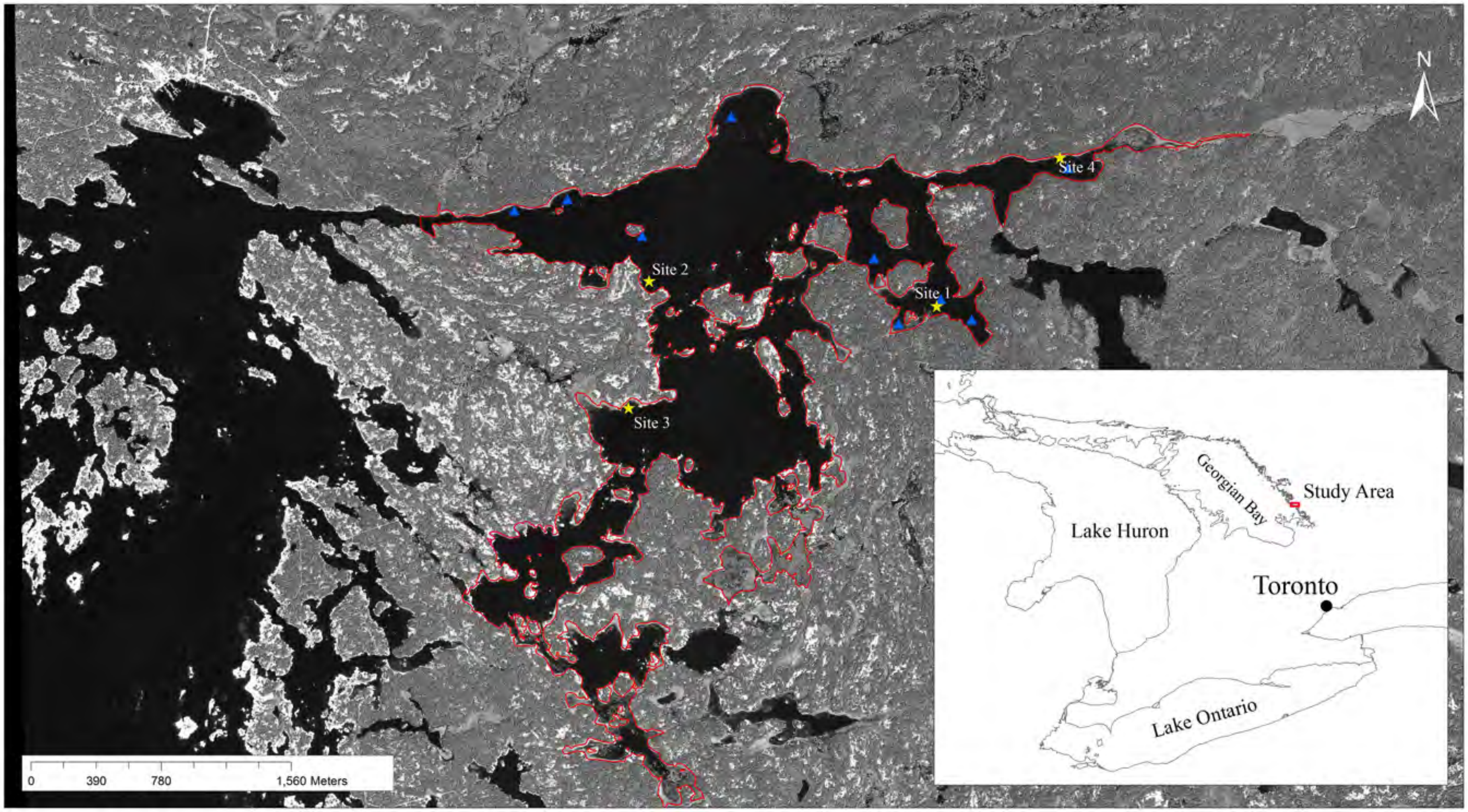

Figure 1. Location of Tadenac Bay within the Great Lakes basin. The red line defines the boundaries of our study area. Pike were observed to leave the study area through the lone entrance to the Bay. Initially tagging location for all pike are indicated with a star. Majority of pike were tagged at site 1 (Table 1). Blue triangles represent the locations where we set up continuous loggers to track seasonal changes in temperature.

