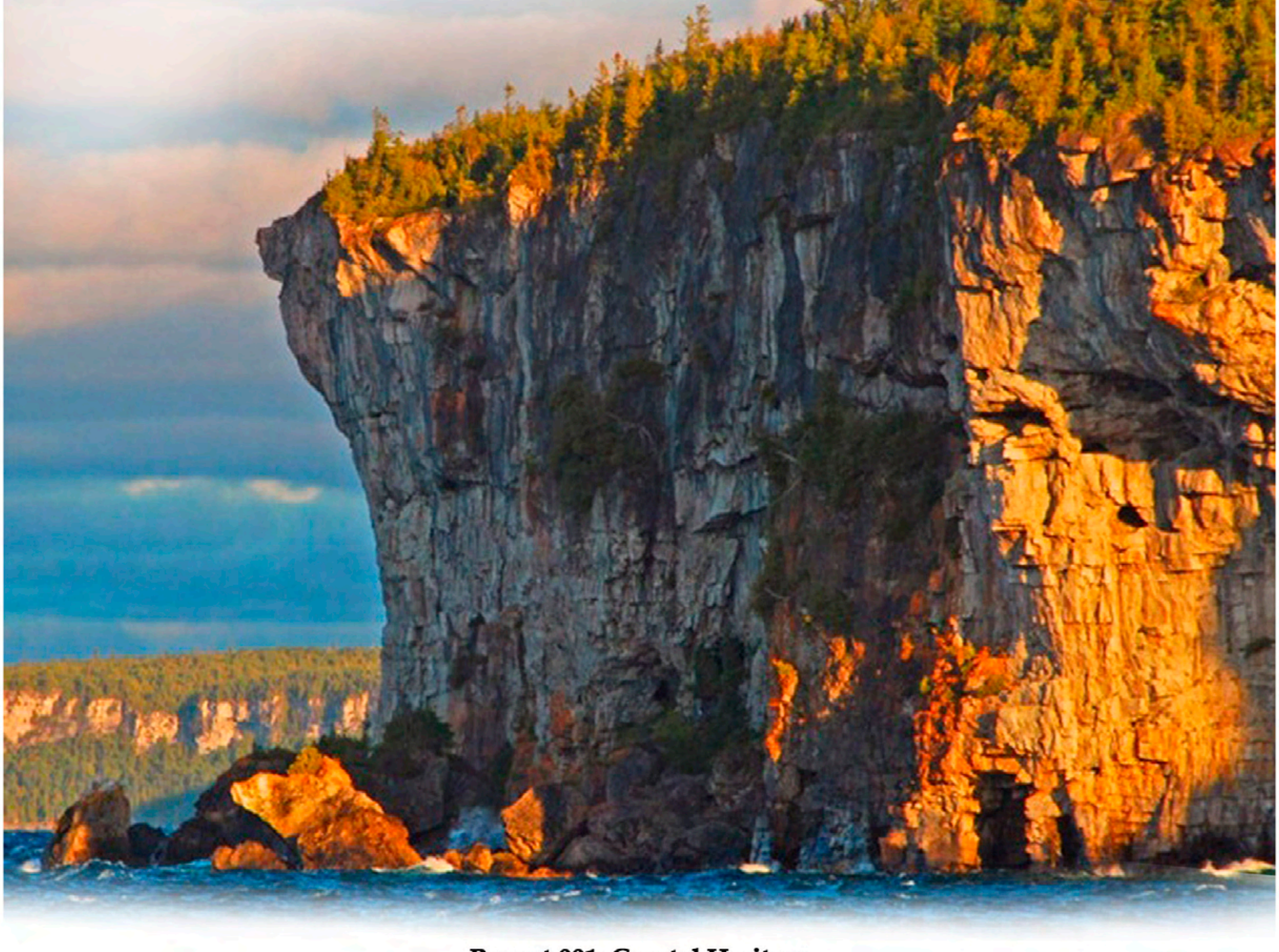
SOURCES OF KNOWLEDGE FORUM:

