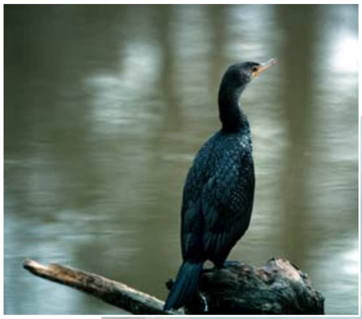

Double-Crested Cormorant and Coastal Fish Monitoring And Assessment in the North Channel and Georgian Bay, Lake Huron:

Field Methods, Site Descriptions and Analysis Information

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Photo: North Channel near Espanola
Cormorant Inset: Ontario Ministry of Natural Resources / JD Taylor

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Table of Contents

List of Figures

List of Tables

List of Appendices

Summary

The Ontario Ministry of Natural Resources (OMNR) undertook a multi-year study (2000-2005) aimed at monitoring the potential effects of double-crested cormorants on nearshore and pelagic fish in coastal areas of Lake Huron. This report summarizes the field methods, data collection details, site descriptions and analysis information associated with the program in the North Channel and Georgian Bay, Lake Huron. This work represents one of the largest scale projects undertaken by the Ontario Ministry of Natural Resources on the Great Lakes. Beginning in 2000, coastal scale monitoring of fish and double-crested cormorant abundance was undertaken in seven sample frames (20 km X 20 km each). Fish relative abundance was assessed with three types of gear, trap netting, electrofishing and hydroacoustics. Cormorant abundance was assessed by nest counts and aerial line transect surveys during the summer months. Egg oiling to reduce prey consumption was carried out in five sample frames in an effort to reveal linkages between cormorants and coastal fish.

1.0 Project Overview

Introduction

The increase in abundance of double-crested cormorants (*Phalacrocorax auritus*) over the past 20 years in the Laurentian Great Lakes region has been dramatic. From relatively few birds in the 1970's the number of nests has reached 76,678 in 2000 in the combined Canadian and U.S. coastal regions of the Great Lakes (Weseloh et al. 1995; 2002). A similar phenomenon of population increase has occurred in the closely related great cormorant (*Phalacrocorax carbo*) in Europe over a similar time period (Bregnballe et al. 2003).

The reasons for this increase in the Great Lakes region are a matter of speculation. Ending the use of pesticides such as DDT eventually led to the decline in toxic substances that cause egg shell thinning, which in turn lowered chick mortality. Large scale changes in fish assemblages stemming from species invasions such as alewife resulted in a large biomass of fish that were not previously available in relatively shallow waters. Alewife move inshore to spawn during the peak period of nesting of double-crested cormorants in the Great Lakes. In the southern U.S., the number and productivity of fish farms has increased. For cormorants wintering near these areas, the success of fish farms provides a significant source of fish biomass. This has led to wintering cormorants roosting near fish farm areas to supplement their diet with reared fish. Whatever the precise reason(s) for the increase in double-crested cormorants, the recent changes in abundance in the Great Lakes have focused attention on the magnitude of effects of cormorants on coastal fish abundance in many locations.

The large increase in numbers of double-crested cormorants has generated a number of concerns related to competition for nest sites with other waterbirds (Jarvie et al. 1999; Shieldcastle and Martin 1999), effects on terrestrial vegetation (Hebert et al. 2005), and effects on recreational and commercial fish populations (Johnson et al. 2002; Lantry et al. 2002; Burnett et al. 2002). In the coastal regions of Lake Huron, concern over local fish populations is the primary focus of stakeholders.

The purpose of this report is to describe field methods, sample sites and analysis information related to monitoring double-crested cormorants (hereafter referred to as cormorants) and coastal fish in Georgian Bay and the North Channel, Lake Huron. The program is unique in scale. The program of work was spatially extensive and covered large sections of the coastal area of the North Channel and Georgian Bay. Some sampling procedures spanned 5 years while others spanned 6 years. Because of the spatial and temporal scale, it is important to document the methodologies, sample site descriptions and related information on dates and timing. This record of field work will hopefully assist in any future field surveys of the coastal ecosystem in Lake Huron.

Possible Approaches

There are a number of approaches available to address the question of potential effects of foraging double-crested cormorants on fish abundance. Science focused at large scales or at ecosystem scales is an important area of basic and applied ecology (Carpenter *el al* 1998; Schindler, 1998). Each approach has positive attributes in terms of learning more about the ecology of cormorants in Lake Huron coastal ecosystems. Each approach is susceptible to unanticipated events that can occur in field work such as changes in fish stocks or severe weather. One important criterion in any choice of approach is the match in scale between the science questions and the policy question of effects of cormorants on coastal fish abundance.

1) Diet Analysis: Analysis of cormorant diets across the coastal areas of North Channel and Georgian Bay would reveal what fish species comprise their diet in Lake Huron. A diet analysis approach could be conducted in many locations along Lake Huron coasts. It would reveal that cormorants take a variety of fish depending on the location of the study and sampling. A number of studies on cormorant diet conducted in the Great Lakes show that their diet ranges from small open water fish like sticklebacks and alewife to bottom feeding fish like suckers and catfish. They appear to take fish as prey relative to local fish abundance and do not show any species specific patterns of prey selection (Hatch and Weseloh, 1999) Such an approach would have to examine seasonal patterns in diet because there are likely changes in diet as fish become seasonally available for birds. Focusing solely on diet as revealed through chick feeding, for example, would bias any assessment of what constitutes cormorant diet in Lake Huron. Focusing on diet at relatively large scales would not address questions related to abundance or interaction of predators and prey.

2) Detailed Small-Scale Controlled Experiments: A detailed study at the scale of an embayment could be conducted to address in precise detail the relationship between fish abundance and bird abundance. Cormorant abundance could be manipulated (perhaps reduced due to scaring tactic) as a treatment effect and the response of fish in a bay or enclosure could be monitored. This kind of experimental approach is well represented in the scientific literature in aquatic ecology where top predators are controlled in aquatic food webs with interesting consequences for the food web and changes in species abundance. This approach provides real experimental control if multiple sites are compared with and without treatment. However, detailed controlled experiments have two hurdles in applied ecology. First, the problem of scaling-up from the results of a detailed small scale experiment presents a significant challenge for policy makers. The experimental approach at this scale is popular from a technical perspective but sometimes results can be difficult to relate to the scale required from a policy perspective. Second, this type of top predator manipulation is often successful in revealing how food webs work by adopting ‘an all or nothing’ approach to the manipulation. Predators are either added in large numbers or eliminated altogether. A sharp change in predator abundance forces changes in the food web more quickly than gradual changes that come about based on responses to measured declines in a top predator. In the case of cormorants, this means that any manipulation is driven by the need to eliminate all individuals. Although this is informative from both an experimental and issue management perspective, this approach is a difficult choice from a policy perspective since it is unlikely to have broad public support.

3) Compare and Contrast Areas in Lake Huron with and without Cormorants: A traditional method is to compare and contrast the effects of cormorant predation by finding locations in coastal Lake Huron with and without cormorants. This was not possible since coverage of the coastal zone of the North Channel and Georgian Bay by cormorants was essentially complete by the start of this study in 2000. There appeared to be no site of suitable habitat where cormorants were absent.

4) Compare Inland Lakes with Coastal Lake Huron: Since cormorants effectively covered the coastal area of Lake Huron, another compare and contrast approach would be a comparison between large inland lakes and Lake Huron coastal areas. Many large inland lakes did not have cormorants during this study and they may have served as a basis for assessing the effects of cormorants on nearshore fish abundance. One critical shortcoming of this approach is that the fish species differ between the Great Lakes and inland lakes. Perhaps more importantly, factors governing the abundance of fish in inland lakes may be fundamentally different than what governs fish abundance in coastal areas of Lake Huron.

5) Large Scale Experiment: One approach is to employ as large an experimental manipulation as possible in an attempt to match the scale of the science with the scale of the policy issue. This approach sacrifices detailed technical rigour available at smaller experimental scales for spatial coverage at more realistic policy scales. In the case of double-crested cormorants in Lake Huron, one of the few options available is to reduce fish consumption by cormorants in some areas and not in other areas. However, unlike experiments at small scales, it is impossible to effectively eliminate cormorants at large coastal scales in an effort to clearly reveal food web connections. One feature of large scale experiments is their vulnerability to the influence of system-wide stochastic processes during the course of the field work since these kinds of changes are more likely in a large scale study with multiple sites. The advantage of this approach is that data collection is at a scale that directly matches the policy questions related to cormorant abundance and fish abundance.

The approach selected for this program was the Large Scale Experiment. In this study, some sites were subject to egg oiling while other sites were not oiled to serve as reference sites. Egg oiling at cormorant colonies was selected because it effectively stops juvenile recruitment in those locations and lowers fish consumption through disruption of foraging adults and suppression of prey demand by chicks. It also is slow to take effect since only juvenile production is affected and not breeding adult abundance.

The fish monitoring methods employed in this study were: 1) trap netting based on the nearshore community index program; 2) quantitative electrofishing in shallow water, and 3) a coastal hydroacoustic survey. Double-crested cormorant abundance was assessed by: 1) nest counts at colonies, and 2) aerial line transect surveys of free-ranging cormorants. Each of these methods and procedures are described in this manual including egg oiling as an experimental manipulation of juvenile production. In addition to the experimental approach outlined here, the methods also provide a means of determining cormorant effects on coastal fish through bioenergetic approaches. The methods and procedures described in this manual represent one of the largest scientific efforts undertaken by the Ontario Ministry of Natural Resources on the Great Lakes.

Study Area and Sampling Locations

The North Channel and Georgian Bay

This study focused on the coastal ecosystems of Georgian Bay and the North Channel, Lake Huron (Figure 1.1). Georgian Bay is 15,111 km^2 in surface area with a coast best described as complex. The shoreline is predominately Precambrian Shield granitic rock. The North Channel is 3,950 km^2 in surface area and is bounded along the north shore by Precambrian sedimentary rocks and along the southern shore by a geological extension of the Niagara Escarpment that continues up through the Bruce Peninsula to form Manitoulin Island (Figure 1.1).

Table 1.1 summarizes some of the features of the North Channel and Georgian Bay. The North Channel has a much shorter flushing time and greater volume of water from land drainage than Georgian Bay. When the volume of water from the St. Mary's River (approx. 8,600 m^3s^{-1}) is included in the characterization of the North Channel, then it is clear that the North Channel has substantial flow through with Lake Superior and large river systems along the north coast contributing roughly similar volumes to the channel. In contrast, Georgian Bay has smaller river drainage systems. Flow through the North Channel is primarily towards Georgian Bay (Bennett 1988). Sediment particle sizes in the North Channel point to relatively few depositional basins compared to the depositional areas of Georgian Bay (Thomas 1988). The depositional areas of Georgian Bay have mud characteristics reflecting past post-glacial drainage patterns (Thomas 1988; Figure 1.1). The fundamental difference between these two regions of Lake Huron are the large river-like features of the North Channel (short flushing time; large drainage basin relative to surface area; lack of significant depositional areas) and the large lake-like features of Georgian Bay (long flushing time; small drainage basin relative to surface area; depositional basins).

Table 1.1. Physical characteristics of the North Channel and Georgian Bay. Information from Sly and Munawar (1988), Thomas (1988) and Weiler (1988).

	North Channel	Georgian Bay
Surface Area (km^2)	3,950	15,111
Mean Depth (m)	22	44
Water from Land Drainage (m^3s^{-1})	6,900	2,050
Drainage Basin Area (km^2)	34,250	45,830
Flushing time (years)	2	8.5

Sample Frames

Seven sample frames were mapped on the Lake Huron coast; three frames in Georgian Bay and four frames in the North Channel. All fisheries sampling methods and aerial estimates of free-ranging densities of cormorants were conducted in the frames. Nest counts occurred in the frames as well as at sites outside the frames.

Each frame is 20 km X 20 km and frames are spaced approximately 20 km apart (Figure 1.1). Frame locations were chosen to have roughly equivalent numbers of nesting cormorants in each while maintaining enough distance between them to serve as separate sample sites. Position coordinates for each frame are listed in Appendix 1. The total amount of water surface area in each frame differs because of differences among frames in coastal complexity (Table 1.2). Detailed maps of each frame showing coastal and bathymetric details are provided in Appendix 1.

Table 1.2. Surface area (km^2) of water in each sample frame

Frame	Location	Total Water Area (km^2)	Total Water Area ≤ 20m Depth Contour (km^2)
1	Georgian Bay	316.3	141.2
2	Georgian Bay	282.9	255.7
3	Georgian Bay	274.1	171.3
4	North Channel	227.2	221.4
5	North Channel	272.4	161.1
6	North Channel	335.3	118.7
7	North Channel	379.2	131.6

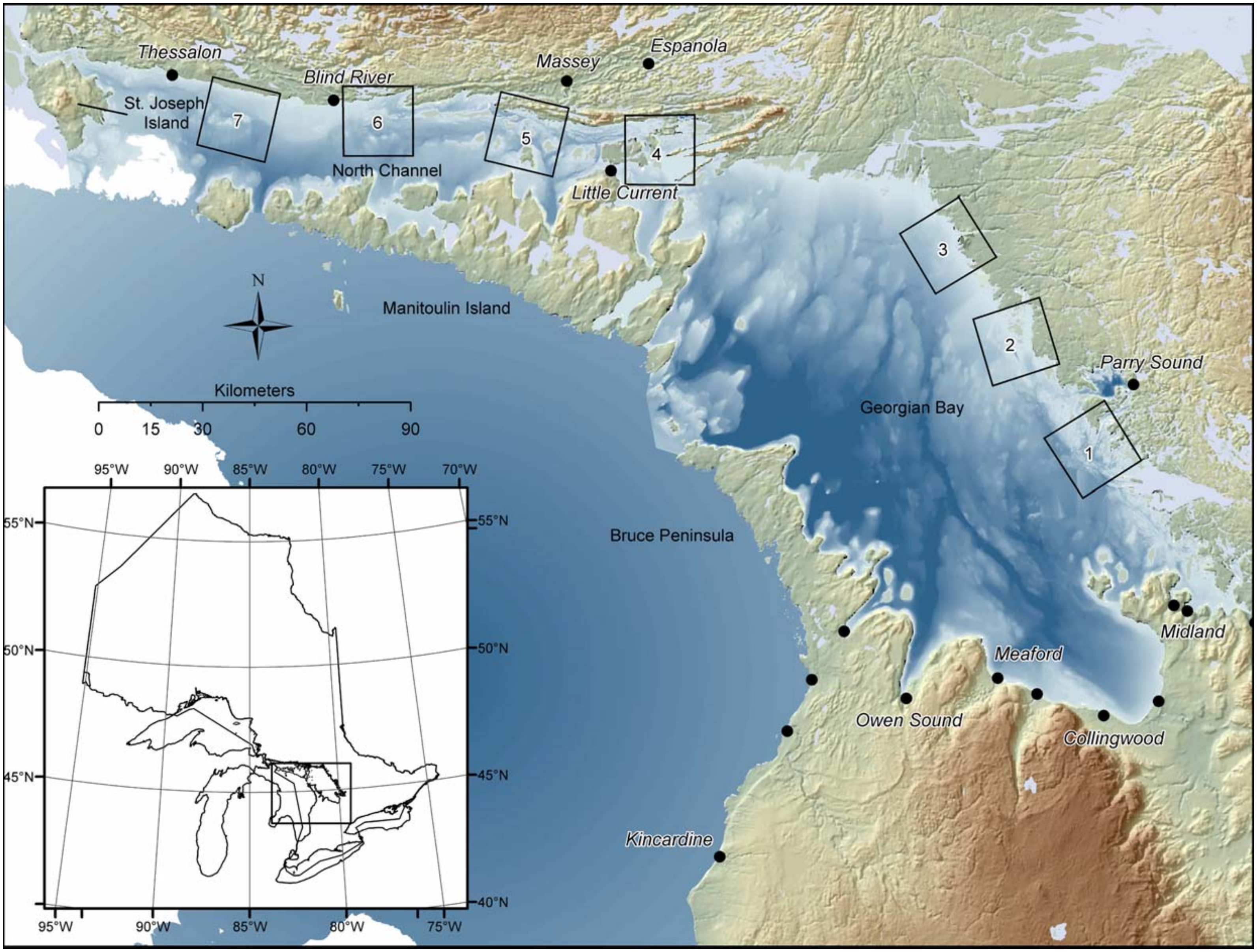

Figure 1.1. Overview of Lake Huron showing location and physiography of the North Channel and Georgian Bay and the location of the study frames.

Study Design

We should expect to find 'time since treatment' effects when implementing a large-scale experiment in coastal ecosystems. That is, any response to egg oiling may not be immediately apparent but instead take time to develop. For example, any decline in nesting adult cormorants stemming from oiling is known to take several years (Bédard et al. 1995). One study design that can account for this time since treatment effect is referred to as the staircase design (Walters et al. 1988). A schematic representation of the design is below (Table 1.3). The design requires a period of data collection prior to any manipulation (i.e. egg oiling in this case) followed by monitoring during periods of egg oiling. In the schematic below, the time periods with no oiling are represented by "NO" while the time periods with observations following egg oiling are represented by "X" and shaded grey. At a minimum, one site remains a reference site throughout the study (no oiling; NO) and one year is required for pre-manipulation observations for all sampling frames (Walters et al. 1988). In this study, 2000 and 2001 were years without egg oiling. Georgian Bay and the North Channel are potentially different with respect to fish production, community characteristics and bird ecology based on differences in their lake characteristics (see above). A control site was employed for each region to account for this possibility (Frame 3 in Georgian Bay and Frame 7 in the North Channel).

Table 1.3. The staircase study design used in Georgian Bay (GB) and the North Channel (NC). Years with observations and no oiling are indicated by NO. Years with observations following egg oiling are indicated by X.