Photo 1: The U-shaped foam surgical table is shown. The battery in the black box (left panel) was used to operate the pump that re-circulated water with 30 ppm of clove oil to keep the fish anaesthetized during the surgery. All surgeries were performed in the boat as shown.

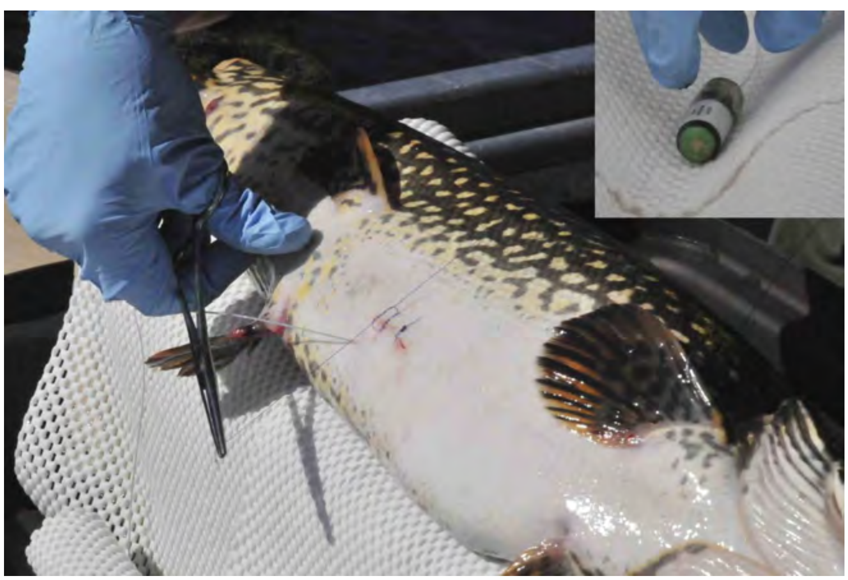

Photo 2: The implant operation involved a small incision in the abdomen of the fish, and insertion of the radio-transmitter (shown in inset) into the abdominal cavity. Two sutures were used to close the incision. Following a short period of recovery, the fish were released into the same waters where they were caught.

Table 1. Length, weight, sex, and estimated age (from Scott & Crossman 1998) for the twelve pike tracked in this study. The location of the tagging sites as well as the study area can be found in **Figure 1**.

Pike Tag Code	Site Tagged	Length (mm)	Weight (kg)	Sex	Estimated Age
11	1	632	1.5	M	2-5
12	1	583	1.2	M	2-5
13	1	962	6.0	F	6-8
14	1	773	3.2	M	3-8
15	3	563	1.2	M	2-5
16	1	912	6.4	F	5-8
17	2	817	4.1	F	4-8
18	4	913	5.2	F	4-8
19	1	574	1.1	unknown	2-5
20	1	620	1.5	M	2-5
21	1	916	6.4	F	4-8
22	2	729	2.6	M	2-7
Average	—	749.5±152.4	3.4±2.2	—	—

Preliminary Results

For simplicity, we will refer to each pike in a coded fashion, i.e. pike 12 will referred to as P12. All twelve pike were successfully tagged in early May 2011 (**Table 1**; **Figure 1**). Following the two-week recovery period, two pike (P17 & P22) could not be detected within the study area; these pike were subsequently found to be alive and living outside of our study area. Four other pike did not spend sufficient time in our study area to allow for a kernel density estimate (P14, P16, P18 & P21; **Table 2**). For the remaining six pike, the number of activity centres ranged from 1 to 7 with the number of wetlands associated with each pike ranging from 1 to 5 (**Table 3**). For each pike, with the exception of P15, we estimated the minimum, maximum, and average distance between each wetland in which they were observed. For all pike, the average distance between adjacent wetlands was 1.44±0.74 km (**Table 4**). The maximum observed distance between wetlands for one pike (P11) was 3.90 km, although it must be acknowledged that P13 moved beyond our study area for several weeks and it is possible that she utilized wetlands that were a greater distance apart.