Sharing Perspectives on the Natural and Cultural Heritage of the Bruce Peninsula

CONFERENCE PROCEEDINGS
Tobermory, Ontario
May 1-2, 2009



Report 001: Coastal Heritage

SOURCES OF KNOWLEDGE TECHNICAL REPORTS IN SOCIAL AND ECOLOGICAL SCIENCES

Edited by Scott R. Parker, Sean Liipere, and J. Gordon Nelson

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Sharing Perspectives on the Natural and Cultural Heritage of the Bruce Peninsula

May 1-2, 2009
National Parks Visitor Centre
Tobermory, Ontario

Organized by
The Parks Advisory Committee of
Bruce Peninsula National Park and Fathom Five National Marine Park

In cooperation with
Parks Canada, Bruce Peninsula Biosphere Association,
Bruce Peninsula District School, St. Edmunds Public School,
and Bruce Peninsula Bird Observatory

Sources of Knowledge Forum
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Sharing Perspectives on the Natural and Cultural Heritage of the Bruce Peninsula

PURPOSE

We believe that the Bruce Peninsula is an extraordinary place, rich in natural and cultural heritage. We recognize that knowledge inspires and guides our actions for social prosperity and ecological sustainability. We see our community as a source of knowledge and through continued research and learning, we can realize a common vision.

GOALS

- To gather and share scientific and traditional knowledge of the northern Bruce Peninsula;
- To operate as a forum that encourages engagement on community wellbeing, on our environment, and the legacy we leave; and,
- To further discussions on the development of an institute for research and learning in the northern Bruce Peninsula.

ORIGIN OF THE FORUM

This Sources of Knowledge Forum was initiated by the Parks Advisory Committee to demonstrate the great value Bruce Peninsula National Park, Fathom Five National Marine Park, and surrounding community play as a unique source of historic and future knowledge - locally, provincially, nationally, and internationally.

Coastal Wetlands of Fathom Five National Marine Park: Biodiversity Values and Threats

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SUMMARY

Although the coast of Fathom Five National Marine Park (FFNMP) is mostly exposed and rocky, coastal wetlands have established in the few protected bays within the park. In the regional context, these coastal wetlands are highly productive and biologically rich areas. A comparative assessment to other coastal wetlands in the Great Lakes was completed in 2005. As determined by water quality, the FFNMP wetlands range from good to excellent. There are, however, growing concerns related to the potential impacts associated with road density and declining water levels.

Figure 1. Researchers sampling fish species at Hay Bay.

INTRODUCTION

Fathom Five National Marine Park (FFNMP) is located at the tip of the northern Bruce Peninsula, intersecting Lake Huron and Georgian Bay, and consists mainly of islands and a strip of land on the mainland surrounding the town of Tobermory (Figure 2). The park's dolomite shorelines are highly exposed to winds and water currents (McNeil and Promaine, 2003), and only a few areas are sufficiently protected to give rise to coastal wetlands that offer spawning and nursery habitat for Great Lakes fishes. These marshes are essential habitat for numerous other species, including many invertebrates, birds, turtles and amphibians. While many wetlands have been studied on both U.S. and Canadian shorelines, little research has been done on the coastal wetlands of Georgian Bay, including those of FFNMP. Recent studies by Chow-Fraser (2006), Croft and Chow-Fraser (2007), and Seilheimer and Chow-Fraser (2007) have determined that a disproportionately large number of pristine wetlands are found in Georgian Bay. Despite their current high quality, however, they are at risk of being degraded by increased pressure from recreational and urban development, and it is important to establish baseline conditions so that changes in wetland quality resulting from human-induced or natural disturbances can be appropriately monitored.