Frame	Year					
	2000	2001	2002	2003	2004	2005
1 GB	NO	NO	NO	**X**	**X**	**X**
2 GB	NO	NO	**X**	**X**	**X**	**X**
3 GB	NO	NO	NO	NO	NO	NO
4 NC	NO	NO	**X**	**X**	**X**	**X**
5 NC	NO	NO	**X**	**X**	**X**	**X**
6 NC	NO	NO	NO	**X**	**X**	**X**
7 NC	NO	NO	NO	NO	NO	NO

At a general level, the staircase design has three major components for analysis. First, for any response variable, say counts of cormorants nests, there is an average nest count over the duration of the study that characterizes each frame. Second, there is also a potential time trend in the nest count data regardless of frame or experimental manipulation. Third, there is a potential response in the number of nests to egg oiling that occurs only during the time periods with egg oiling (time periods with an "X"). The statistical approach for analyzing the staircase design is outlined in Table 1.4. It represents a design matrix for estimating time since treatment effects in management experiments that potentially generate transient responses to experimental manipulation (Walters et al., 1988). The general linear model approach is used (intercept = 0) to analyze data collected in the staircase design (Walters et al., 1988) The six year design is presented as shown in Table 1.4. Fish response data from trapnetting, hydroacoustics, and electrofishing were collected during a five year period. For trapnetting and hydroacoustics, the first year of observation was 2000 and the last year was 2004. For electrofishing, the first full year of data collection was 2001 and the last year was 2005. The design matrices for these programs would be a subset of the six year design shown below.

Table 1.4. The six year design matrix for the staircase design. It partitions the variance in response variables among three components. The columns marked Fr are the elements of the mean response level for each frame. The columns marked T are the time trend for each frame regardless of treatment. The columns marked R are the response elements to egg oiling for each year of egg oiling per frame. The response variable is any variable (i.e., nest counts, fish abundance etc) estimated throughout the study.

Year and Frame	Fr 1	Fr 2	Fr 3	Fr 4	Fr 5	Fr 6	Fr 7	T 2	T 3	T 4	T 5	T 6	R 1	R 2	R 3	R 4	Response Variable
2000 Fr 1	1																$Y_{2000\ Fr1}$
2001 Fr 1	1							1									$Y_{2001\ Fr1}$
2002 Fr 1	1								1								$Y_{2002\ Fr1}$
2003 Fr 1	1									1			1				$Y_{2003\ Fr1}$
2004 Fr 1	1										1			1			$Y_{2004\ Fr1}$
2005 Fr 1	1											1			1		$Y_{2005\ Fr1}$
2000 Fr 2		1															$Y_{2000\ Fr2}$
2001 Fr 2		1						1									$Y_{2001\ Fr2}$
2002 Fr 2		1							1				1				$Y_{2002\ Fr2}$
2003 Fr 2		1								1				1			$Y_{2003\ Fr2}$
2004 Fr 2		1									1				1		$Y_{2004\ Fr2}$
2005 Fr 2		1										1				1	$Y_{2005\ Fr2}$
2000 Fr 3			1														$Y_{2000\ Fr3}$
2001 Fr 3			1					1									$Y_{2001\ Fr3}$
2002 Fr 3			1						1								$Y_{2002\ Fr3}$
2003 Fr 3			1							1							$Y_{2003\ Fr3}$
2004 Fr 3			1								1						$Y_{2004\ Fr3}$
2005 Fr 3			1									1					$Y_{2005\ Fr3}$
2000 Fr 4				1													$Y_{2000\ Fr4}$
2001 Fr 4				1				1									$Y_{2001\ Fr4}$
2002 Fr 4				1					1				1				$Y_{2002\ Fr4}$
2003 Fr 4				1						1				1			$Y_{2003\ Fr4}$
2004 Fr 4				1							1				1		$Y_{2004\ Fr4}$
2005 Fr 4				1								1				1	$Y_{2005\ Fr4}$
2000 Fr 5					1												$Y_{2000\ Fr5}$
2001 Fr 5					1			1									$Y_{2001\ Fr5}$
2002 Fr 5					1				1				1				$Y_{2002\ Fr5}$
2003 Fr 5					1					1				1			$Y_{2003\ Fr5}$
2004 Fr 5					1						1				1		$Y_{2004\ Fr5}$
2005 Fr 5					1							1				1	$Y_{2005\ Fr5}$
2000 Fr 6						1											$Y_{2000\ Fr6}$
2001 Fr 6						1		1									$Y_{2001\ Fr6}$
2002 Fr 6						1			1								$Y_{2002\ Fr6}$
2003 Fr 6						1				1			1				$Y_{2003\ Fr6}$
2004 Fr 6						1					1			1			$Y_{2004\ Fr6}$
2005 Fr 6						1						1			1		$Y_{2005\ Fr6}$
2000 Fr 7							1										$Y_{2000\ Fr7}$
2001 Fr 7							1	1									$Y_{2001\ Fr7}$
2002 Fr 7							1		1								$Y_{2002\ Fr7}$
2003 Fr 7							1			1							$Y_{2003\ Fr7}$
2004 Fr 7							1				1						$Y_{2004\ Fr7}$
2005 Fr 7							1					1					$Y_{2005\ Fr7}$

2.0 Nest Counts in Lake Huron (2000–2005)

The count of cormorant nests in Lake Huron represents the baseline information on changes in abundance through time. Nest counts through 2000 were supervised by the Canadian Wildlife Service (Weseloh et al. 2002). Nest counts from 2001-2005 were supervised by the Ontario Ministry of Natural Resources. The coding system for colony location was developed by Weseloh et al. (2002) and is used here. Nest counts of all colonies in the North Channel and Georgian Bay occurred in 2000 (Canadian Wildlife Service), 2003, 2004, and 2005 (all OMNR). Nest counts were conducted only in the sample frames in 2001 and 2002. Total nest counts for the study period (2000-2005) including both Georgian Bay and the North Channel are shown in Figure 2.1.

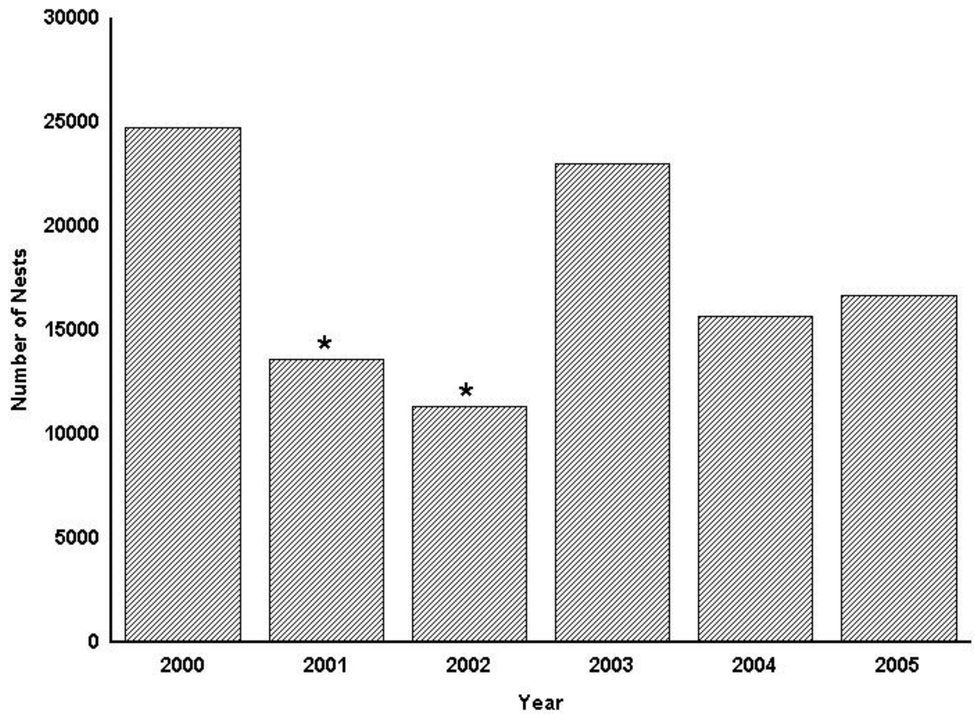

Figure 2.1 Total nest counts for North Channel and Georgian Bay during the study.(*in 2001 and 2002 nest counts were conducted only within the 7 study frames and are therefore lower than other years.)

The general procedure for nest counting was to survey known nesting colonies and search for new colonies during the course of traveling among known colonies. Apparently occupied nests were characterized by fresh nesting material and/or eggs or young. Nest counts were conducted in the latter half of June each year. The period of significant colony growth occurred prior to 2000 in Lake Huron with the peak nest count occurring in 2001. The development of new colonies relative to the number of established colonies was low during this study.

The locations of nesting colonies in 2005 are shown in Figure 2.2 (Georgian Bay) and Figure 2.3 (North Channel). Nest colonies were located based on long-term records of colony development as well as discovery of new colonies based on travel during nesting surveys in the coastal areas of the North Channel and Georgian Bay. Appendix 2 lists the coordinates for each colony, the years when colony counts were conducted at each site during the course of this project, and the nest counts for each year.

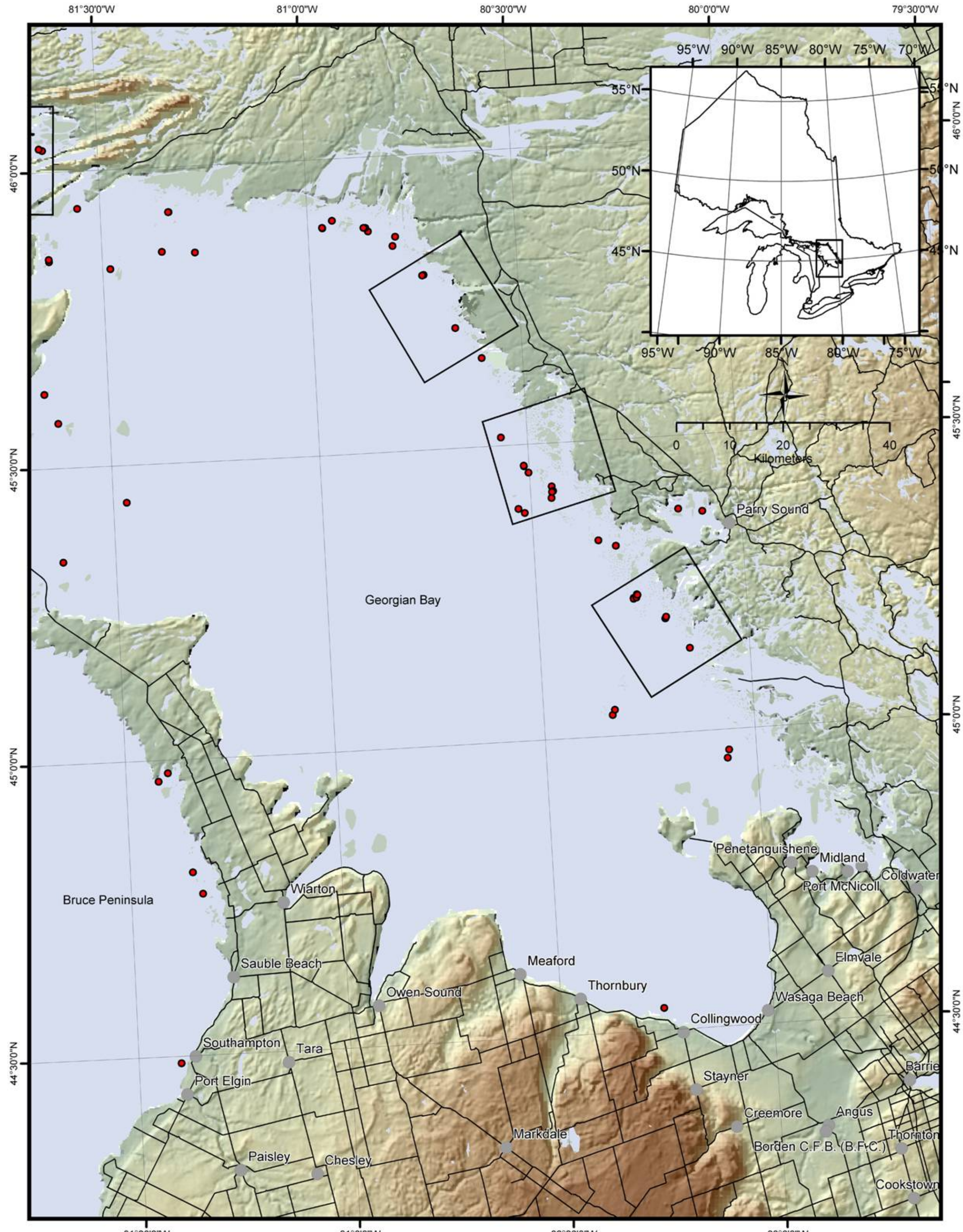

Figure 2.2. Location of double crested cormorant nesting colonies in Georgian Bay

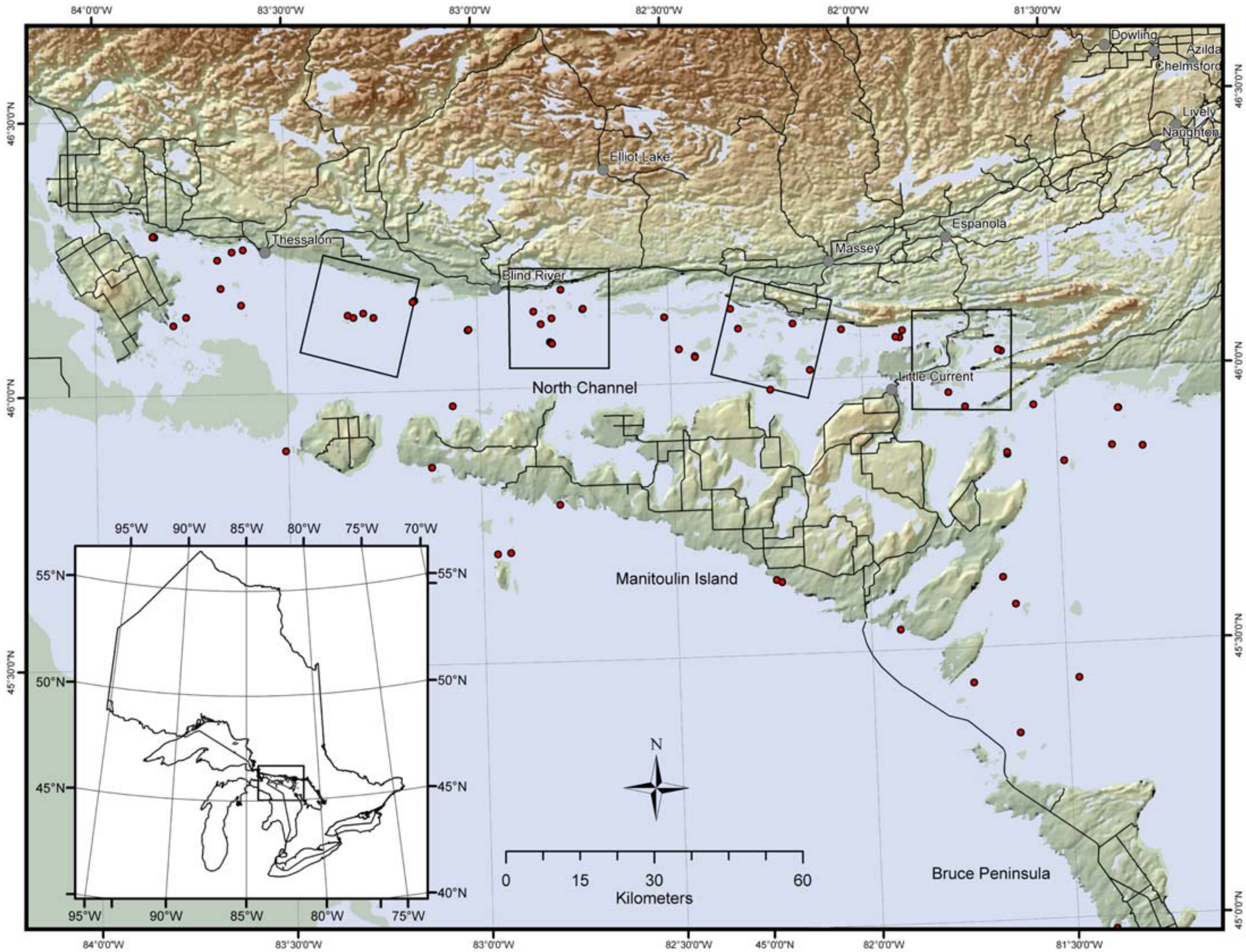

Figure 2.3. Location of double crested cormorant colonies in the North Channel

3.0 Egg Oiling (2002–2005)

Egg oiling was used to suppress recruitment and reduce prey demand by foraging cormorants. Egg oiling was initiated in 2002 on three study frames (2, 4, & 5). In 2003, colonies in the same three frames were treated with the addition of frames 1 and 6. In 2004, all previously treated study frames were treated once again leaving only frames 3 and 7 as untreated "control" study frames (Figure 1.3).

Significant colonies located outside the study frames but close enough to be accessible to foraging adults were also oiled.

Colonies were oiled up to three times each year between mid May and mid June. Tables 3.1 and 3.2 summarize the years in which each colony was oiled and the number of oiling visits to each colony per year.

White mineral oil (Daedol NF) was applied to eggs using an agricultural backpack sprayer. Daedol NF when applied to eggs, blocks pores in the shell and suffocates the developing embryo (Christens *et al.*,1995). As the egg is not destroyed, parent birds will continue to incubate the eggs until it is too late to re-nest. The use of this oil was authorized via a research permit issued from the Pest Management Regulatory Agency. All oiling staff wore full face respirators with NIOSH filters. Spray paint was used to mark the edge of nests which had been oiled. Orange paint was used to mark nests oiled on the first visit and blue paint for the second visit. Two staff sprayed nests while a third staff member recorded the number of nests oiled, and the number of eggs in each nest.

Table 3.1. Cormorant colonies oiled in years 2002-2005 and the number of oiling visits to each colony for the Georgian Bay area. At some sites on some visits no nests were observed and therefore no oiling was conducted.