Temperature data have been downloaded from the 8 stations where data loggers had been installed at meter intervals. Bathymetric data were also collected in September and will be processed to produce a contour map for Tadenac Bay.

Table 2. Summary of the total number of observations for each pike. Tracking window refers to the time, in days, between the first and last observation. Pike that remained in the study area are identified as well as whether a kernel density estimate was possible. It is unknown if pike number 12 is still in our study are because it has not be observed since July 2011.

Pike Tag Code	**Length (mm)**	**Tracking Window (days)**	**Total Observations**	**In Study Area (Y/N)**	**Kernel Density Estimated (Y/N)**
11	632	93	52	Y	Y
12	583	60	39	unknown	Y
13	962	93	47	Y	Y
14	773	38	29	N	N
15	563	93	52	Y	Y
16	912	6	7	N	N
17	817	—	2	N	N
18	913	44	20	N	N
19	574	87	48	N	Y
20	620	90	39	Y	Y
21	916	18	10	N	N
22	729	—	2	N	N

Table 3. Number of activity centres and the number of wetlands that these activity centres overlap.

Pike Tag Code	**Length (mm)**	**Number Activity Centres**	**Number In Wetlands**
11	632	3	5
12	583	3	3
13	962	4	5
15	563	1	1
19	574	4	4
20	620	7	4

Table 4. Summary of the distances among wetlands for each pike. With the exception of pike number 15 who used only one wetland, all pike used wetlands that were greater than 750 m apart.

Pike Tag Code	**Length (mm)**	**Avg. Dist. Btw. Wetlands (km)**	**Min. Dist. Btw. Wetlands (km)**	**Max Dist. Btw. Wetlands (km)**
11	632	2.37	0.14	3.90
12	583	0.75	0.23	1.03
13	962	2.12	0.33	3.77
15	563	—	—	—
19	574	1.05	0.41	1.90
20	620	0.93	0.19	1.20
Average	—	1.44±0.74	0.26±0.11	2.36±1.39

PROJECT 2

Comparison of ecological factors affecting migratory behaviour of the Blanding's turtle using radio-telemetry in Georgian Bay Islands National Park and Rondeau Provincial Park *(Graduates: Bob Christensen, JohnPaul Leblanc, Jon Midwood, Amanda Fracz, Catherine Dieleman; Undergrads: Chantel Markle, Margaret Sawatzky, Dallas Taylor, Leslie Breadner)*

Background

The Great Lakes St. Lawrence population of the Blanding's turtle (*Emydoidea Blandingii*) in Canada is designated as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and under the Species at Risk Act (SARA). Of all North American species of turtles, Blanding's turtles have one of the smallest species home ranges, 20% of which is contained within southern Ontario and the southwest edge of Quebec (COSEWIC, 2005). Like many freshwater turtles that occur in wetland habitats, they also travel through and nest in terrestrial habitats such as woodlots and open meadows. The Blanding's turtle is of particular interest because we do not fully understand their use of and movements over these habitats on a seasonal basis. Blanding's turtles are known to migrate long distances seasonally compared to other freshwater turtles (Edge, et al., 2010), and are therefore more likely to encounter modified habitats such as agricultural lands and roads. Past studies on habitat use have focused on their presence within wetland areas but we do not have a good understanding of upland habitat use and what environmental factors are critical in seasonal migrations (Edge, et al., 2010) . In addition, many turtles have been found to return to the same major areas of activity each year, while others travel to new locations (Innes, Babbitt, & Kanter, 2008), and the reasons for these behaviours are not understood.