During the summer of 2005, nine coastal marshes in FFNMP were sampled with standardized protocols and analytical methods following the methods described in Chow-Fraser (2006). Variables included primary nutrients (total phosphorus, soluble reactive phosphorus, total ammonia nitrogen, total nitrate nitrogen, and total nitrogen), water clarity (chlorophyll), total suspended solids, turbidity, as well as physical parameters (temperature, pH, and conductivity). These values were used to generate a Water Quality Index (WQI) score for each wetland (after Chow-Fraser 2006). The WQI was specifically developed for large-scale, long-term monitoring of

Great Lakes coastal wetlands. It uses 12 variables to measure the degree of water quality impairment that could be attributed to anthropogenic disturbance caused by altered land use or direct nutrient influx (Chow-Fraser 2006). The WQI scores can range from -3, corresponding to "Highly Degraded" wetlands to +3, representing "Excellent" quality; an easy way to interpret the scores is that all values less than zero are associated with some level of degradation, whereas all values greater than zero are associated with different degree of ecological integrity. DeCatanzaro *et al.* (2009) showed that the WQI was extremely sensitive to anthropogenic degradation of water quality in coastal marshes even within the lower end of the disturbance gradient, such as those in Georgian Bay.

CURRENT QUALITY OF FFNMP WETLANDS

All of the WQI scores for FFNMP sites were greater than zero, ranging from 0.79 to 2.01 (Table 1). None of these sites currently show any signs of water-quality impairment, and in fact, the island sites are in "Very Good" or "Excellent" condition according to Chow-Fraser's (2006) categories. By comparison, the mainland sites have significantly lower mean WQI scores (1.28 vs 1.94; t-test; P=0.009), and it is suggested that the lower scores for HB1 (1.12), HB3 (1.22) and HB2 (0.79) are related to the higher level of human activities experienced there.

Figure 2. Map of sampling sites in Fathom Five National Marine Park. See Table 1 for full descriptions of each site.

Table 1. Description of study sites sampled in FFNMP during 2005. Water Quality Index (WQI) scores are given, along with latitude and longitude for each site, and the type of threat from low water levels and human activities.

Location	Wetland Name	Wetland Code	Latitude	Longitude	WQI	Type of Threat
Island	Cove Island North	CN	43.31340	81.76227	2.01	Low water level
Island	Cove Island North Pond	CNP	45.31446	81.76140	--	Low water level
Island	Boat Passage	BG	45.28953	81.71899	1.83	Low water level, boat traffic
Island	Russel Island West	RUW	45.26458	81.70412	2.00	Low water level
Island	Russel Island East	RUE	45.26604	81.68941	1.91	Low water level
Mainland	Hay Bay 1	HB1	45.24089	81.68385	1.12	Public beach, cottage development
Mainland	Hay Bay 2	HB2	45.23341	81.69424	0.79	Low water level, cottage development
Mainland	Hay Bay 2a	HB2a	45.23459	81.69380	1.60	Cottage development
Mainland	Hay Bay 3	HB3	45.24137	81.69059	1.22	Cottage development
Mainland	Ragged Bight	RG	45.23483	81.70277	1.65	Cottage development

CURRENT THREATS

Effect of Water Level on Wetland Habitat

Wei and Chow-Fraser (2007) used IKONOS imaging to map wetland habitat in FFNMP and found that CNP and BB (Figure 2) have both become hydrologically disconnected from Lake Huron because of the recent decline in water levels beginning in 1999 (Figure 3). A series of aerial photos from 1978 to 2002 show how the CNP wetland has become stranded from the rest of the bay in 2002 (Figure 4). This has resulted in a large proportion of the spawning and nursery habitat (e.g., submersed aquatic vegetation) becoming inaccessible to the Great Lakes fish community. This is best demonstrated by overlaying the vegetation map created by Geomatics in 1993 over the 2002 IKONOS image in a Geographic Information System (Figure 5). Similar stranding was confirmed for wetlands in Russel Island East (Figure 6).

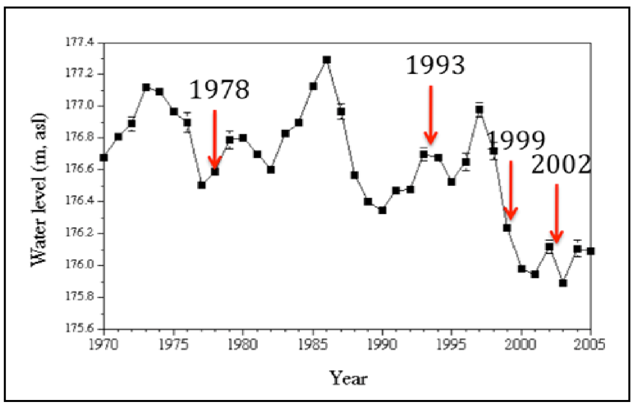

Figure 3. Mean annual water level of Lake Huron from 1970 to 2005. Data obtained from US. Army Corps of Engineers.