Area	Frame	Site Number	Site Description	2002	2003	2004	2005
Georgian Bay	1	6	Island SSE of Haystack Rock & SW of Double Island		3	3	3
	1	7	Caleb Island, islet to south		3	3	3
	1	9	South Tribune Island		2	3	3
	1	11	3 islands east of the Tribune Island		3	3	3
	2	17	Wallis Rocks		3	3	1
	2	18.1	Rock SE of Wallbank Island	1	3	3	3
	2	19	Island E of Garland & Elmtree Islands (The Birnies)	2	3	3	3
	2	20	Southwest Island	2	3	3	3
	2	21	Colin Rock (South Colin Rock)	1	3	3	3
	2	22	Duncan Rock (north Colin Rock; NE of Colin Rock)	1	3	3	3
	2	23	Main Blackbill Island	1	3	3	3
	2	*48	Island W of Dart, E of SW Rock		2		
		15	Island SE of Hoopers Island		3	3	3
		16	Snake Island	1	3	3	3
		37	West Rock	1	2	1	1
		38	Kokanongwi Shingle		3	3	3
		39.1	East and West Mound Island	1			1

* No colony counts for this oiling location

Table 3.2. Cormorant colonies oiled in years 2002-2005 and the number of oiling visits to each colony for the North Channel area. At some sites on some visits no nests were observed and therefore no oiling was conducted.

Area	Frame	Site Number	Site Description	2002	2003	2004	2005
North Channel	4	1	1.2 km S of Parsday Crag Island		2	1	3
	4	*1.1	1 km SW of Parsday Crag Island				1
	4	2	Heywood Rock	2	3	3	3
	4	3	Island SW of Mary Island	2	3	3	3
	5	8	Elm Island	2	3	3	3
	5	10	Gull Rocks	3	3	3	3
	5	11	West Rock of Hiesordt Rocks	2	3	3	3
	5	13.1	Meredith Rock Clapperton Channel		3	3	3
	6	15	Middle island of Robb Rocks		3	3	3
	6	**15.1	Robb Rock (100m W of Robb Rock)			3	3
	6	16	West island of Magazine Island		3	3	3
	6	17	North island of Fortin Rocks		2	2	3
	6	18.1	NW island in the Cousins Island cluster		3	3	3
	6	18.2	NE Island (Cousins Island Cluster)		3	3	3
	6	18.3	S Island (Cousins Island cluster)		3	3	3
	6	19	Black Rock (between the Cousins & Doucet Rock)		1		3
	6	20	Doucet Rock		3	3	3
		4	Island NNE of Carpmael Island (Whitby Island)	1		3	3
		5	Carpmael Island	2	3	3	3
		6	West Rock of Gordon Rock	2	3	3	3
		7	Nisbet Rock (N. of Bedford Island				3
		9	East Rock		1		3
		12	North Rock of Howland Rocks	2	2	3	3
		12.1	South Rock of Howland Rocks	1	2		3
		13	Egg Island	2	3	3	3
		14	Mouse Island		3	3	3

*Nest counts grouped with site 1
Nest counts grouped with site 15

4.0 Aerial Flights for Estimating Cormorant Density (2000-2005)

Estimating bird abundance in each study frame involved two components. First, the nest count of each colony in each frame provided estimates of adult abundance in May and June during the parental care period. This was used to determine density during the nesting period (May-June). Second, aerial transect distance sampling was used to estimate the density of cormorants from the end of parental care in early July to the period prior to southward migration in September. This procedure provided estimates of free-ranging cormorant density not reliant on nest counts. This is the only approach available to estimate density because the end of the parental care period results in the dispersal of adult and juvenile birds from the nesting colonies. Stationary site-based counts of birds would not provide good estimates of cormorant density after the nesting period. Extending estimates of abundance from nest counts into the summer and fall periods assumes that density estimates derived from nest counts of colonies earlier in the year apply throughout the entire season. This is not likely the case for cormorants since they are well known for their seasonal movements over large geographic regions.

The procedure for estimating abundance of free-ranging cormorants was line transect distance sampling (Buckland et al. 2001). The general procedure in line transect sampling is to record distances of detected animals as the observer travels along a straight line. The method is based on developing a detection function, a mathematical relationship that describes how an observer's ability to detect animals declines as a function of the animal's distance from the line. This principle of detection as a function of distance is the same whether the observer is walking the line or, in the case of this study, traveling the line by airplane.

Ten aerial line transects were mapped in each frame with each divided into 8 sections 2.5 km in length (Appendix 3). The 80 line sections per frame represent the line transect samples for the aerial survey. The set of parallel lines were oriented perpendicular to the coast and were approximately 2.5 km apart, a distance that was beyond the detection range of observers. The lines surveyed were fixed for each year (listed in Appendix 3). The distribution of mean water depth for each aerial transect line is shown in Figure 4.1. The distribution shows that most transect lines in the coastal zone covered water less than 20 m mean depth.

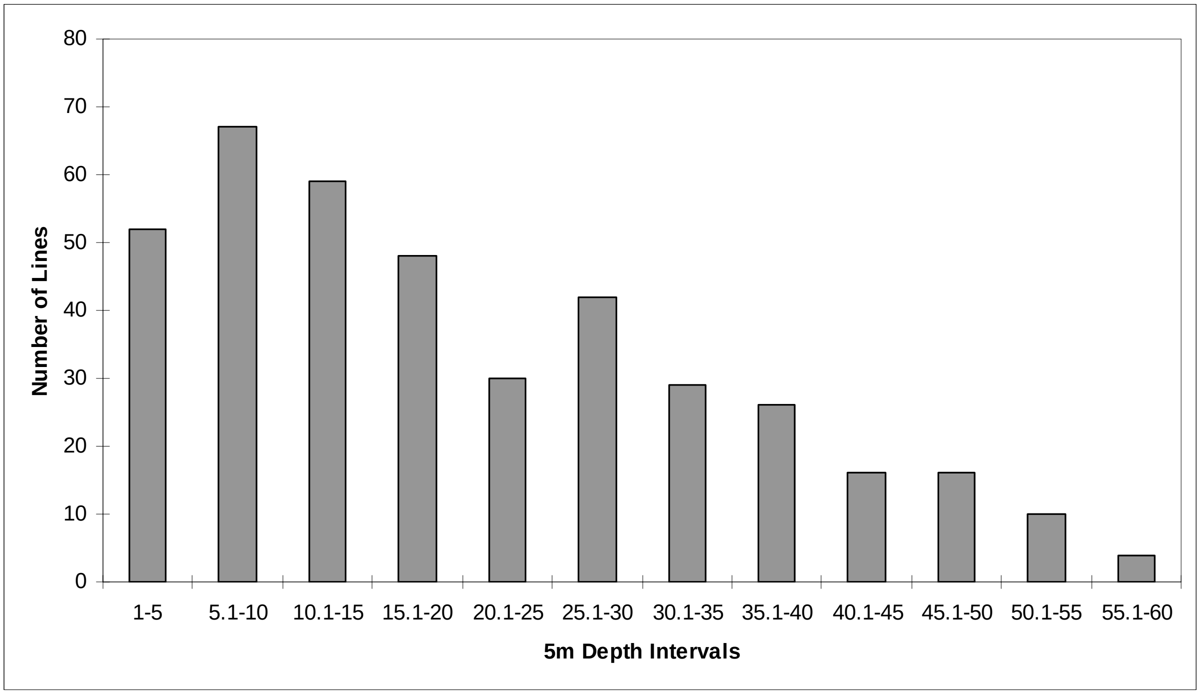

Figure 4.1. The distribution of mean water depths associated with each 2.5 km aerial line transect section, North Channel and Georgian Bay combined.

The procedure for counting cormorants along the aerial line transects was as follows. The distance of each detected bird(s) from the flight line was based on a set of markers on the wing struts that served to demarcate distance categories. The plane flew at an altitude of 100 m and a speed of approximately 90 nautical miles per hour for each survey. Two observers participated in each survey with one located on each side of the plane. The plane was navigated along the line using GPS-based mapping software that tracked the position of the plane. Based on this approach, observers could determine when they were leaving one transect section and moving into another. Observers recorded the following observations into tape recorders during the flights for later transcription: 1) estimated number of cormorants in a group; 2) distance category in which the cormorant group was detected, and 3) whether or not the group was in one of three behavioural states (flying, on the water, or standing on shore).

Distance categories were demarcated on the wing struts based on the formula:

$$\text{Strip Width} = H*\tan(90-\theta)$$

Where H is altitude (m) and θ is the restricted viewing angle. In this study, the pontoon edge of the plane was 63º below the horizon meaning the obstructed strip below the plane (and not available to the observers) was approximately 50 meters on each side of the plane. In the first three seasons, 2000-2002, only two strips were used based on the advice of waterfowl biologists. The distance strips were 0 m (pontoon edge) – 200 m and from 200 m to 520 m. In 2003 an additional distance strip was added from 520 m to 1000 m. Finally, in 2004-2005, distance strip boundaries were set at 0 m (pontoon edge), 50 m, 150 m, 300 m, 500 m, and 1000 m.

A fundamental assumption of line transect distance sampling is that animals on or near the line are fully detected (detection probability = 1.0). In the aerial survey of cormorants, the plane was traveling at approximately 50 m per second ground speed so there is a likelihood that birds were missed that should have been detected. During one flight in 2001, both observers were located on the same side of the plane and operated independently of each other in recording cormorant detections. At a ground speed of 50 m/sec, it was assumed that the detections of cormorants on any given line transect was instantaneous for both observers. This facilitated a mark-recapture approach to determine the number of cormorants missed based on the number of detections that observers had in common and the number of detections that one or the other observer had detected alone (i.e., missed by the other observer). This provided an estimate of detection efficiency on the line. Based on this approach, the probability of detection on the line = 0.732.

Table 4.1. Dates of aerial line transect surveys for cormorants

Flight Number	2000	2001	2002	2003	2004	2005
1	July 4-7	June 25-26	July 2-5	July 2-7	July 6-13	June 14-17
2	July 17-20	July 9-12	July 15-18	July 8-10	July 26-29	July 6-8
3	Aug 1-4	July 23-26	July 29-Aug 2	July 22-24	Aug 11-16	July 25-27
4	Aug 14-17	Aug 7-13	Aug 12-15	Aug 11-14	Aug 23-30	Aug 15-17
5	Aug 26-30	Aug 21-23	Aug 26-29	Aug 25-28		Aug 29-31
6	Sept 13-15	Sept 4-7	Sept 5-8	Sept 8-9		

5.0 Nearshore Fish Community Trap Net Index Program (2000-2004)

Field Methods

Generally, the field methodology of the cormorant trap net program followed closely the protocol outlined in the “Manual of Instructions: Nearshore Community Index Netting (NSCIN)” (Stirling, 1999). Although the original NSCIN standard was developed for smaller inland lake systems it has been adapted successfully by the Upper Great Lakes Management Unit (UGLMU) for several ongoing coastal Lake Huron fish spawning and community assessment programs. The NSCIN protocol also provides standardized measures of relative fish abundance, growth, biomass, and productivity that can be used to compare Lake Huron stocks with other locations.

Sampling Dates

The trap netting program was typically completed within the July to August period with the exception of 2000 when sampling began in late July and continued on into early October (see Table 5.1). Although the NSCIN protocol requires that netting begin after August 1, field crews running the program in 2000 reported that unpredictable weather and strong winds encountered frequently in mid- to late September made netting difficult and was of concern to crew safety. Therefore, in 2001-04, the sampling period was changed to begin in mid July and finish by late August to take advantage of more reliable weather conditions.

Table 5.1. Sampling dates for the Nearshore Community Trap Net Index program (2000-2004) by frame number. Field crews typically began in the North Channel (frame 6 -7), then completed the Little Current sites (frames 4-5), then moved south along the Georgian Bay coast completing the Britt and Parry Sound sites (frames 1 -3).

Frame	2000	2001	2002	2003	2004
1	Sept. 28 – Oct. 1	Aug. 24 – 28	Aug. 19 – 22	Aug. 13 – 16	Aug. 16 - 19
2	Sept. 20 - 27	Aug. 20 – 24	Aug. 8 – 11	Aug. 7 – 10	Aug. 7 - 10
3	Sept. 12 - 20	Aug. 10 – 14	Aug. 5 – 8	July 25 – 29	Aug. 3 - 6
4	Aug. 31 – Sept. 8	July 23 – 28	July 29 - Aug. 1	July 21 – 24	July 23 - 26
5	Aug. 15 – 30	July 28 - Aug. 10	July 22 – 25	July 16 – 19	July 19 - 22
6	Aug. 10 – 14	July 14 – 18	July 12 – 15	July 7 – 10	July 9 - 12
7	July 31 - Aug. 5	July 9 – 14	July 9 – 12	July 3 – 7	July 6 - 9

The NSCIN protocol also requires that netting discontinue once surface temperatures fall to 13^{o}C. Water temperatures within the coastal regions of the North Channel and Georgian Bay have been observed to be highly variable and are driven by wind and seiche events. Although the observed average surface water temperature never fell below 13.3^{o}C , there were twelve netting events in 2000, 2001, and 2004 (all from frame 7) where the surface water temperatures were observed to be between 11^{o}C and 13^{o}C (Figure 5.1).

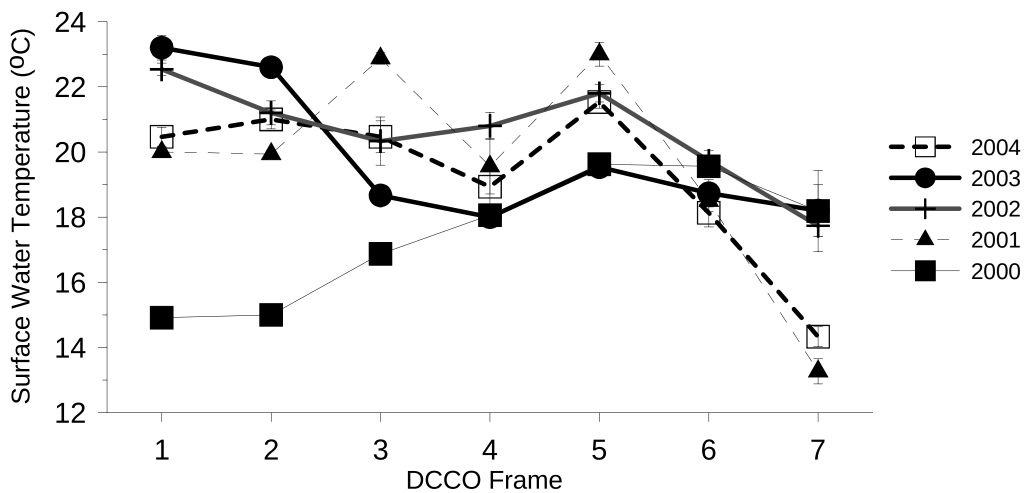

Figure 5.1. Mean surface water temperature (°C) observed at each netting site by frame for 2000 to 2004. Error bars are standard error of the mean and in some instances are obscured by the symbol.

Random Site Selection

The sample areas or "frames" are 20km by 20km areas centered around cormorant breeding colonies in the North Channel and Northeastern Georgian Bay. Within each of these seven frames, a 500m X 500m contiguous grid was layered on a map of the shoreline deemed suitable for netting, each grid being assigned a unique number (Appendix 4). Individual netting sites or grids were selected using a random number generator. A site would not be reused within the same year. If the crew upon visiting the site, decided that the site was not suitable for setting the gear (i.e. insufficient water depth, poor substrate and/or wave exposure), the crew was instructed to cross the grid number off the list and proceed to the next randomly selected site. Due to fluctuating lake levels over the time period of the program, sites deemed as unsuitable for setting the gear in one year were not precluded from being chosen the following year.

A detailed summary of the netting locations with GPS coordinates is in Appendix 5. Maps of the trapnet site locations are in Appendix 6.

Gear Description & Deployment

Standardized 1.83m (6') trap nets with 150m (492') leads were set and fished using the same methods as described in the "Manual of Instructions: Nearshore Community Index Netting (NSCIN)" (Stirling, 1999). A schematic of a standard trap net is provided in Figure 5.2.

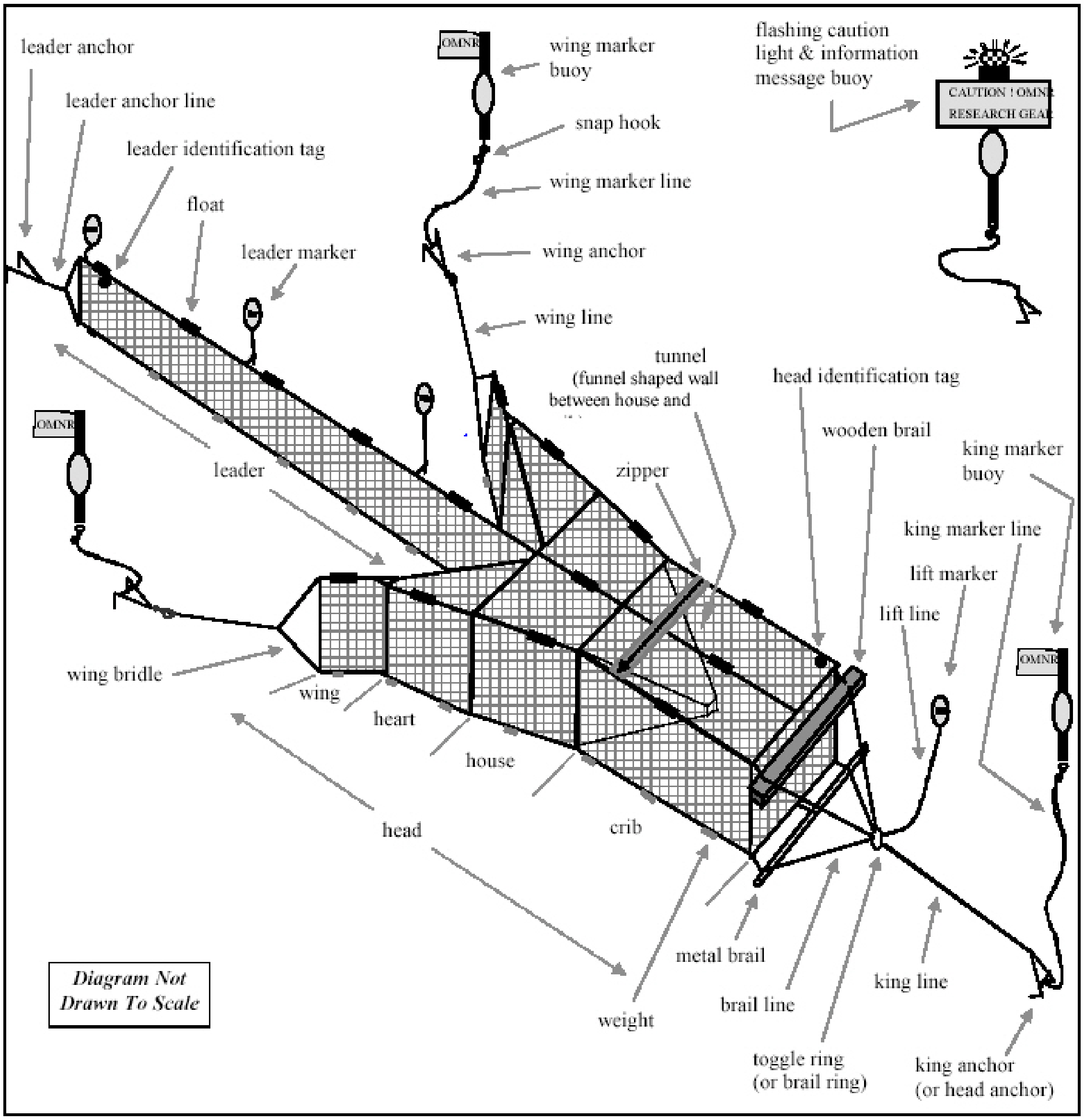

Figure 5.2. Schematic of a standard NSCIN trapnet.