We would like to determine the ecological factors that affect turtle movement and migration patterns, including choice of high activity centres (foraging, aestivation and hibernation) and where they select sites for nesting. Specific characteristics of their habitat that will we investigate include: dominant vegetation, food availability, water levels and hydroperiod in temporary ponds, presence of invasive and non-native species, and dominant substrate. Although the observed decline in Blanding's populations has been primarily attributed to the destruction of their wetlands habitats (Schuler & Thiel, 2008); (Edge, et al., 2010); (COSEWIC, 2005), it is possible that the importance of upland habitat has been underestimated. We anticipate that comparisons across two very different landscapes will reveal insights into overriding determinants of micro- and macro-habitat use that may have eluded past investigations focused on a single study site.

Choice of study sites:

The published research on Blanding's turtles in Ontario has focused primarily on populations within the inland wetland ecosystems of Algonquin Provincial Park (Edge, et al., 2010) which is an area with no agricultural activities and limited rural impacts. There is an urgent need, however, to conserve terrestrial and aquatic habitat for this species on the coastal zone of the Great Lakes, especially along Lakes Erie (i.e. Long Point Bay, Rondeau Bay, and Point Pelee), where populations are subject to both agricultural and rural impacts that are very different than those in Algonquin Park. Furthermore, there is growing development pressure in southeastern Georgian Bay (near Honey Harbour) that may impact the terrestrial habitat for the Blanding's turtle. Our proposed research in Rondeau Bay and Beausoleil Island (Georgian Bay Island National Park) should provide key information to identify critical areas that this species will use for aestivation, hibernation and nesting in these contrasting landscapes. This is also the first study to be conducted on an island and gives us an opportunity to determine if individuals on an island utilize habitat that have been ascertained for those in mainland populations.

Method:

Upon their emergence from hibernation in April of 2011, Blanding's turtles were located and captured by hand, or with baited hoop-nets and basking traps in Georgian Bay Islands National Park and Rondeau

Provincial Park (see **Figure 2**). During their captivity, they were fitted with a radio transmitter or a combination of a radio transmitter and a GPS Bug tag (Lotek Wireless, 10g). Turtles were kept overnight and monitored for the first 3 hours to ensure that the devices were properly fitted (i.e. the devices have not shifted) (see **Photo 3**). The turtles were released the following morning at their point of capture. Throughout the active season, we assessed the position of turtles on the landscape to maintain a general knowledge of their location. Several times throughout the summer, we recaptured the turtles to retrieve the GPS data, and to check the device fittings (see **Photo 4**). Where possible, nesting locations were recorded by GPS, as were their time and date of nesting.

Over the 2011 field season we radio-tagged and tracked 20 adult Blanding's Turtles (10 male, 10 female) in Beausoleil Island (Georgian Bay Island National Park, GB) and in Rondeau Bay (RD). We tracked and monitored the movements of the turtles over the active season, recording over 60 locations in RD and over 200 locations in GB. Additionally, we tagged 3 females with state-of-the-art GPS tracking devices in GB to determine fine scale movement patterns and migration routes. We spent a total of 18 weeks in the field. The following is a summary of the monitoring conducted during 2011.

Georgian Bay Island National Park
- 12 Blanding's turtles radio tagged, tracked throughout active season, over 200 locations
- 3 Blanding's females fitted with GPS tracking devices
- Determined main areas of activity
- Determined nesting area
- Determined hibernation sites
- Calculated individual home ranges and combined home ranges
- Collected habitat data within turtle home ranges

Rondeau Provincial Park
- 8 Blanding's turtles radio tagged, tracked thorough active season, over 60 locations
- Determined main areas of activity
- Determined hibernation sites
- Calculated individual home ranges and combined home ranges
- Collected habitat data within turtle home ranges

Preliminary results:

Using a Geographical Information System (GIS) for preliminary spatial analysis, we have confirmed that there are significant differences in movement characteristics between these populations, particularly in terms of animal home ranges. We are continuing with our preliminary analysis, and sampling will continue into the fall and winter months. The next steps involve detailed analysis of turtle movement patterns and home ranges on a seasonal basis, as well as an evaluation of their habitat use. We will also test whether the observed differences in movement characteristics can be linked to the distinctive landscape characteristics at each of our study locations.