Effect of Human Disturbance

Besides water-level fluctuations, human-induced disturbance can have profound effects on wetland quality. In particular, development of roads and cottages surrounding wetlands can lead to predictable reduction in WQI scores for Georgian Bay wetlands. Chow-Fraser *et al.* (2009) calculated road density (RD) within 2 km of wetlands for 113 wetlands in 18 quaternary watersheds of eastern and northern Georgian Bay, including wetlands of FFNMP (Figure 6). They also determined the number of buildings (bldgs) within 50 m of each wetland, and the number of docks within 250 m of each wetland.

Using these land-use variables, it was determined that WQI scores can be predicted as follows:

Eq. 1: Pred **WQI** =
1.648 - 0.0441***RD** (m/ha) - 0.3082*#**bldgs** - 0.0215*#**docks**

Adj R^2 = 0.46 P<0.0001 n = 113

Growth in the town of Tobermory and increased popularity of this area as a tourist destination over the past 60 years has led to a tremendous increase in road and cottage development surrounding the mainland sites of FFNMP (Figure 7). Eq. 1 was used to calculate predicted WQI scores for FFNMP wetlands, which were plotted against observed values (Figure 8). Most of the sites have higher WQI scores than can be predicted based on land-use variables; however, HB2 has an observed WQI score of 0.79 that is much lower than the predicted value of 1.17. This lower than expected value may be related to the stranding of this embayment as a result of recent low water levels, and suggests a possible synergistic effect of poor water circulation and human development on water quality of HB2.

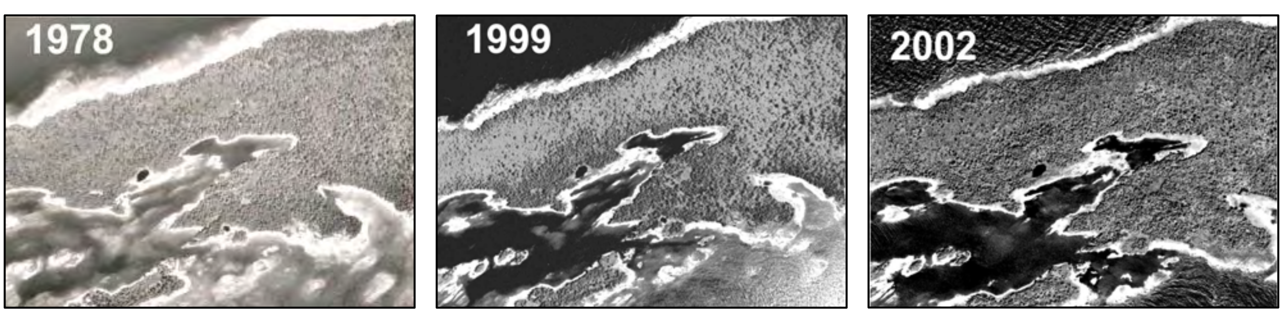

Figure 4. Aerial photo of Cove Island North taken in 1978, 1999 and 2002.