Field crews typically set 4 to 5 nets per day for a total of 14 - 16 net sets per frame per year. Nets were typically set in the late afternoon or evening and fished the following morning in the same order in which they were set. Nets fished overnight for an average 21.2 hours (+/- 3.10 hrs) (Table 5.2). On four occasions in 2001 (frames 4 and 7) inclement wind and wave conditions prevented the crew from retrieving the nets until 38 – 42 hours after the nets were set.

Table 5.2. Average set duration (hrs) of the trap net gear for each frame 2000-04. Shown below each value in parentheses is the observed minimum and maximum set duration as well as the total number of nets set (n).

	Average Set Duration (Hrs) (Min - Max, n)				
Frame	**2000**	**2001**	**2002**	**2003**	**2004**
1	21.1 (19.6 - 23.7, 12)	21.9 (17.7 - 24.3, 14)	22 (17.2 - 24.3, 15)	20.2 (17.3 - 25.6, 15)	19.4 (15.7 - 22.5, 15)
2	19.9 (17.1 - 22.4, 16)	21.9 (17 - 24.2, 16)	22.1 (17.8 - 24, 15)	19.8 (15.4 - 22.7, 15)	21.9 (17.9 - 24.1, 15)
3	21.9 (20.3 - 24.9, 16)	21.1 (16 - 22.9, 16)	21.9 (19.6 - 24.6, 15)	21.2 (16.3 - 27.2, 15)	17.7 (12.7 - 23.8, 15)
4	20.1 (16.8 - 23.8, 16)	24.4 (17.2 - 41.2, 16)	22 (18.2 - 25.5, 15)	18.9 (15 - 23.3, 15)	20.1 (15.8 - 25.5, 15)
5	22.7 (17.9 - 28, 16)	21.3 (17.9 - 23.5, 14)	20.6 (16.4 - 24.4, 15)	19.4 (16.7 - 23.1, 15)	19.7 (15.4 - 26.2, 15)
6	22.7 (21.1 - 25.1, 16)	21.7 (17.9 - 24.4, 16)	21 (18 - 23.7, 15)	18.5 (13.7 - 24.3, 15)	20 (13.1 - 26.8, 15)
7	20.9 (17.2 - 24.6, 16)	24.9 (19.3 - 41.2, 15)	22.6 (20.7 - 24.5, 15)	23.3 (17.7 - 29.8, 15)	21.5 (19.4 - 24.9, 15)

Data Collection

All effort information, catch descriptions, biological measurements, and site descriptions were recorded by the field crew on a data logger. A description of the data logger pages and corresponding data fields are provided in Appendix 7.

Site and Effort Information

Information about the time and date the gear was set and fished, the GPS coordinates of the net set, gear descriptions as well as air and water temperature, weather conditions, cloud cover and wind direction and speed were recorded for each netting site.

Catch Information

All fish in the catch were identified and counted to obtain a total catch for each species. While in the field, only those fish that were not bio-sampled (not entered in FN125) were entered in the CATCNT in the FN123 table. CATCNT in the current database has since been updated to include both bio-sampled and non bio-sampled fish. All fish in the catch observed to be marked with a caudal punch from that year were tallied and recorded both in the “CATCNT” and “RCPCNT” fields. Redhorses were identified only to genus (*Moxostomus* spp.) as species identification would have required more time processing the catch when time was critical. Past trapnet surveys have shown that shorthead redhorse (*Moxostoma macrolepidotum*) is the most common species here.

Biological Sampling

The field crew was instructed to sample all fish for fork length, total length, weight, lamprey marks, tags and age structures where possible. In those sites (nets) where the crew encountered greater than fifty fish of a given species, the first fifty randomly selected fish were fully sampled and the remaining were sampled for fork length only. All fish sampled were also given a caudal punch before being released. The caudal punch mark was used to identify any fish recaptured within the current year. In 2004, the field crew was instructed to make note of any slash marks or scars on fish that may have resulted from a possible cormorant attack.

From 2000-2004, field crews observed a total of 15,963 fish in the catch representing 29 different species. Of the observed catch, 10,901 were bio-sampled for length and 7,210 had their weight recorded.

Aging Structures

Scale samples were taken from all species (excluding bowfin, gars, carp and cyprinids as well as common white suckers in 2003-04), from up to 10 fish per 10 mm size class. The crew was instructed to keep a record of the number of samples collected per frame per size class on a dot tally sheet.

Where possible, common white suckers captured in 2004 (and from frames 1 – 3 in 2003) were sampled and their operculum extracted for aging. For this particular species, ages interpreted from the operculum are considered more reliable than those from scales (Beamish, 1973; Ovchynnyk, 1965). Within each frame, the crew collected structures from up to 10 suckers per 10 mm size class. The crew was instructed to keep track of the number of samples per size class per frame on a dot tally sheet. All opercula were cleaned and dried at the end of each sampling day.

The age structures from each fish were stored within a standard UGLMU scale envelope and identified with the date, effort sample number, fish number and fish sampling information.

Age Interpretation

All aging tissue preparation and age interpretation (scales and opercula) were completed by private contractors. Table 5.3 summarizes the number of fish collected in the Nearshore Community Trap Net Index Program where an age was assigned from aging tissue. Age interpreters assigned ages to 5,919 fish over the five year program.

Table 5.3. Summary of the number of age structures collected and interpreted in the Nearshore Community Trap Net Index Program by species and year.

Species Name	2000	2001	2002	2003	2004
Alewife				20	
Black Crappie	17	1	1	1	
Bluegill	17				
Lake Herring	1			17	30
Lake Trout	8				
Lake Whitefish				1	
Largemouth Bass	31	11	4	3	2
Longnose Sucker				1	
Muskellunge			1	2	2
Northern Pike	94	91	60	71	28
Pumpkinseed	74			10	16
Rainbow Trout	3				
Rock Bass	3			637	679
Round Whitefish					2
Smallmouth Bass	406	662	415	805	832
Walleye	26	10	34	55	90
White Perch	1				
White Sucker	1	1		63	318
Yellow Perch	54	86	57	19	43
Total	*736*	*862*	*572*	*2086*	*2042*

6.0 North Channel & Georgian Bay Coastal Hydroacoustic Survey (2000-2004)

Data Collection Methods

Study Sites

The coastal hydroacoustic surveys were completed within the sample frames. Figure 6.1. shows the boundary within which hydroacoustic sampling was conducted. Within each frame, a series of transects were surveyed. Transects were approximately 1 km apart and typically perpendicular to shore. The length and number of transects within each frame varied depending on the general shape and complexity of the coastline (Table 6.1.). Appendix 8 provides detailed maps of the survey area and plots of the hydroacoustic transects completed within each year of the program.

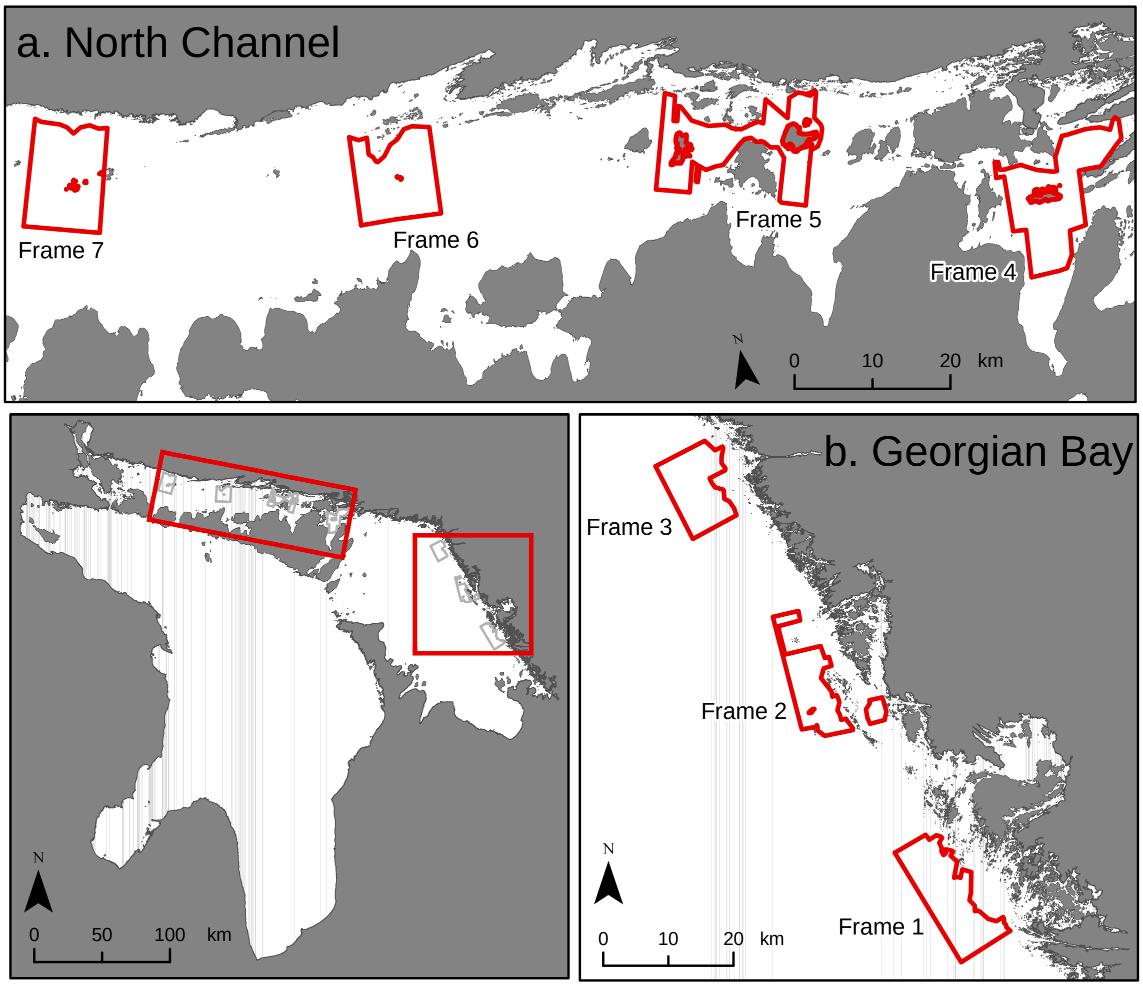

Figure 6.1. Maps of the Lake Huron coastline with plots of the acoustic survey transect boundaries of the 7 study frames in the North Channel (a) and Georgian Bay (b) of Lake Huron 2000-04.

The total area surveyed within the boundaries of the survey frames was approximately 84,000 hectares per year, covering approximately 4.7% of the total surface area of the North Channel and Georgian Bay basins (1.8×10^6 hectares) of Lake Huron. The greatest distance between survey frames was ~250 km with each frame representing a diverse suite of pelagic habitats varying from highly exposed deep water areas fragmented with steep shoals and bedrock islands, to relatively shallow, wind protected areas with relatively soft bottom. Other survey areas were likely influenced by large river systems or strong wind driven water movement (Table 6.1).

Hydroacoustic System Hardware

Hydroacoustic data in 2000-2002 were collected using a Simrad EY500 7.1^{o} 120 kHz split-beam system. The Simrad EY500 system was owned and operated by a private contractor. The contractor used an ES120-7^{o} transducer mounted on an aluminum I-beam that was affixed to the port side at mid-ship of the survey vessel.

Data collected in 2003-04 were recorded using a BioSonics DT-6000 or DT-X digital 6^{o} 123 kHz split-beam system. The transducer deployed with the two surface unit systems was the same for both years of the survey. The BioSonics system was operated by an OMNR survey crew and was leased from the manufacturer for the period of the survey. The digital transducer was installed within a BioSonics tow body and was towed from the survey vessel from the stern on the port side to avoid cavitation interference from the hull and prop-wash (Figure 6.2 & 6.3). The tow-body was deployed from a davit on a ~5m tether and was towed ~50cm below the surface.

Real-time GPS data strings were provided to the acoustic systems either from the ship-based differential GPS system (2000-2003) or from a hand-held WAAS unit (2004).

Figure 6.2. The BioSonics DT-6000 transducer installed on the tow-body.

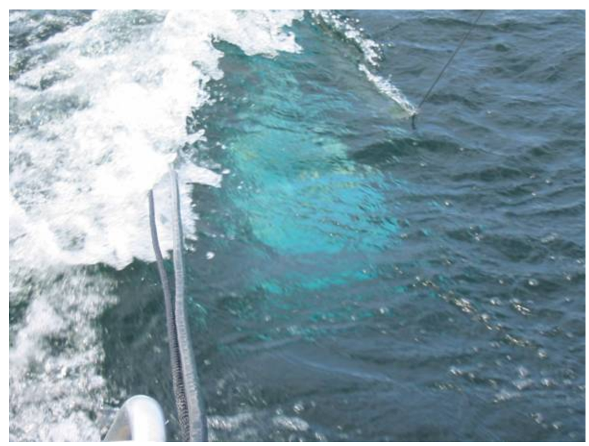

Figure 6.3. Image of the BioSonics tow-body and transducer on survey.

Table 6.1. General summary and description of the seven hydroacoustic survey frames within the North Channel (NC) and Georgian Bay (GB) of Lake Huron.

											Substrate Reflectivity (% of Survey Area) ←Softer Harder→		
Frame	**Basin**	**Town or City (Port)**	**Site Features**	**Survey Boundary Area (ha)**	**Basin Area (km^2)**	**% of Basin Coverage**	**Mean Survey Depth (m)**	**Max Survey Depth (m)**	**Number of Transects**	**Total Transect Length (km)**	**Low (Peak Sv<-20 dB)**	**Medium (Peak Sv >=-20 & <0 dB)**	**High (Peak Sv>= 0 dB)**
1	GB	Parry Sound	exposed coast, many islands	13,909	1433	1.0	36	72	23	100	16.8	49.7	33.6
2	GB	Pte Au Baril	exposed coast, many islands	9,661	1433	0.7	15	29	20	95	1.3	17.7	80.9
3	GB	Britt	exposed coast, offshore, near river delta	10,232	1433	0.7	22	38	13	101	0.1	37.6	62.3
4	GB	Little Current	low exposure, deep gullies flat slopes	13,665	1433	1.0	24	62	24	126	10.2	77.8	12.0
5	NC	Little Current	mod. exposure, currents	13,298	368	3.6	24	47	26	117	1.1	72.2	26.7
6	NC	Blind River	mod. exposure, low slope & complexity	10,633	368	2.9	31	50	11	105	0.1	77.2	22.7
7	NC	Thessalon	mod. exposure, low slope & complexity	12,721	368	3.5	25	43	17	102	0.6	61.3	38.1

Survey Dates and Times

Acoustic surveys were completed within the early fall in 2000 and mid to late summer in 2001-2004. Surveys typically commenced in the early afternoon and continued until all transects were completed. In 2000 the average cruise duration was ~8.3 hours and in 2001-2004 the average cruise duration was ~11.9 hours. A summary of the survey dates and times are shown in Table 6.2.

Table 6.2. Summary of the hydroacoustic survey dates and times for each frame in 2000-04. Note that the 2000 survey transects were completed much later in the year with only limited night-time coverage.

	2000		2001		2002		2003		2004	
Frame	Date	Time	Date	Time	Date	Time	Date	Time	Date	Time
1	Sept. 22	13:33 - 21:26	Aug. 26-27	14:41 - 01:36	July 30-31	16:13 - 02:47	Aug. 10-11	13:54 - 02:10	Aug. 9-10	13:10 - 00:14
2	Sept. 23	11:57 - 18:47	Aug. 28-29	13:16 - 00:11	Aug. 15	12:31 - 22:37	Aug. 8-9	13:18 - 02:57	Aug. 7-8	13:40 - 02:05
3	Sept. 24	12:21 - 20:55	Aug. 23-24	14:38 - 00:45	Sept. 5	15:08 - 23:44	Aug. 6-7	13:30 - 02:30	Aug. 4 & 5-6	13:18 - 01:43
4			July 29-30	14:47 - 02:05	July 28-29	16:33 - 04:24	July 28-29	13:12 - 03:12	July 27-28	12:22 - 03:13
5	Sept. 13	11:07 - 21:13	July 30-31	14:49 - 03:06	July 26-27	15:24 - 03:27	July 24-25	14:14 - 04:17	July 25-26	13:26 - 03:59
6	Sept. 25	13:18 - 20:46	Aug. 21-22	14:38 - 00:09	July 10-11	15:35 - 01:15	July 21-22	15:02 - 03:15	Aug. 21-22	18:41 - 03:18
7	Sept. 14	11:29 - 19:25	July 25-26	15:01 - 00:58	July 9-10	14:44 - 01:28	July 22-23	14:45 - 02:14	Aug. 17	13:05 - 23:53

All transects within all frames were surveyed at least once each year. In 2000 all transects within the frames were surveyed in the order of the transect number. The survey vessel would commence the survey on one end of the frame and would finish at the opposite side. In 2000 all surveys commenced in late morning or early afternoon and continued until all transects in the frame were completed. In most cases the survey continued on into the low-light crepuscular or the night-time period (Figure 6.4a).