In Beausoleil Island, the 12 turtles were trapped from two wetlands (indicated in top panel of Figure 2); although they were both bogs, they had very different features. Bog 1 (to the right) had a few trees, with shallow pools, and contained pitcher plants, sundew and a thick peat mat. Bog 2 (to the left) contained dead trees, deep pools and had no pitcher plants or sundews, and a thin peat mat, suggesting that it had been formed later than Bog 1. All of the features within the home range of the 12 turtles will be digitized and assigned to 10 habitat features. Analyses will be conducted to determine if habitat classes are used according to their availability or if turtles chose specific classes to spend majority of their time during the pre-nesting, nesting and post-nesting seasons.

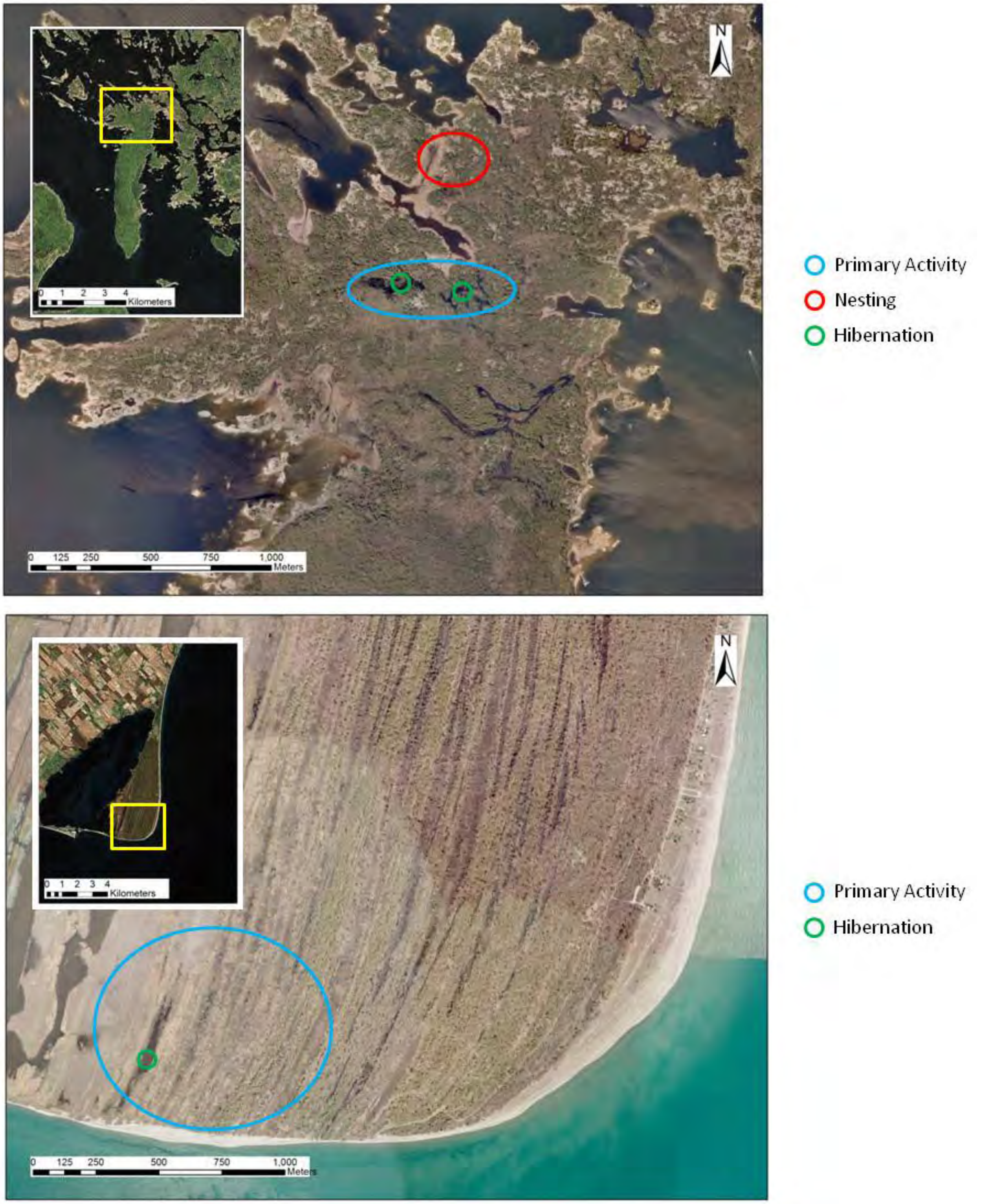

Figure 2. Location of the two study sites for Project 2. Top: Beausoleil Island of the Georgian Bay Islands National Park and Bottom: Rondeau Provincial Park. Circles indicate the general area for nesting, hibernation and primary activity centres.

Photo 3: Photo of a Blanding's turtle equipped with a radio transmitter and antenna (on the right) and a wireless GPS device (on the left)

Photo 4: Bob Christensen uses his computer to download data from the GPS device on a Blanding's turtle in Beausoleil Island.

Project 3

Effects of rain effects and agricultural practices on the water quality of first-order streams in the Beaver River watershed (*Graduate: Catherine Dieleman, Amanda Fracz; Undergraduates: Leslie Breadner, Margaret Sawatzky, Chris Biberhofer, Dallas Taylor)*

Background

Agriculture has long been associated with environmental degradation as a non-point source of pollutants including primary nutrients and suspended sediments in waterways. Besides contaminating drinking water, these pollutants can also lead to habitat degradation and loss. Despite this general knowledge, the ecological impacts of specific agricultural practices have not been well studied. Proper management and monitoring must be conducted at the individual farm scale in order to elucidate the impacts that specific agricultural practices have on the