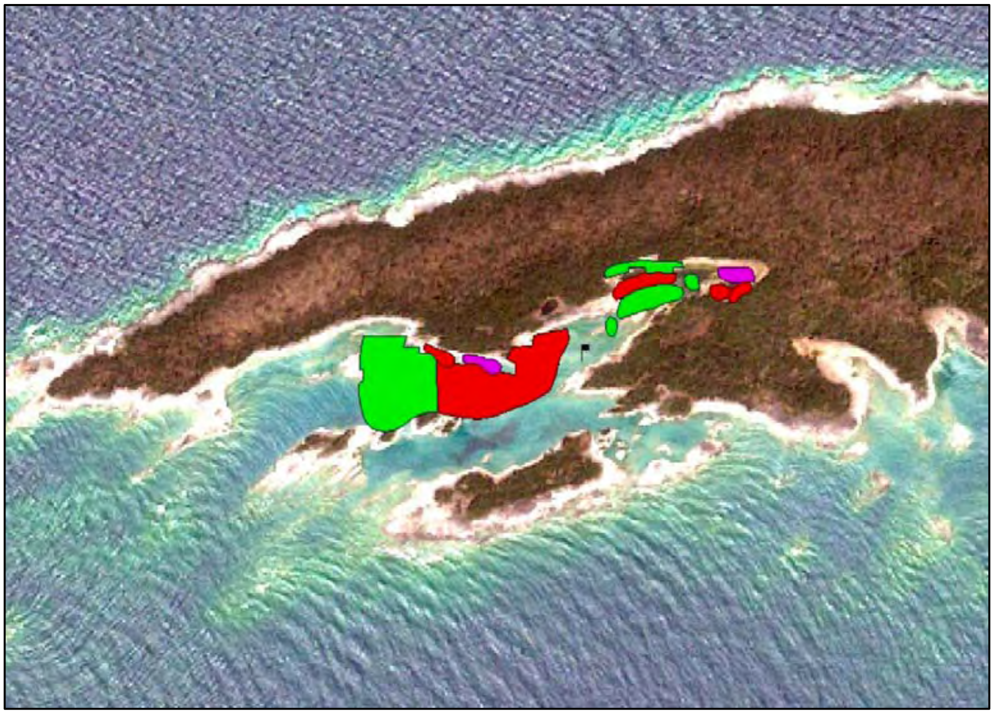

Figure 5. Location of emergent (green), submergent (red), and mixed (purple) vegetation during a 1993 survey, superimposed on IKONOS image taken in 2002.

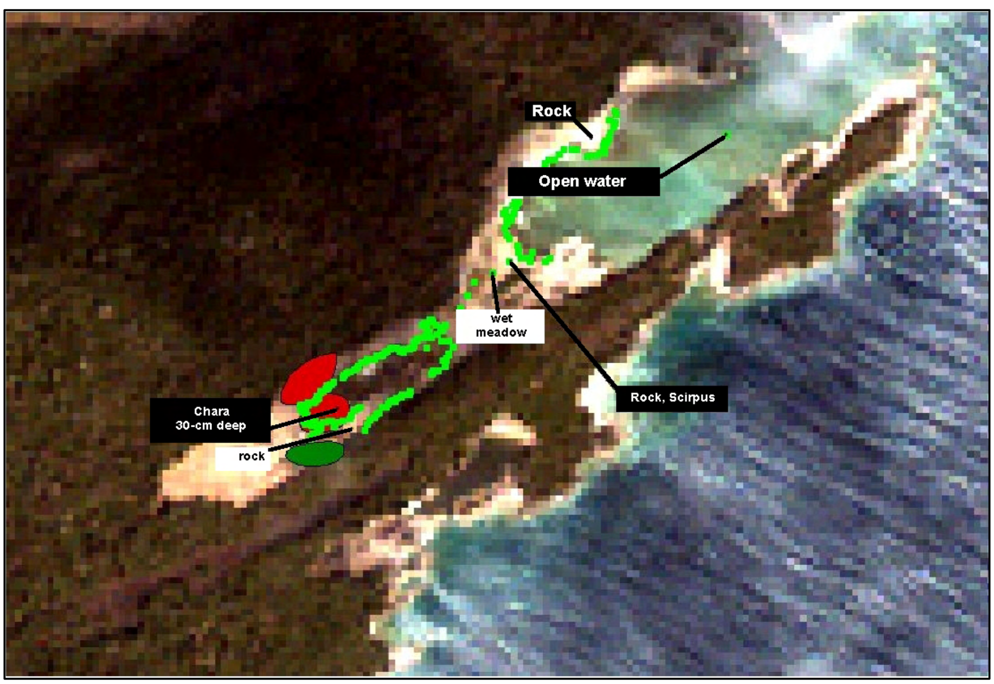

Figure 6. Location of emergent (green) and submergent (red) vegetation during a 1993 survey, superimposed on IKONOS image taken in 2002. Bright green line traces the shoreline and edge of the upland pond that has been "stranded" as a result of low water levels during 2005.