To investigate diurnal behavioural changes in the pelagic fish community within each frame, and to obtain a more reliable estimate of fish density and biomass (available only from night-time surveys), the survey times were modified in 2001-2004 to broadly survey the entire frame under both daytime and night time conditions. In these years the survey crew was instructed to begin the survey at one side of the frame during the early afternoon and proceed to the far side surveying every other transect (i.e. 1 transect every 2 km apart). Once the survey vessel completed the last transect on the far side of the frame, the crew was instructed to wait until darkness. Once dark, the survey resumed, completing all remaining transects with the survey vessel finishing on the same side of the frame as it had started the day transects (Figure 6.4b). On occasion the survey crew was unable to complete all of the daytime transects within the day light period. In this case the crew continued surveying through the crepuscular period and into night without stopping the survey.

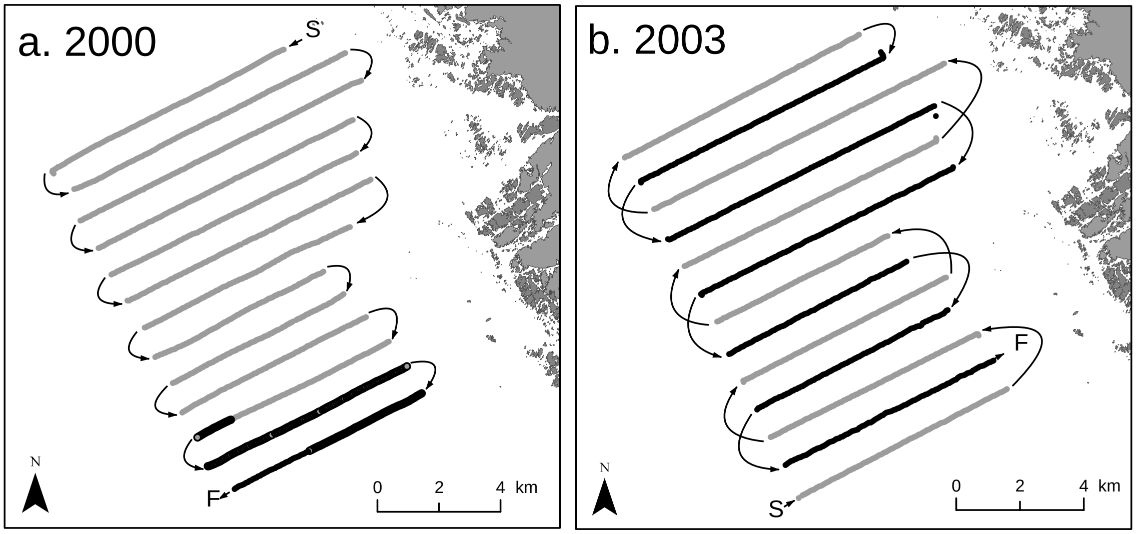

Figure 6.4a & 6.4b Schematic of the survey vessel path while on transect in 2000 (a) and 2003 (b) on the frame 3 cruise. Light shaded line is daytime transects, dark shaded line is night-time transects. Shaded circles with dark outlines denotes crepuscular portion survey in 2000. Arrows denote the path of the vessel from the start ("S") to the finish ("F") of the acoustic survey.

Hydroacoustic System Calibration and Parameter Settings

Simrad EY500 (2000-2002)

Calibration of the Simrad EY500 system in 2000-02 was completed by the contractor. TS observations of a standard Simrad calibration sphere were analysed using the Simrad "LOBE" calibration software following the calibration methods described in the "EK500/EY500 LOBE Calibration Program" manual (Simrad Subsea, 17.1.1995). From this software, an estimate of the "TS gain" correction factor was updated to the EY500 parameter file (Appendix 9). An "Sv gain" correction was estimated from the "TS gain" using a standard equation provided by Simrad. Available parameter files indicate that both the "TS gain" and "Sv gain" were set to 26.1 dB in 2001.

Post-processing Calibration Adjustments

Inspection of the hydroacoustic data in 2002 revealed inconsistencies in single target detections and integrated backscatter compared to 2000 and 2001. These differences exceeded what could be reasonably expected due to any change in the pelagic fish assemblage. Adjusting for this discrepancy required a common acoustic target which could be expected to remain unchanged between years.

Our approach was to identify spatial points within the frames where survey transects overlapped between different years to compare measures of bottom reflectivity (peak Sv; the maximum backscatter from the sonar detected bottom). The acoustic reflectivity of a particular substrate type within the survey region was not expected to vary significantly between years and would therefore provide a series of standardized data points that could be measured to test the relative sensor stability across surveys. We used a GIS to identify all points on a given survey that were spatially located within **0.5m** of another survey and then calculated the mean arithmetic difference between the observed peak Sv values of all the data pairs. Consistent bias was detected in backscattering strength when comparing among the same substrates in different years.

Therefore, to ensure that we can provide accurate acoustic estimates of fish density and biomass and be able to reliably test for differences between years and frames, we have applied a calibration correction offset value to all post-processed measures of integrated backscatter that adjust the data towards a calibrated standard

Biosonics DT-6000 and DTX (2003-04)

Biosonics DT acoustic systems can only be calibrated by the manufacturer. Calibration verification was completed with the Biosonics DT-6000 and DT-X systems just prior to and following the surveys in 2003 and 2004. Calibration verification was completed using a standard 33 mm tungsten carbide calibration sphere. We followed the methods described in the Biosonics Operation Manual: DT / DE Series -Appendix H.

Analysis of the DT-6000 calibration verification data from 2003 indicated the observed target strength (upper 10^{th} percentile of all TS observations) of the calibration sphere was on average 1.6 dB greater than that of the theoretical target strength provided by BioSonics (Table 6.3). Therefore a calibration offset of -1.6 dB was applied to all Sv and TS Echoview analyses in 2003.

Analysis of the DT-X calibration verification data from 2004 indicated that the observed target strength (upper 10^{th} percentile of all TS observations) of the calibration sphere was on average only 0.07 dB greater than that of the theoretical target strength provided by BioSonics (Table 6.3). This value is considered well within the error expected and therefore no calibration adjustments were applied to the 2004 data.

Table 6.3. Analysis of the BioSonics calibration verification data from 2003 and 2004 for estimating the calibration offset to be applied to all analysis in Echoview. Data shown in the table is a statistical summary of the observed single target detections and target strengths of a standard ~33mm Biosonics calibration sphere. We used the average difference between the theoretical target strength of the calibration sphere and the observed target strength during the tests for each year as an estimate of the final calibration offset.

Month	Year	Number of Single Targets	Mean TS (dB)	Min TS (dB)	Max TS (dB)	Lower 10% TS (dB)	Upper 10% TS (dB)	Std. Dev.	Theoretical TS (dB) of ~33 mm Calibration Sphere	Difference (Theor. TS-Upper 10% of Obs TS)	Average Annual Difference TS (dB)
July	2003	131	-39.50	-41.13	-37.85	-40.20	-38.79	0.539	-40.75	-1.96	-1.60
August	2003	161	-39.95	-40.39	-39.45	-40.21	-39.66	0.207	-40.90	-1.24	
July	2004	20	-41.11	-43.10	-40.30	-42.27	-40.45	0.732	-40.65	-0.20	-0.07
August	2004	228	-42.24	-44.40	-38.35	-43.51	-40.71	1.116	-40.65	0.06	

All parameter settings required to operate the BioSonics system are read from a configuration file (*.cfg) within the Visual Acquisition software directory. A text version of the parameter file with all machine settings from the surveys for 2003 and 2004 are available in Appendix 9.

Cross-calibrations between the Simrad EY500 and Biosonics DT6000-DTX

To verify that the two systems were providing comparable data, we compared the backscatter response of the two systems. Comparisons between a properly calibrated Simrad EY500 and the BioSonics DT-6000 system were completed on July 9, 2003 at Harkness Laboratory of Fisheries Research on Lake Opeongo. A number of night-time transects were surveyed to compare the operation and results of the DT-6000 system leased from BioSonics to the Simrad EY500 120kHz split-beam acoustic system currently owned and operated by the Harkness Lab. The Harkness EY500 surface unit model, transducer model and frequency were identical to that of the system used to collect the 2000-2002 hydroacoustic data.

Methods

Both hydroacoustic units were installed onboard the survey vessel. The transducer for the EY500 was fixed to the gunnel of the vessel and the DT-6000 transducer was deployed in the BioSonics tow-body and towed approximately 50cm below the water surface. As the EY500 and the DT-6000 systems transmit at approximately the same frequency we were unable to operate the two systems simultaneously.

We plotted a single transect within the South Arm of Lake Opeongo. After night fall we began the first survey with the BioSonics DT-6000 system moving east to west along the plotted transect. We then surveyed the same transect with the Simrad EY500 system moving west to east.

Sv and single target echograms from both hydroacoustic systems were processed using the same processing parameters in Echoview. Virtual single target detection variables were created in Echoview for the BioSonics DT-6000 data. In addition, a calibration offset of -1.6 dB was applied to the DT data. Surface and bottom exclusion lines were applied within Echoview. An estimate of the integrated Sv over the entire water column was estimated for each 1 minute horizontal survey bin. “Fish Track” single target detection regions were applied to the single target detection echograms in Echoview and exported for analysis.

Results

Although we were unable to simultaneously sample the water column using the BioSonics DT-6000 and the Simrad EY500 acoustic systems, preliminary results indicate that the two systems were providing similar estimates of integrated Sv (Table 6.4) and similar target strength distributions within the target strength ranges of the analysis (Figure 6.5). Although the target strength frequency (fish track) distributions from the two systems detected similar modes, the total number of single target detects and the range of observed target strengths was greater for the EY500 system.

Table 6.4. Mean, standard deviation, minimum and maximum observed integrated Sv by 1 minute bins from the BioSonics DT-6000 and the Simrad EY500 hydroacoustic systems from the July 9-10, 20003 survey on Lake Opeongo.

System	Date	Time	Mean Sv (1 minute bins)	Std. Dev.	Min Sv	Max Sv
DT-6000	July 9, 2003	22:50:34.01 - 23:12:36.40	-63.16	2.55	-69.05	-59.67
EY500	July 9-10, 2003	23:38:35.20 - 00:02:19.10	-62.59	1.98	-66.67	-58.75

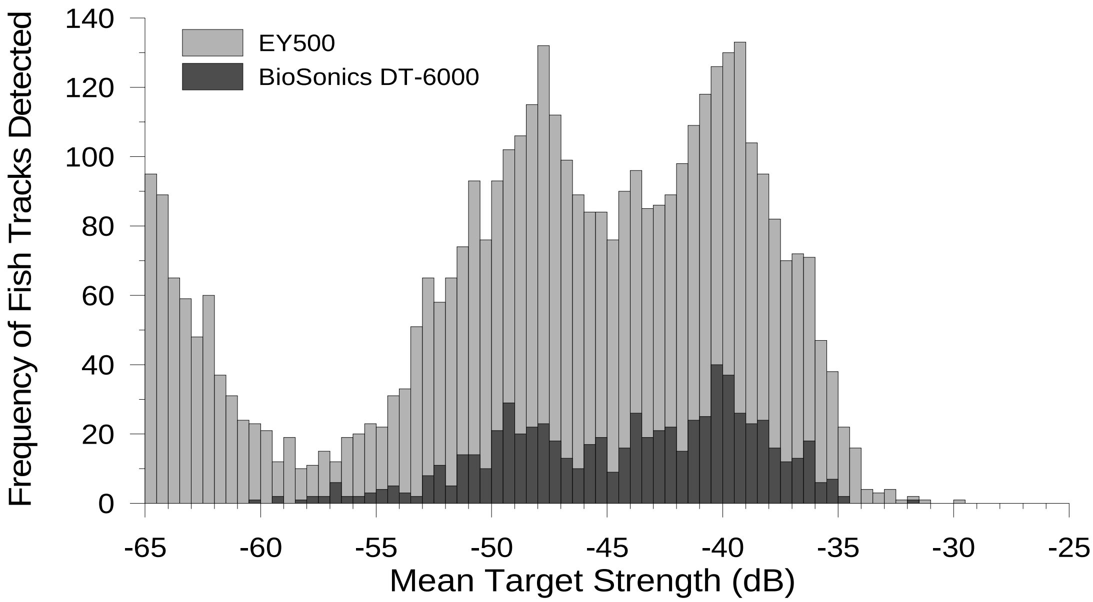

Figure 6.5. The mean "fish track region" target strength frequency distributions as detected by the Simrad EY500 7.1° 120kHz (light shaded bars) and BioSonics DT-6000 6.0° 123 kHz (dark shaded bars) split-beam hydroacoustic systems. Results indicate that although both systems detected similar modes within the typical range of fish targets, the EY500 system detected a greater number of single targets over a greater range of target strengths.

Mason and Schaner (2001) performed more rigorous comparisons of Simrad EY500 and BioSonics DT hydroacoustic systems as part of a report by the Great Lakes Fisheries Commission Acoustic Working Group. Overall results from their test also show comparable estimates of Sv and target strength distributions however they also found differences in the number of single target detects.

Target Verification and Fish Sampling Methods

To ground truth the targets observed during the acoustic surveys, the private contractor deployed gill nets to sample fish over the duration of the acoustic survey in 2002. One standard gill net index (GL01 + 15m 1" multi-mesh) was set in each of frame 2 (north-east side of North Limestone Island) and frame 4 (north-west side of Heywood Island) in 2002 before beginning the acoustic surveys. At the conclusion of the acoustic survey, the net was retrieved and the catch counted and sampled for length and round weight.

Catches were primarily common white suckers in frame 4 and primarily lake whitefish and lake trout in frame 2.

In 2003, the nearshore community trap net index crew was available to provide some limited gill netting within the acoustic survey areas of frames 1, 3, and 6. Two standardized monofilament index gillnets (each with an additional 15m panel of mono 1" mesh) were set at specific areas within each of three study frames during the acoustic survey period to collect information on the size distribution and species composition of the fish community in each area of the lake. Unexpected large catches of lake chub (*Couesius plumbeus)* and trout perch (*Percopsis omiscomaycus*) were observed in the catches in frames 1 and 3. These preliminary results indicated that the fish community composition of the study frames were likely very different and put into question our previous acoustic fish density estimates that were derived from target strength models for alewife. Only one alewife was observed throughout all of the net catches in 2003.

Coastal Gill Netting Survey Program

Based on observations from the 2003 acoustic and gillnetting surveys, gillnetting effort was increased across all frames in 2004 (Figure 6.6). The Coastal Gillnetting Survey Program was developed and implemented in July-August 2004. This intensive overnight gill netting survey utilized the standard "GL10" index gear (25m of 38mm and 50m each of 51mm, 63.5mm, 76.2mm, 89mm, 101.6mm, 114.3mm, and 127mm) as well as an additional gang of small monofilament mesh gear ("GLSM" – 15m panel of 19mm, 2 x 15m panels of 25mm and 15m panel of 32mm). The gear were set either on the bottom or suspended below surface floats ("canned") to fish the pelagic thermocline region (Table 6.5). Results from this program provided estimates of the critical parameters required to derive estimates of fish density and biomass from the hydroacoustic surveys (i.e. average round weight, length distributions, CUE, estimates of σ etc.). Netting site information (spatial locations, dates, times, etc.) as well as a more detailed description of the Coastal Gill Net Program methodology is available in Appendices 10 and 11.

Table 6.5. Summary of the UGLMU Coastal Gill Netting Survey program gill net effort in 2004. The values shown are the number of gill nets set by gear & set type within each acoustic survey frame.