ecological health of a stream system. In this project, we examine the impacts caused by activities of a single farm on eight headwater streams in the Beaver Valley watershed in Ontario. The study included eight sites (4 crop-based and 4 livestock-based; see **Figure 3**) and allowed us to study changes in water quality of the first-order streams in response to release of livestock wastes, livestock and crop rotations, and other farm practices (fertilizer application and tillage techniques).

In all cases, the first-order streams had a permanent flow, with little or no riparian buffer between the farm and the stream, and located within 100m of a road. Each of the 8 sites were sampled biweekly during the growing season and monthly at other times during a 14-month period (see **Photo 5**). Water-quality parameters that were of interest included total phosphorus, total nitrogen, total nitrate nitrogen, turbidity, total suspended solids, pH, conductivity, temperature and dissolved oxygen. We also used an ISCO sampler to collect water draining from one livestock-based farm every 6 hours continuously from May to October in 2010, to understand how total phosphorus responded to periodic precipitation events. A YSI 6600 multi-parameter sonde was also used to collect hourly measurements of dissolved oxygen, specific conductivity, chlorophyll, turbidity, temperature, and pH. On a biweekly basis, discrete water samples were collected for measurements of total nitrate nitrogen, total phosphorus, total suspended solids, total nitrogen, pH, conductivity, temperature and turbidity. The soil type, site elevation and slope were determined for each site.

In addition to the in-stream parameters, biofilms were used as an indicator of stream health. A set of three acrylic rods (about 1 m in length) were placed both above and below a stream junction to determine how much nutrient was available for microbial uptake by the periphytic algal community (see **Photo 6**). Algae were allowed to accumulate for four weeks. Subsections of the rod were then removed and extracted for chlorophyll a. Water samples were taken biweekly at each site and these were analyzed for primary nutrients.