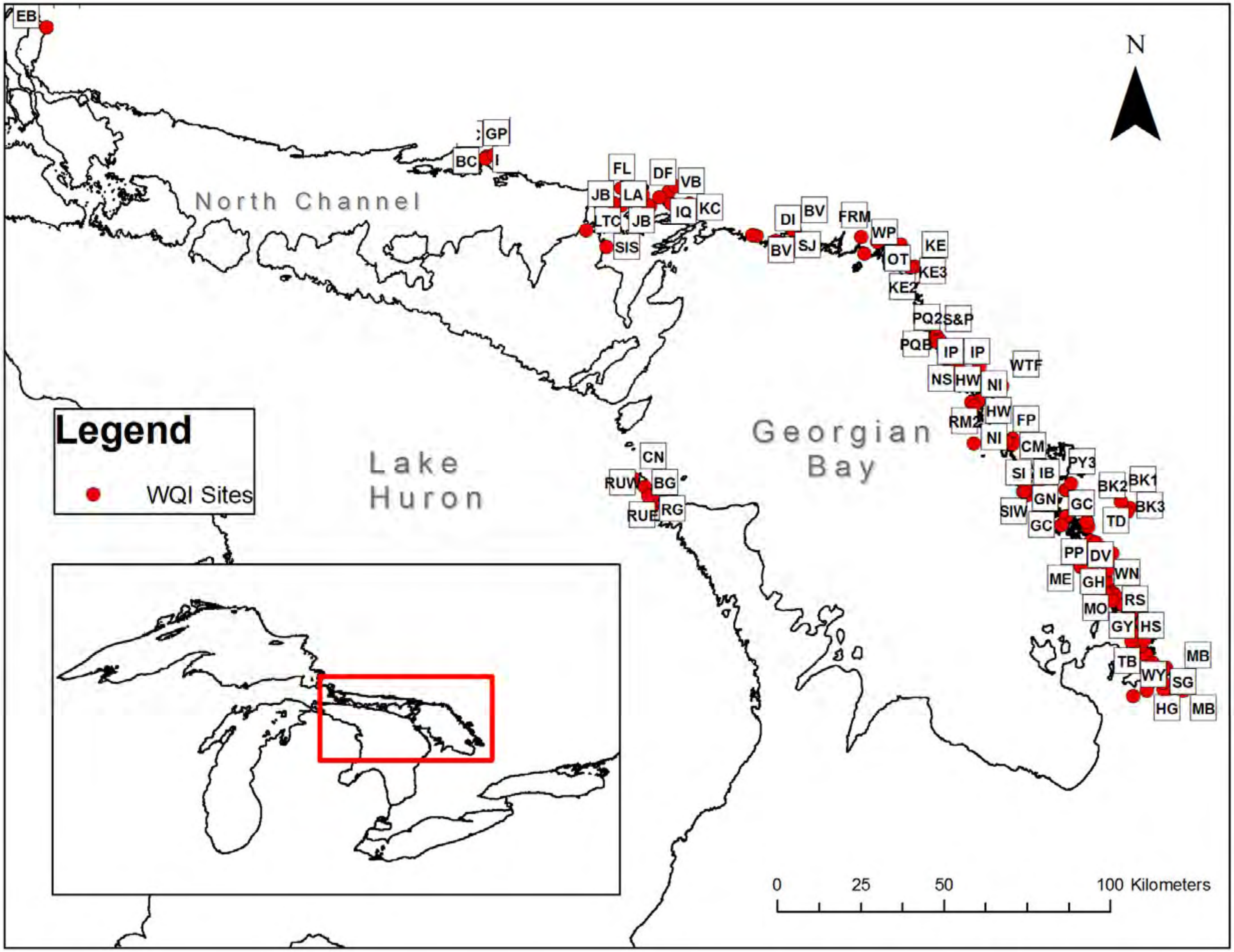

Figure 7. Map showing location of wetlands corresponding to WQI scores used to analyze the effects of road density.