		Frame							
Gear	**Set Type**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Small-mesh Gear	Bottom	1	2	2	2	2	3	6	*18*
Small-mesh Gear	Canned	1	2	2	2	2	3	6	*18*
UGLMU Index Gear	Bottom	1	2	2	2	2	3	6	*18*
UGLMU Index Gear	Canned	1	1	1	2	2	2	6	*15*
	Total	*4*	*7*	*7*	*8*	*8*	*11*	*24*	***69***

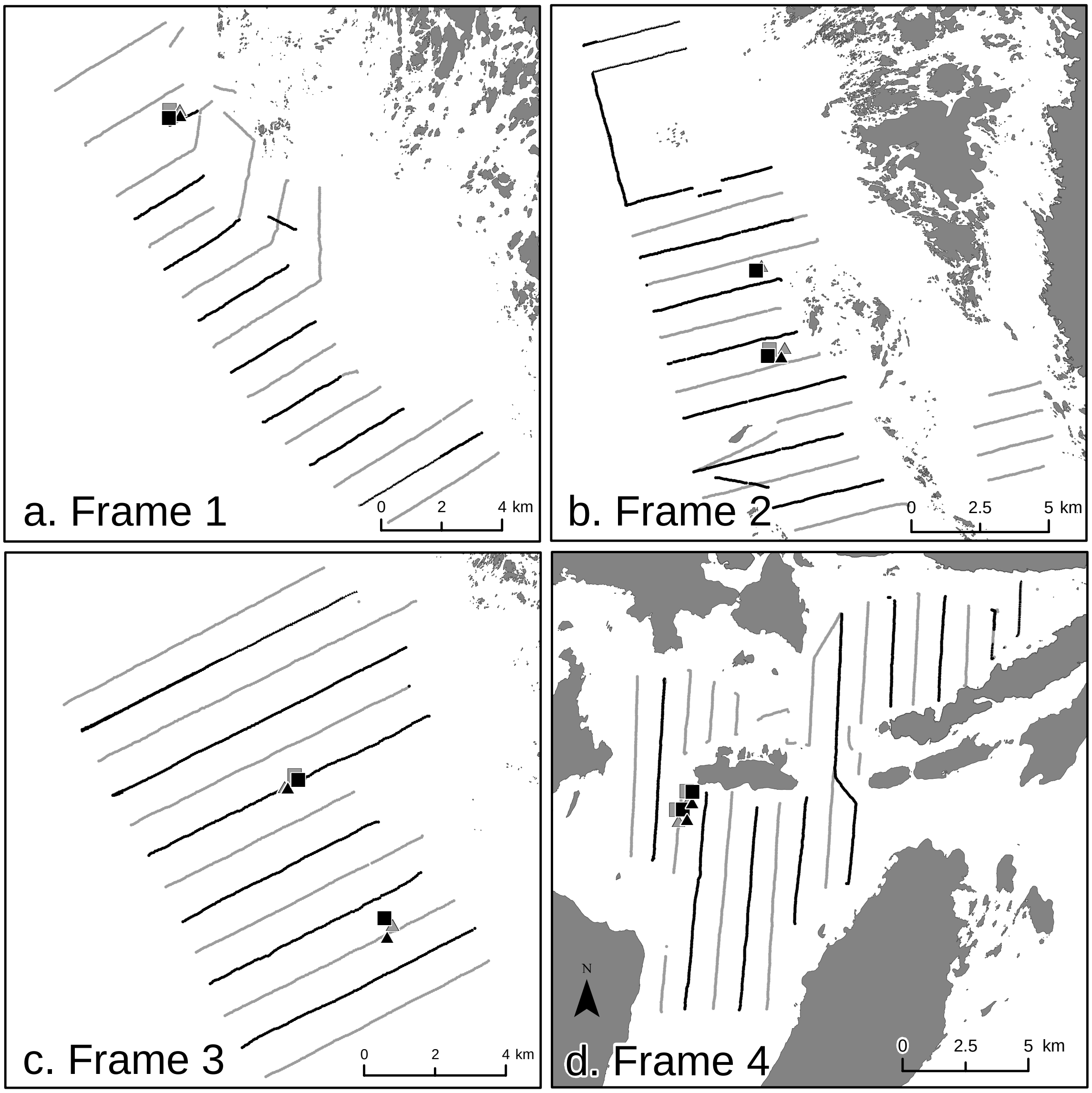

Figure 6.6. a-d Netting sites from the 2004 Coastal Gill Net Index Program. "■" – Standard index gear "GL10" set on bottom, "□" – Standard index gear "GL10" canned at thermocline, "▲" – Small mesh gear "GLSM" set on bottom, and "△" – Small mesh gear "GLSM" canned at thermocline. Transects from the 2004 hydroacoustic survey are included for reference.

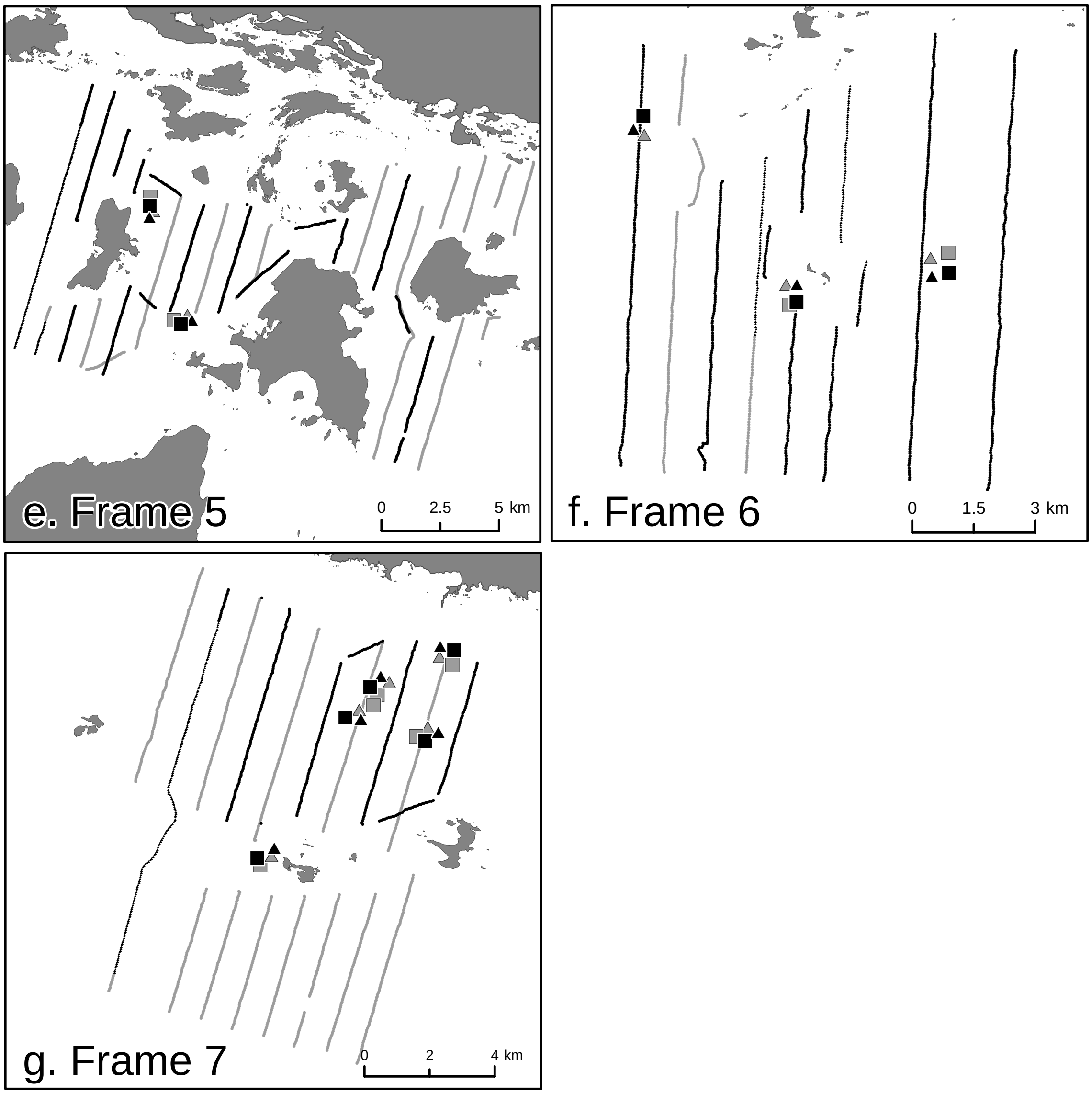

Figure 6.6. (e-g) Netting sites from the 2004 Coastal Gill Net Index Program. "■" – Standard index gear "GL10" set on bottom, "□" – Standard index gear "GL10" canned at thermocline, "▲" – Small mesh gear "GLSM" set on bottom, and "△" – Small mesh gear "GLSM" canned at thermocline. Transects from the 2004 hydroacoustic survey are included for reference.

Offshore Gill Net Index (Clapperton Island)

The UGLMU IA Offshore Gill Net Index is an annual gill net survey that is conducted within a number of different areas of Lake Huron including the waters around Clapperton Island within frame 5 (Figure 6.7). The intent of this project is to provide an annual assessment of the relative stock "health" of commercially targeted and non-targeted species. This program not only provides fundamental catch (i.e. CUE, catch-at-age, pre-recruit indices etc.) and biological (length, weight, age, maturity etc.) information required for UGLMU's stock status reports and population modeling but also provides a relative measure of large-scale changes in the fish community.

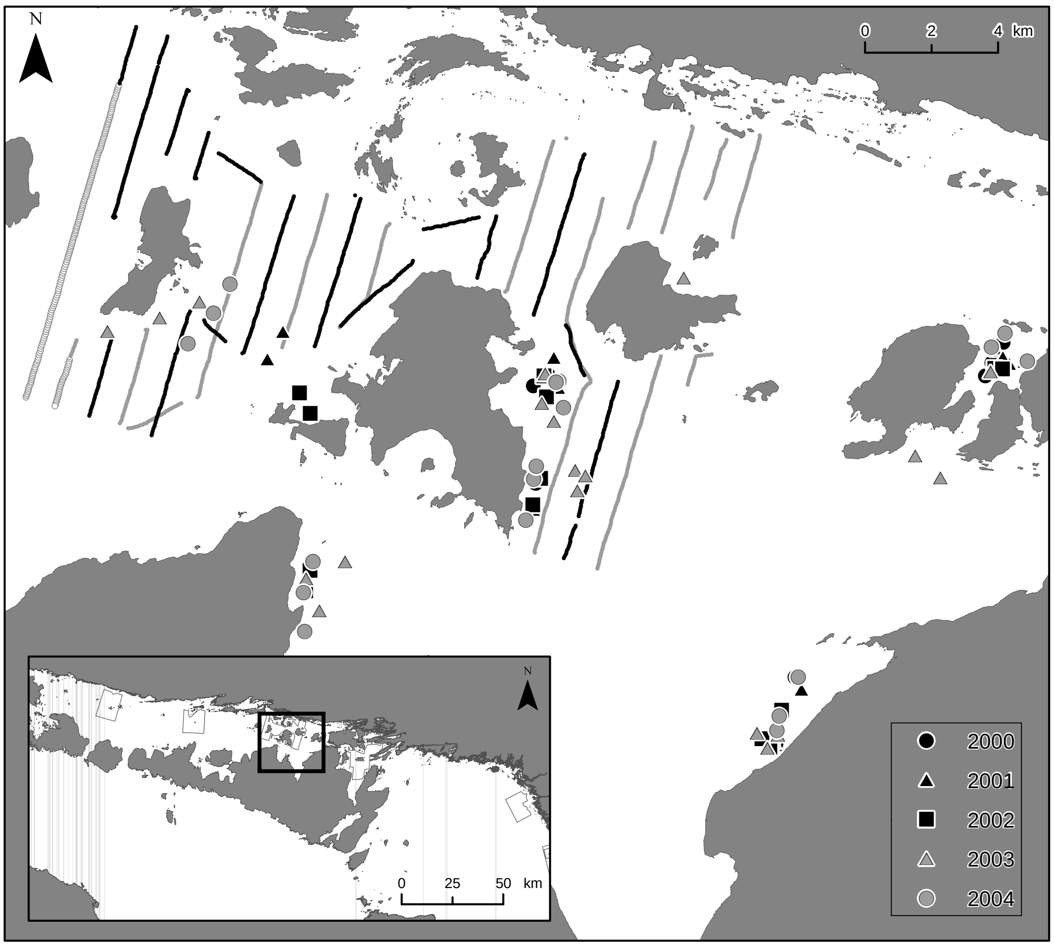

Figure 6.7. Netting sites from the UGLMU IA Offshore Gill Net Index Program within the frame 5 hydroacoustic area. "●" – 2000 IA Offshore netting sites, "▲" – 2001, "■" – 2002, "△" – 2003, and "○" – 2004. Transects from the hydroacoustic survey are included for reference

The gear used within this program for the period 2000-03 was the UGLMU standard "GL10" index gill net configuration (25m of 38mm and 50m each of 51mm, 63.5mm, 76.2mm, 89mm, 101.6mm, 114.3mm, and 127mm). In 2002-03 the "GL32" ("GL10" + 12m of 31.8mm) gear configuration was added to the methodology. The additional panel of 1.25" mesh was included to effectively sample smaller fish within the offshore community. In 2004, the UGLMU assigned the "GL32" gear configuration as the new standard for the Offshore program and the "GL10" gear was discontinued. All analysis of CUE of small fish was standardized to only include catches from the "GL32" gear.

All data from the UGLMU IA Offshore Index program reside at the UGLMU office in Owen Sound within the "IA_Offshore.mdb" MS Access database. Data from this program within the frame 5 area are available back to 1979 however special attention to changes in the gear configuration (i.e. mesh sizes, materials, and lengths) is required when analyzing catch data over this time. A detailed description of the methods, gear and data is available from the UGLMU (Cottrill 2002).

Hydroacoustic Data Processing and Analysis Methods

Data Acquisition and Processing Parameters

All hydroacoustic data were processed using Echoview (Sonardata, 3.00.80 - 3.30.60) processing software. Echoview project files (*.EVI) were created from the available echograms for each frame in all years. For each echogram type the appropriate parameter and calibration settings were updated from the acoustic systems parameter settings of that year (Table 6.6). Other required settings such as water temperature and speed of sound in water were measured directly or estimated using parameter calculators within Echoview.

	2000 Simrad EY500	2001 Simrad EY500	2002 Simrad EY500	2003 BioSonics DT-6000	2004 BioSonics DT-X	Units
Global Settings						
Est. Sound of Speed	1447.27	1447.27	1447.27	1447.27	1465.93	m/s
Water Temperature	10	10	10	10	15	Celcius
Depth	25	25	25	25	0	m
Absorption Coefficient	0.0038	0.0038	0.0038	0.004698	0.003927	db/m
Sv						
Array Frequency	120	120	120	123	123	kHz
Sv Calibration Offset				-1.6	0	db
Transducer Pulse Length	0.3 (Medium)	0.3 (Medium)	0.3 (Medium)	0.3	0.3	ms
Ping Rate	4 to 6	4 to 6	4 to 6	2.7 to 3.0		pps
Sample Depth	140 or 100	140 or 100	140 or 100	120 or 100	120 or 100	m
Sv Threshold	-65	-65	-75(Fr.5=-63)	-65	-60	db
Single Target Detections						
TS threshold	-65	-60 (Fr.7=-55)	-75	-65	-60	dB re 1m2
Pulse length determination level (PLDL)			6	6	6	dB re 1m2
Min. norm. pulse length			0.8	0.8	0.8	-
Max. norm. pulse length			1.5	1.5	1.5	-
Max. beam compensation	7.1	7.1	6	6	6	dB re 1m2
Max. st. dev. of minor-axis angles			0.5	2	0.15	°
Max. st. dev. of major-axis angles			0.5	2	0.15	°

Table 6.6. Summary of the parameter settings used within Echoview to process the 2000-04 hydroacoustic data.

Table 6.6. con't: Summary of the parameter settings used within Echoview to process the 2000-04 hydroacoustic data.

	2000 Simrad EY500	2001 Simrad EY500	2002 Simrad EY500	2003 BioSonics DT-6000	2004 BioSonics DT-X	Units
School Detection Parameters						
Min. total school length	3.5	3.5	3.5	3.5	3.5	m
Min. total school height	1.28	1.25	1.25	1.25	1.25	m
Min. candidate length	0.15	0.15	0.15	0.15	0.15	m
Min. candidate height	3.1	0.1	0.1	0.1	0.1	m
Max. vertical linking distance	0.2	0.2	0.2	0.2	0.2	m
Max. horizontal linking distance	2.5	2.5	2.5	2.5	2.5	m
Distance mode	GPS	GPS	GPS	GPS	GPS	m
Fish Track Detection Parameters						
Data (range, angles and time)		4D	4D	4D	4D	
Track Detection						
Alpha Major axis		0.10	0.10	0.10	0.10	
Alpha Minor axis		0.10	0.10	0.10	0.10	
Beta Range		0.10	0.10	0.10	0.10	
Beta Major axis		0.10	0.10	0.10	0.10	
Beta Minor axis		0.10	0.10	0.10	0.10	
Beta Range		0.10	0.10	0.10	0.10	
Target Gates						
Excl. Dist. (m) Major Axis		2.00	2.00	2.00	2.00	m
Excl. Dist. (m) Minor Axis		2.00	2.00	2.00	2.00	m
Excl. Dist. (m) Range		0.20	0.20	0.20	0.20	m
Missed Ping Exp. (%) Major Axis		15.00	15.00	15.00	15.00	%
Missed Ping Exp. (%) Minor Axis		15.00	15.00	15.00	15.00	%
Missed Ping Exp. (%) Range		5.00	5.00	5.00	5.00	%
Weights						
Major Axis		30	30	30	30	
Minor Axis		30	30	30	30	
Range		40	40	40	40	
TS		0	0	0	0	
Ping gap		0	0	0	0	
Track Acceptance						
Min # of ST's in Track		1	1	1	1	ST's
Min # of Pings in Track		1	1	1	1	pings
Max Gap Between ST's		3	3	3	3	pings

EDSU & Ping Rates

The Elementary Distance Sampling Unit (EDSU) is the length of cruise track along which measures of backscattered energy are integrated (or averaged) to give one sample (Simmonds and MacLennan, 2005). The survey provides a series of “samples” from contiguous sections of tracks or EDSU’s. If the EDSU chosen is too large we risk losing potentially useful information about the spatial patterning and distribution of fish patches and if the EDSU chosen is too small meaningful ecological patterns may be dominated by local variability (Simmonds and MacLennan, 2005). In this document we also refer to the EDSU as the survey or analysis “bin”.

We have chosen ~60m as an appropriate EDSU or survey bin. This size was chosen based on the preliminary analysis of the 2003 data processed using bins that were 50 pings or approximately ~60m long. Changes in the acoustic systems and survey vessels between survey years produced variation in the vessel speed and transmitted ping rate. Therefore, to standardize the size (in pings) of the EDSU’s of the 2000-02, and 2004 surveys to the size applied within the 2003 analysis, we estimated the number of pings within a 60m survey segment from the average logged vessel speed (Fugawi track files where available) and the theoretical ping rate of the acoustic system. The actual ping rate of the acoustic system varied during a survey and was dependent on many factors (i.e. depth, scattering properties etc.). Therefore our estimate of the number of pings within a ~60m transect segment was different from the observed segment length calculated from the GPS coordinates after processing the data in Echoview (Table 6.7 a-e).