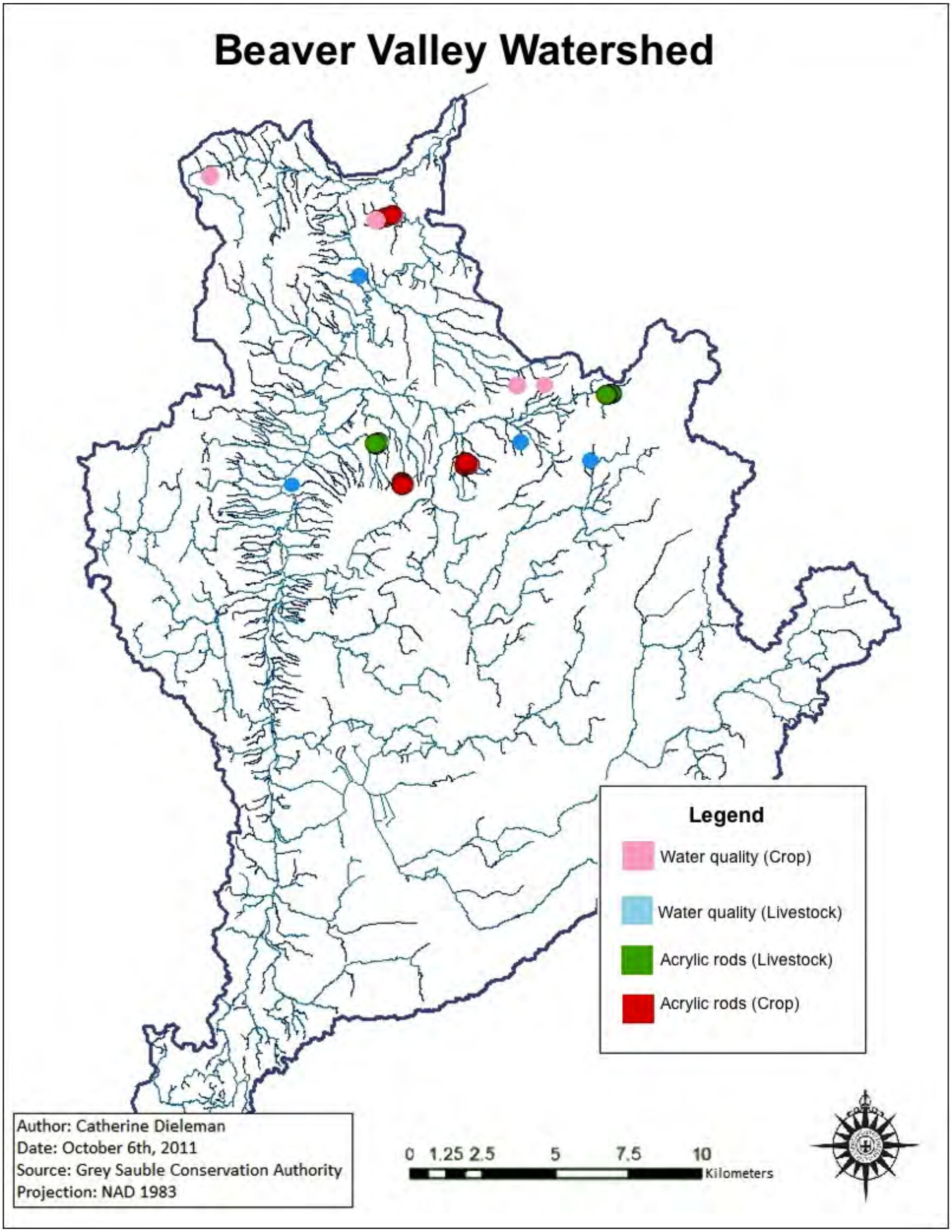

Figure 3: Location of the 8 study sites for Project 3.

Photo 5: Catherine Dieleman measuring stream discharge at one of the sites.

Photo 6: Photo of an acrylic rod (left panel) being prepared to be inserted into a stream (right panel).

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