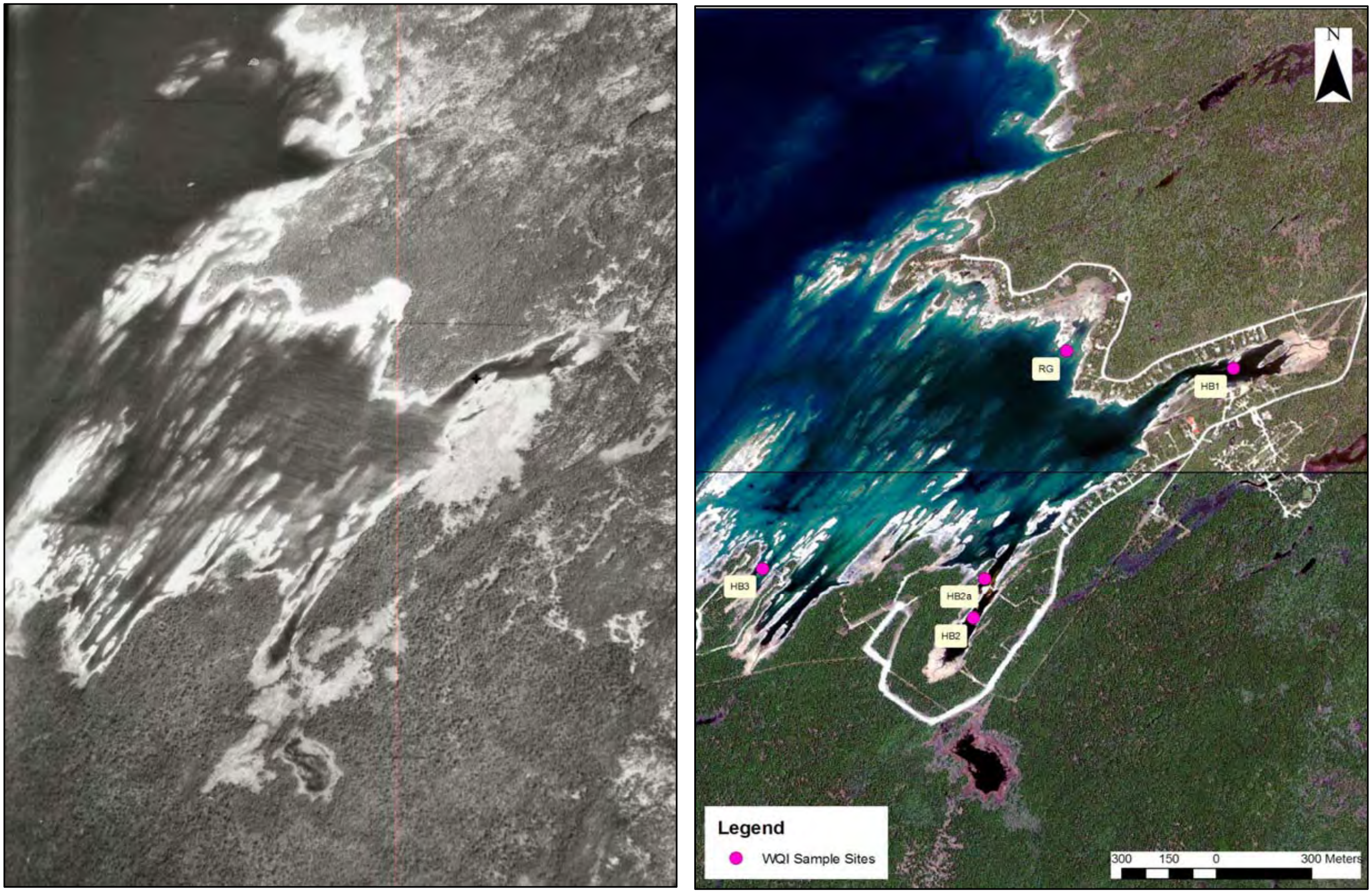

Figure 8. Comparison of aerial photos taken in 1938 and 2006 over mainland sites of FFNMP, showing the road network and cottage development in the recent era.