Table 6.7. (a-e) Summary of the average bin size (or EDSU), average vessel speed and average transmitted ping rate for each year and frame of the Hydroacoustic Survey Program. The observed average bin size was measured as the Euclidean distance between the reported GPS position of the first ping in the bin and that of the last ping.

a. 2000

Frame	Bin Size (pings)	Avg. Bin Size (m)	Avg. Vessel Speed (m/s)	Avg. Ping Rate (pings/sec)
Frame 1	68.00	50.70	4.12	5.51
Frame 2	68.00	54.87	4.44	5.50
Frame 3	68.00	55.56	4.51	5.51
Frame 4				
Frame 5	68.00	50.63	4.10	5.51
Frame 6	68.00	66.85	5.41	5.50
Frame 7	68.00	58.12	4.74	5.49
Average	*68.00*	*56.12*	*4.55*	*5.50*

b. 2001

Frame	Bin Size (pings)	Avg. Bin Size (m)	Avg. Vessel Speed (m/s)	Avg. Ping Rate (pings/sec)
Frame 1	68.00	64.24	3.75	3.97
Frame 2	68.00	64.47	3.77	3.97
Frame 3	68.00	64.53	3.78	3.98
Frame 4	68.00	67.37	3.93	3.97
Frame 5	68.00	68.05	3.98	3.98
Frame 6	68.00	67.11	3.92	3.98
Frame 7	68.00	67.40	3.94	3.98
Average	*68.00*	*66.17*	*3.87*	*3.98*

c. 2002

Frame	Bin Size (Avg # pings)	Avg. Bin Size (m)	Avg. Vessel Speed (m/s)	Avg. Ping Rate (pings/sec)
Frame 1	57.42	58.56	3.99	3.91
Frame 2	57.22	58.64	4.02	3.91
Frame 3	56.37	55.35	4.11	3.92
Frame 4	n/a	n/a	n/a	n/a
Frame 5	47.00	47.92	3.89	3.91
Frame 6	60.06	58.62	3.84	3.92
Frame 7	58.96	57.84	3.82	3.89
Average	*56.17*	*56.16*	*3.94*	*3.91*

d. 2003

Frame	Bin Size (pings)	Avg. Bin Size (m)	Avg. Vessel Speed (m/s)	Avg. Ping Rate (pings/sec)
Frame 1	50.00	62.13	3.53	2.83
Frame 2	50.00	56.81	3.37	2.95
Frame 3	50.00	57.37	3.43	2.98
Frame 4	50.00	58.90	3.55	3.01
Frame 5	50.00	54.71	3.21	2.93
Frame 6	50.00	52.14	3.03	2.90
Frame 7	50.00	53.97	3.24	2.98
Average	*50.00*	*56.58*	*3.34*	*2.94*

e. 2004

Frame	Bin Size (pings)	Avg. Bin Size (m)	Avg. Vessel Speed (m/s)	Avg. Ping Rate (pings/sec)
Frame 1	83.00	58.93	3.48	4.89
Frame 2	80.00	59.96	3.42	4.55
Frame 3	83.00	59.86	3.40	4.71
Frame 4	88.00	60.86	3.54	5.12
Frame 5	86.00	60.09	3.44	4.92
Frame 6	89.00	59.94	3.38	5.02
Frame 7	84.00	59.42	3.37	4.76
Average	*84.71*	*59.87*	*3.43*	*4.85*

Echo Integration

Estimates of fish density (and biomass) were calculated from the echo-integrator equation;

$$F_i = \left(C_E / \langle \sigma_i \rangle\right) E_i$$

where the subscript *i* refers to a size class of fish or species group, C_E * is the equipment calibration factor, $\langle \sigma_{bs} \rangle$ is the expected value of the back-scattering cross-section, and E_i is the mean echo integral (Simmonds and MacLennan, 2005).

*Note that C_E (i.e. absorption coefficients, calibration offsets, wavelength, TVG etc.) is applied internally within the EY500 acoustic data whereas C_E was applied manually within Echoview to the Biosonics DTX data. Therefore for all estimates and calculations using post-processed data generated from Echoview we assume C_E is equal to 1.

An estimate of fish biomass (F_{Biom}) was estimated with the equation;

$$FBiom_i = \left(F_i\right) RWT$$

where subscript *i* refers to a size class or species group of fish, F_i is the estimate of fish density and *RWT* is the estimated mean round weight of a fish within the class or group.

Echoview acoustic processing software was used to calculate the echo integral (E_m) or the integrated volumetric backscattering strength (S_v) across each sample or ~60m EDSU. A 20log R time varied gain compensation factor was applied to all integrated values during logging (Simrad EY500) or processing (Biosonics DT).

The integrated volumetric S_v value of each bin was then transformed to the area backscatter equivalent (ABC (m^2/ m^2)) or nautical area scattering coefficient (NASC (m^2/n.mi.^{2})) using the equations;

$$ABC = \left(10^{\left(\frac{Sv}{10}\right)} \times T\right)$$

$$NASC = 4 \times \pi \times 1852^2 \times ABC$$

where *ABC* is the area backscatter coefficient (m^2/ m^2), *NASC* is the nautical area scattering coefficient (m^2/n.mi.^{2}), S_v is the mean volumetric backscatter, and *T* is the mean thickness of the integrated EDSU in metres. Note that the terms *Sv*, *ABC* , and *NASC* can be used interchangeably as an estimate of the echo-integral (E_m) in the echo integration equation however the units of C_E and σ must be adjusted accordingly.

Single Target Detection and Target Strength

Single target (ST) detection data and the resultant target strength (TS) information for all years and acoustic systems were detected and processed using the "Single Target

Detect (Method 1) Operator" variable in Echoview. This virtual variable uses the TS power and angular position telegrams as operands to best distinguish those echoes coming from isolated fish targets. Based on user settings, Echoview identifies only those echoes that are within a suitable range of amplitude and pulse duration (i.e. "echo envelope") as single target detects. Analysis boundaries and target strength thresholds were applied in Echoview before final processing. Refer to the "Single Target Detection" section of Table 6.6 for parameter settings.

We used the "Fish Track" detection function within Echoview to identify those individual targets that may have been acoustically sampled multiple times and therefore potentially detected as multiple single targets. For those targets identified within a "fish track" we used the observed maximum target strength within the region as a measure of the target strength.

Steps for Estimating Biomass

The following steps describe the general methodology used to estimate biomass from the hydroacoustic information. The headings of the sections below correspond to those within the flow diagram in Figure 6.8. The intent of this diagram is to provide a visual representation of the steps described below for estimating biomass from acoustic data collected within a single ~60m x 1m deep EDSU from the 2004 survey. The EDSU we provide as an example is from Frame 6, Interval 1007, Layer 45, ping 89534 – 89622, August 21, 2004, 23:36:52.95 to 23:37:10.45.

All analyses were completed for night-time survey transects only. "Night" was defined as the period one hour greater than civil twilight (sunset) to one hour previous to civil twilight (sunrise) the next day.

Echogram (Sv and TS) Processing Results

All of the hydroacoustic data were processed (echo integration and single target detection) using four different depth strata (Table 6.8). Within each depth stratum echo integration and single target detect information was exported from Echoview for each ~60m survey bin (EDSU). All of the processed data were exported from Echoview into Microsoft Access databases for analysis. Outliers and anomalous data values (i.e. from cavitation, bottom interference and line analysis line breaks etc.) were identified and verified visually within the echogram and, if required, removed from the database.

Gill Net Data

Typically, estimates of acoustic fish density and biomass are reported by species or family grouping. This type of estimate requires specific information about the composition and spatial distribution (i.e. depth and habitat) of each target grouping throughout the survey. This type of information is usually obtained by some other complementary sampling method such as trawling or seining. However, limited resources and logistical constraints did not permit the inclusion of an active-gear sampling method within the Hydroacoustic Survey Program.

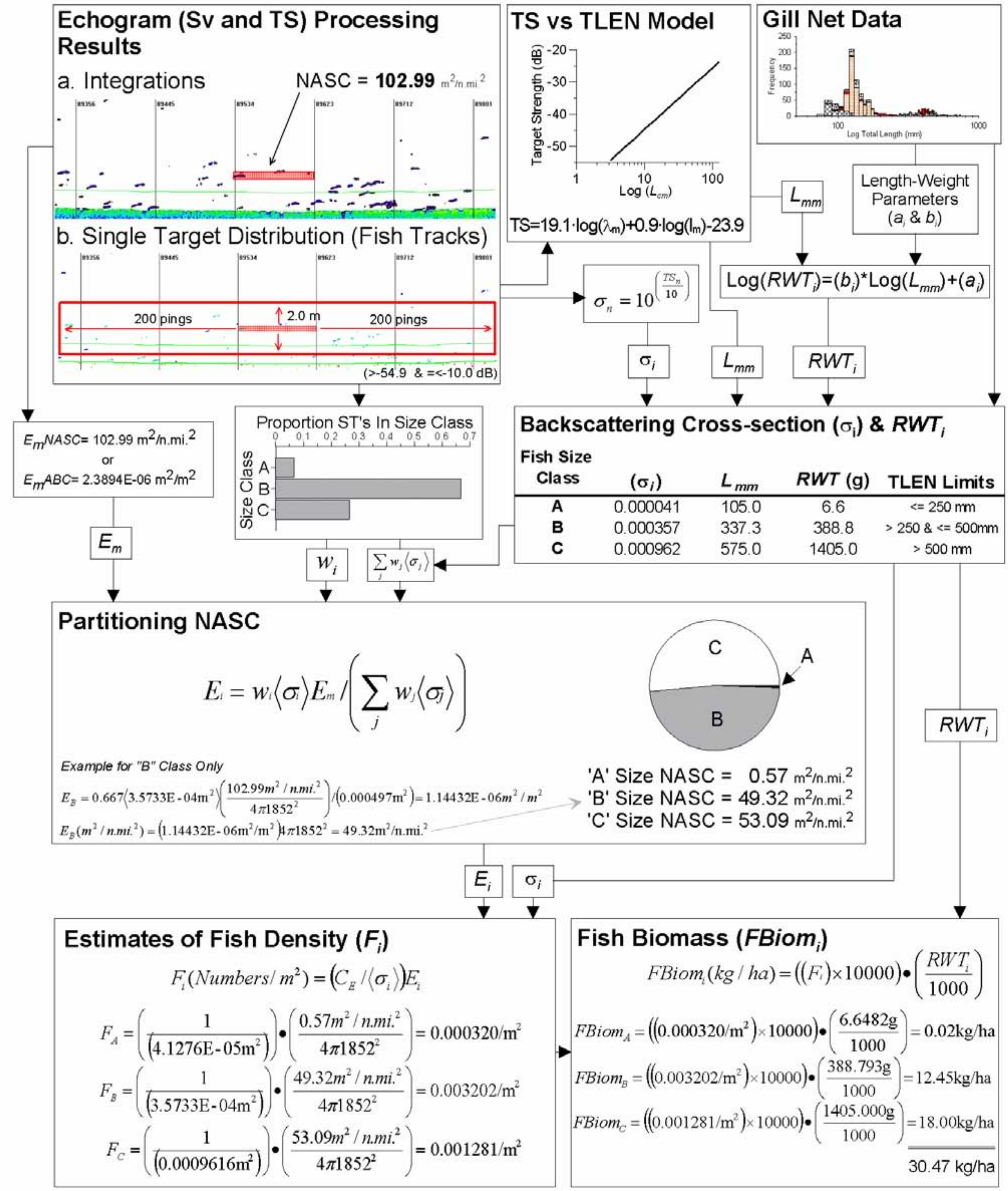

Figure 6.8. A logical flow diagram showing the data sources and calculations required to estimate the size partitioned fish density and biomass from hydroacoustic data. Data shown are for a single analysis bin (EDSU) from the 2004 hydroacoustic survey (Frame 6, Interval 1007m Layer 45, ping 89534-89622, August 21, 2004, 23:36:52.95 – 23:37:10.45). Refer to section "Acoustic Data Processing – Steps for Estimating Biomass" for a detailed description of the steps shown in the figure.

As an alternative to presenting estimates of fish density and biomass by species or family grouping, we partitioned the integrated backscatter into three categories of fish size using total length. The three categories were chosen based on the observed size frequency distribution of gill net catches obtained from the Coastal Gill Netting Program (Figure 6.9) and the UGLMU Offshore Index (Figure 6.10). These two index programs operated during the same time period and within the same area as the hydroacoustic survey. The three size categories we chose are as follows; "A" size class where total length <=0-250mm, "B" size class >250mm & <=500mm, and "C" size class>500mm.

Table 6.8. Summary of the four depth strata used to analyse the hydroacoustic survey data.

	Echoview Echogram Analysis			
Analysis Strata	Exclude Above Line	Exclude Below Line	Analysis Grid (m)	Description
WaterColumn	swm_Surface_X.Xm	swm_Bottom_Pick	100	Integration over the entire water column. Depths for each horizontal bin (interval) varies between 2m -73m. The NASC value is not standardized to depth and therefore comparison of NASC between intervals of differing depth is biased.
Benthic	swm_Benthic_3.0m	swm_Bottom_Pick	100	Defined as the water column from bottom to 3.0m above bottom. The sum of the "Benthic" NASC for a given horizontal bin (interval) and the "Pelagic" NASC for the same horizontal bin (interval) is equal to the "WaterColumn" NASC. Observed NASC values at d
Pelagic	swm_Surface_X.Xm	swm_Benthic_3.0m	100	Defined as the water column shallower than 3.0m above bottom. The sum of the "Pelagic" NASC for a given horizontal bin (interval) and the "Benthic" NASC for the same horizontal bin (interval) is equal to the "WaterColumn" NASC.
1mBins	swm_Surface_X.Xm	swm_Bottom_Pick	1	Integration over entire water column and divided into 1m depth strata. The sum of NASC across each 1m depth strata (layer) within a horizontal bin (Interval) is equal to the total NASC of the "Water Column" for the same interval.

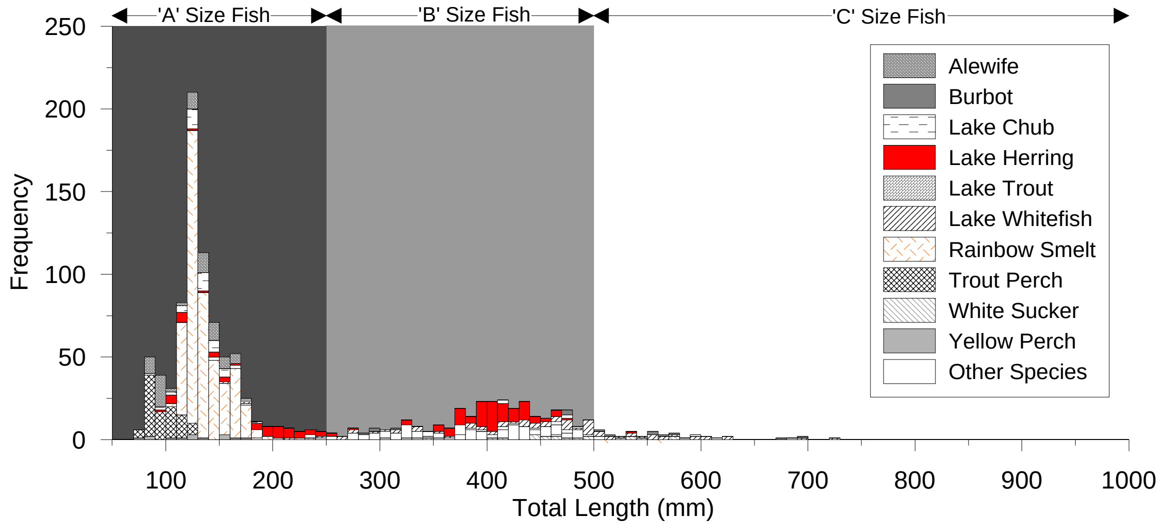

Figure 6.9. Observed total length (TLEN) frequency distribution of all catches by species from all frames in the 2004 Coastal Gill Net Index Program. Background shading indicates fish size classes chosen to partition the observed acoustic NASC. ‘A’ size class TLEN <=250mm, ‘B’ size class TLEN >250mm and <=500 mm, and ‘C’ size class TLEN >500 mm.

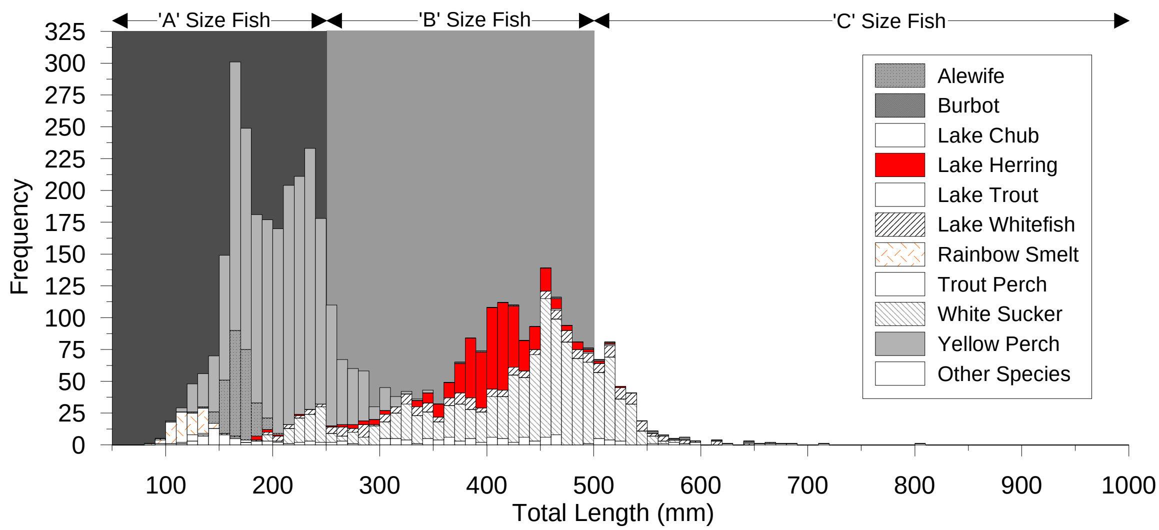

Figure 6.10. Observed total length (mm) frequency distribution of all species captured within the UGLMU IA Offshore gill net index around Clapperton Island (Frame 5) 2000-2004. Total length was estimated from fork length where total length was not recorded. Also note that the inclusion of 1.25” mesh was only for 2002-2004. The smallest mesh used in 2000-01 was 1.5”. Background shading indicates fish size classes chosen to partition the observed acoustic NASC. ‘A’ size class TLEN <=250mm, ‘B’ size class TLEN >250mm and <=500 mm, and ‘C’ size class TLEN >500 mm.