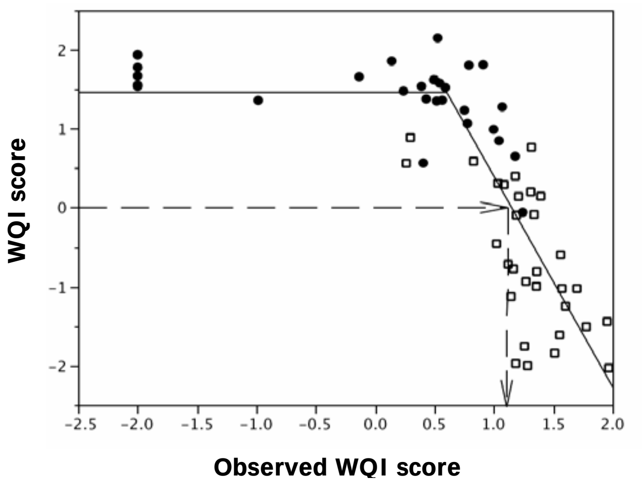

Figure 9. Comparison of predicted WQI based on Equation 1 versus observed WQI score.

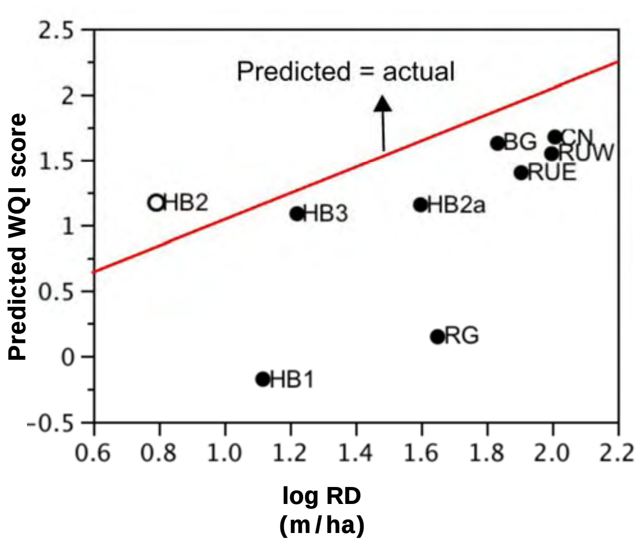

Figure 10. (Redrawn from Cvetkovic *et al.* 2009). Regressions of WQI score versus $\log_{10}$Road Density when when split-line regression analysis is used. Data are for 60 watersheds occurring in the drainage basins of Lakes Erie and Ontario (open symbols) and Georgian Bay (closed symbols). Dashed lines with arrows indicate the $\log_{10}$RD (1.15; equal to 14m/h) beyond which wetlands are considered degraded (i.e., WQI value < 0)

How Close to Threshold?

In their study of the effect of road density on water quality of wetlands of the Canadian Great Lakes, Cvetkovic *et al.* (2009) found that wetlands showed signs of degradation above a RD threshold of 14 m/ha (Figure 9), and recommended that this level be used to guide conservation efforts to protect Great Lakes coastal marshes. By comparing this threshold to the RD calculated within 2 km of the FFNMP wetlands, it is clear that several of the mainland wetlands are close to or have already exceeded the threshold (Table 2), and may be vulnerable to irreversible damage if further development is permitted.

CONCLUSION

The quality of wetlands in FFNMP range from good to excellent quality as determined by WQI scores. Although there is no indication that human activities are having a negative impact on water-quality conditions, road density around wetlands on the mainland portion of FFNMP is at or approaching threshold value for wetland degradation. This is especially a problem for HB2, because of the possible synergistic effect of low water levels. Declining water levels in the recent decade have stranded several wetlands in the Park (i.e., CNP, HB2, and RUE), and these are having negative impact on access of the fish community to spawning and nursery habitat.

Table 2. Comparison of present road density (RD; m/ha) calculated within 2 km of each wetland and for the Tobermory watershed. Only data for wetlands in the mainland portion of FFNMP are presented.

Site	RD (2-km)	RD (watershed)
Hay Bay 1	14.48	11.75
Hay Bay 2	11.33	11.75
Hay Bay 2a	11.72	11.75
Hay Bay 3	8.82	11.75
Ragged Bight	12.67	11.75

ACKNOWLEDGEMENTS

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