“A” Size Class (<=250mm)

Species in this size group tend to be known “schooling” species such as alewife, rainbow smelt, lake chub (C. plumbeus), and trout perch. Each of these species occupy the coldwater habitats of Lake Huron and are considered important prey species for larger pelagic predators such as Chinook salmon and lake trout as well as avian predators such as loons and cormorants. These species rarely exceed 250mm (see Figure 6.9 & 6.10). This size class also includes yearling and juvenile life stages of larger planktivores and predators.

Although yellow perch larger than 250 mm made up a significant proportion of the IA Offshore catches in 2000, catches were observed to be from nets set in shallower, more inshore areas of the survey frames and therefore were not considered a major component of the fish biomass surveyed acoustically.

"B" Size Class (>250mm and <=500mm)

The "B" size class can be considered a mix of large planktivorous and small piscivorous pelagic species (i.e. *coregonids*, immature *Salmo* and *Salvelinus* species etc.), as well as more benthic oriented species (i.e. burbot, *catastomids* and *moxostomid* species etc.)

"C" Size Class (>500mm)

This size class was used to segregate the larger piscivorous predators such as the Chinook salmon, northern pike, lake trout, and other large trout species but may also include large bodied planktivores such as lake whitefish and the benthic oriented burbot and *catastomid* species. Fish in this category are not considered optimal prey for avian predators due to their large size and their potential ability to evade capture. However, the larger piscivores that fall into this size category have high energetic demands and as a result may have a significant impact on the "A" size category species.

TS vs TLEN Model

We used a modified Love's equation (from Hartman *et al,* 2000) to estimate the equivalent target strength of the class limits for each of the 3 fish size categories (Table 6.9). The estimated equivalent target strength was defined as;

$$TS = 19.1 \times \log(L_m) + 0.9 \times \log((c/f)/1000) - 23.9$$

where L_m is the total length (m), c is the speed of sound in water (m/s) and f is the transmitted frequency (kHz).

Table 6.9. The equivalent target strength (TS) of the three fish size class limits estimated from Love's equation (from Nagy and Hartman, 2000).

Size Category	Size Code	TS Min (dB)	TS Max (dB)
Small Planktivores (Smelt, Lake Chub, Trout Perch, Alewife)	A	-54.90	-37.12
Large Planktivores & Small Piscivores	B	-37.12	-31.37
Large Piscivores	C	-31.37	-10.00

Using target strength limits defined for each size class we summed the total number of single target detections within the local area of each EDSU (Figure 6.8). We defined the “local area” of each EDSU as the region within 200 pings of the EDSU start and end ping (horizontal plane) as well as the area within a defined depth range (vertical plane) that varied depending on the depth strata (Table 6.10). For each EDSU we assumed that the observed target strength distribution of the single targets within the local area of the EDSU is indicative of the size composition of fish included within the integrated backscatter estimate. The total number of single target detections in each size class were then expressed as a proportion of the total number of single target detections between -54.9 dB and -10.0 dB (Figure 6.8).

Table 6.10. Summary of the horizontal and vertical boundary parameters used to define the limits of the single target search region around each EDSU by depth strata. Only those single targets observed within the local area of the EDSU were included in the calculations for partitioning the observed integrated backscatter.

	Single Target Detection Region	
Analysis Strata	Horizontal (Number of Pings Fore & Aft of EDSU)	Vertical (Depth (m))
WaterColumn	200	0m
Benthic	200	1m Above EDSU
Pelagic	200	0m
1mBins	200	2.0m Above & Below EDSU

Partitioning NASC

Using the observed single target proportions within the local area of each EDSU and an estimate of the expected backscattering cross-section for each size class, we partitioned the observed integrated backscattered energy into three fish size categories using a modified “mixed species” method described in Simmonds and MacLennan (2005). This method partitions the observed integrated backscattered energy by the expected area backscatter contribution of a fish within each size category weighted by the proportion of observed single targets. We estimated the integrated backscattered energy (*E*) within size category using the equation;

$$E_i = w_i \langle \sigma_i \rangle E_m / \left(\sum_j w_j \langle \sigma_j \rangle \right)$$

where *E* is the integrated backscattered energy, *w* is the proportional number of single targets within the size class, σ is the expected backscattering cross-section and the sub-script *i* refers to the size classes A, B and C. We estimated the expected backscatter cross-section (σ) from the mean target strength of all targets observed within each of the three size classes. The term indicated with the subscript *j* is the weighted mean backscatter cross-section across all size class categories and is estimated from the mean observed target strength of all targets.

In some instances there was significant backscatter energy observed within a cell however few or no single targets were detected within the local area. Several criteria must be satisfied for a particular echo to be included as a single target detect. Acoustic shadowing, position within the acoustic beam, fish density (i.e. schooling) and overlapping targets may limit the ability of the hardware (or software) to resolve individual fish targets. If no single targets were detected within a cell where integrated backscattered energy was greater than the minimum threshold, we applied the proportional single target detects observed within the three fish classes of the entire survey transect of the same year, frame, and depth stratum for the night-time period. Table 6.11 summarizes the number (%) of analysis cells within the 2001-04 surveys for each frame where no single targets were detected and therefore the frame wide estimate of the same strata was applied. Note that as the analysis cells become smaller (i.e. 1m depth stratum) the proportion of cells where no single targets were detected increases.

Table 6.11. Summary of the number of analysis cells for each frame and depth stratum within the 2001-04 hydroacoustic surveys where significant backscattered energy was observed but no single targets were detected. Values are expressed as the percentage of all cells where no single targets were detected however the observed integrated NASC was greater than 0. “WC” is the entire water column depth stratum, “Ben.” is the benthic depth stratum, “Pel.” is the pelagic depth stratum, and “1m Bins” is the depth stratum of the entire water column divided into 1m depth strata.

Frame	2001				2002				2003				2004			
	WC	Pel.	Ben.	1m Bins	WC	Pel.	Ben.	1m Bins	WC	Pel.	Ben.	1m Bins	WC	Pel.	Ben.	1m Bins
1	0.0	0.0	1.9	22.5	0.0	2.2	41.2	38.6	0.0	0.1	2.4	14.4	0.0	0.0	3.5	19.6
2	32.2	40.8	42.2	48.8	27.1	50.0	38.7	53.0	8.9	16.3	9.1	15.2	3.6	7.4	12.8	15.3
3	11.7	16.2	14.7	20.5	2.5	7.8	18.0	30.6	0.4	2.4	1.7	12.5	0.0	0.0	4.1	15.2
4	0.0	0.2	13.0	13.5	n/a	n/a	n/a	n/a	2.3	3.9	6.1	16.2	2.4	3.5	11.0	29.6
5	0.0	2.1	5.7	19.3	n/a	n/a	n/a	n/a	0.0	1.4	1.8	15.0	0.0	0.0	1.4	12.2
6	0.0	0.2	0.2	13.0	1.7	2.5	43.7	51.9	0.0	0.0	0.5	14.2	0.0	0.0	1.1	6.3
7	77.0	81.0	55.9	85.3	43.6	54.5	64.7	82.0	1.3	3.1	9.4	15.7	0.0	1.6	0.2	5.1

Observations of the single target distributions from the 2000 surveys indicate a potential problem with the TS gain calibration. As a result, target strength distributions from single target detections in 2000 were not included in the analysis of integrated backscatter for that year. Instead, we partitioned the 2000 integrated backscatter estimates using the observed 2001 frame-wide target strength distributions with the assumption that the overall fish size composition for 2000 was not different from 2001. Netting data from the UGLMU Offshore Gill Net Index suggest the species composition and size distribution of the fish community for the survey area around frame 5 changed little between 2000 and 2001.

Fish Density Conversion Coefficient - Backscattering Cross-section (σ)

The expected backscattering cross-section (σ_i) is required to scale estimates of integrated backscatter into an estimate of fish density within each size class. We estimated the expected backscattering cross-section from the observed mean backscattering cross-section $(\bar{\sigma})$ of observed fish track detects (maximum TS) within each survey frame. The mean backscattering cross-section $(\bar{\sigma})$ for each of the size categories (A, B & C) was calculated as;

$$\bar{\sigma}_i = \frac{\sum \sigma_1 + \sigma_2 + ...\sigma_n}{N_i}$$

where,

$$\sigma_n = 10^{\left(\frac{TS_n}{10}\right)}$$

and where TS_n, is the observed maximum target strength from a fish track detect region within the size class (*i*). The size class of an individual target (or fish track region) was determined by the target strength class limits summarized in table 6.9.
A summary of the backscattering cross-section $(\overline{\sigma})$ scaling values for each size class and survey (year and frame) is shown in 6.12. For those survey frames where single target information was not available (i.e. 2000 surveys) or the number of fish track detections was low we applied annual means (refer to footnotes in table 6.12).

Table 6.12. Summary of the scaling parameters (σ, *RWT*) used to estimate the fish density (F_i) and fish biomass ($FBiom_{,i}$) for each size class of fish by frame in 2000-04. The expected backscattering cross-section (..for all size class “A” (<=250mm) and “B” (>250mm and <=500mm) fish were estimated from the mean backscattering cross-section $\langle\bar{\sigma}\rangle$. The estimated total length (TLEN) for these size classes were calculated from the observed mean target strength using Love’s (1971) equation. The RWT parameters for the “A” and “B” size classes were estimated from length-weight relationships generated from observed data collected within the 2004 Coastal Gill Netting project. Scaling parameters (. total length, and RWT) for “C” class fish (>500mm) were estimated from gill net catch data.

		Mean Equivalent BackScatter Coefficient (σ) *10^{-5}			Equivalent TLEN (mm) from Love's (1971)			Estimate Round Weight (g) from Log(RWT)=b*Log(EquivTLEN)+a		
Year	Frame	A	B	C	A	B	C	A	B	C
2000	1	1.99073[1]	36.36768[3]	107.69001[7]	72.8[1]	341.5[3]	609.5[7]	2.68[1]	403.93[3]	2456.40[7]
2000	2	1.99073[1]	36.36768[3]	107.69001[7]	72.8[1]	341.5[3]	609.5[7]	2.68[1]	403.93[3]	2456.40[7]
2000	3	1.99073[1]	36.36768[3]	107.69001[7]	72.8[1]	341.5[3]	609.5[7]	2.68[1]	403.93[3]	2456.40[7]
2000	4	1.99073[1]	36.36768[3]	107.69001[7]	72.8[1]	341.5[3]	609.5[7]	2.68[1]	403.93[3]	2456.40[7]
2000	5	1.99073[1]	36.36768[3]	107.69001[7]	72.8[1]	341.5[3]	609.5[7]	2.68[1]	403.93[3]	2456.40[7]
2000	6	1.99073[1]	36.36768[3]	107.69001[7]	72.8[1]	341.5[3]	609.5[7]	2.68[1]	403.93[3]	2456.40[7]
2000	7	1.99073[1]	36.36768[3]	107.69001[7]	72.8[1]	341.5[3]	609.5[7]	2.68[1]	403.93[3]	2456.40[7]
2001	1	1.97899	31.91711	107.69001[7]	72.4	320.1	609.5[7]	2.62	332.03	2456.40[7]
2001	2	1.62707	36.36768[3]	107.69001[7]	66.1	341.5[3]	609.5[7]	1.99	403.93[3]	2456.40[7]
2001	3	1.94493	39.14934	107.69001[7]	70.8	355.4	609.5[7]	2.46	455.71	2456.40[7]
2001	4	1.78682	34.01945	107.69001[7]	69.0	330.6	609.5[7]	2.27	366.06	2456.40[7]
2001	5	2.01628	43.06117	107.69001[7]	74.2	374.6	609.5[7]	2.83	533.97	2456.40[7]
2001	6	2.14444	33.97766	107.69001[7]	76.1	328.4	609.5[7]	3.07	358.88	2456.40[7]
2001	7	1.99073[1]	36.36768[3]	107.69001[7]	72.8[1]	341.5[3]	609.5[7]	2.68[1]	403.93[3]	2456.40[7]
2002	1	1.78859	38.21688	107.69001[7]	68.9	350.2	609.5[7]	2.76	435.62	2456.40[7]
2002	2	1.79178	37.46813[4]	107.69001[7]	68.2	347.0[4]	609.5[7]	2.68	423.80[4]	2456.40[7]
2002	3	2.36982	37.46813[4]	107.69001[7]	77.2	347.0[4]	609.5[7]	3.73	423.80[4]	2456.40[7]
2002	4	1.98481[2]	37.46813[4]	107.69001[7]	71.7[2]	347.0[4]	609.5[7]	3.06[2]	423.80[4]	2456.40[7]
2002	5	1.98481[2]	37.46813[4]	107.69001[7]	71.7[2]	347.0[4]	609.5[7]	3.06[2]	423.80[4]	2456.40[7]
2002	6	2.65602	37.46813[4]	107.69001[7]	81.5	347.0[4]	609.5[7]	4.32	423.80[4]	2456.40[7]
2002	7	6.19108	37.46813[4]	107.69001[7]	130.6	347.0[4]	609.5[7]	15.32	423.80[4]	2456.40[7]
2003	1	2.24762	35.54663[5]	120.74221[8]	76.9	337.8[5]	648.3[8]	2.68	390.63[5]	2996.88[8]
2003	2	1.84819	35.54663[5]	120.83761[8]	70.9	337.8[5]	648.1[8]	2.11	390.63[5]	3107.89[8]
2003	3	2.51287	35.54663[5]	111.23797[8]	80.9	337.8[5]	621.7[8]	3.10	390.63[5]	2343.00[8]
2003	4	2.56828	35.54663[5]	96.03819[8]	82.7	337.8[5]	575.8[8]	3.31	390.63[5]	2028.13[8]
2003	5	2.16573	35.54663[5]	101.18107[8]	76.9	337.8[5]	591.6[8]	2.68	390.63[5]	2440.00[8]
2003	6	2.81144	32.36495	96.164890[8]	85.9	323.1	575.0[8]	3.70	341.41	1405.00[8]
2003	7	3.24733	35.54663[5]	81.79547[8]	91.1	337.8[5]	530.6[8]	4.39	390.63[5]	1529.17[8]
2004	1	3.56360	35.57720[6]	120.74221[8]	98.4	336.6[6]	648.3[8]	5.50	386.63[6]	2996.88[8]
2004	2	2.32812	37.00009	120.83761[8]	78.4	345.2	648.1[8]	2.83	417.28	3107.89[8]
2004	3	3.70362	36.82503	111.23797[8]	99.3	343.7	621.7[8]	5.65	411.62	2343.00[8]
2004	4	4.01974	35.57720[6]	96.03819[8]	105.1	336.6[6]	575.8[8]	6.68	386.63[6]	2028.13[8]
2004	5	3.72241	34.97127	101.18107[8]	99.5	333.7	591.6[8]	5.68	376.40	2440.00[8]
2004	6	4.12765	35.73288	96.164890[8]	105.0	337.3	575.0[8]	6.65	388.79	1405.00[8]
2004	7	4.47535	28.96563	81.79547[8]	109.7	303.2	530.6[8]	7.57	281.90	1529.17[8]

Footnotes for Table 6.12:
[1,2]Backscatter coefficient (σ) and equivalent total length (*TLEN*) for A size fish for this frame estimated from nighttime fish track detects (TS_Max) averaged over all frames in 2001[1], and 2002[2]. [1]Log (RWTg)=(3.04947)*Log(TLENmm)+(-5.251521) and [2]Log(RWTg)=(2.682945)*Log(TLENmm)+(-4.491943).

[3,4,5,6](σ) and (*TLEN*) for B size fish est. from nighttime fish track detects averaged over all frames in 2001[3], 2002[4], 2003[5], and 2004[6]. [3,4,5,6]Log(RWTg)=(3.024035)*Log(TLENmm)+(-5.054921).

[7](σ), *RWT* and *TLEN* for C size fish within this frame estimated from the observed mean total length and round weight of all fish greater than 500mm within the 2004 Coastal Gill Net survey.

[8](σ), *RWT* and *TLEN* for C size fish within this frame estimated from the mean total length and round weight of fish greater than 500mm within the 2004 Coastal Gill Net survey observed within this frame. We assume that the fish community within the C size category has not changed between 2003 and 2004 within each frame.

Fish Biomass Conversion Coefficient – Mean Round Weight (RWT)

Fish biomass ($FBiom_i$) within each EDSU was estimated as the product of the numerical fish density estimate (F_i) and the round weight (RWT_i) of a target within size class *i*. Estimates of round weight (*RWT*) for targets within a given size class were estimated using two methods;

1. Length-Weight Relationships – Species or size specific relationships were generated from observed total length and round weight information available within the 2004 Coastal Gill Netting project (table 6.13). Estimates of total length (L_{cm}) were calculated from the mean backscattering cross-section $(\overline{\sigma})$ using Love's equation;

$$L_{cm} = 10^{\left(\frac{((10\times\log(\overline{\sigma}))+((0.9\times\log((c/f)/1000)-23.9)*-1))}{19.1}\right)}*100$$

   Where L_{cm} is the equivalent total length in cm, $(\overline{\sigma})$ is the mean backscattering cross-section, c is the speed of sound in water (m/s) and f is the transmitted frequency (kHz).

2. Direct observation of the mean round weight of fish within the catch from the 2004 Coastal Gill Netting Project.

Table 6.13. Length-weight relationship parameters used to estimate the round weight (RWT) of size class A & B fish from the equivalent total length (L_{cm}) of a target within a given size class where $RWT=10^{(b*LOG(Lcm)+a)}$.

Size Class - Year(s) Estimated	Species/Size Model	n	Slope (b)	Intercept (a)
A - 2000 & 2001	Alewife	74	3.04947	-5.251521
A - 2002	Alewife, Rainbow Smelt & Trout Perch	608	2.682945	-4.491943
A - 2003 & 2004	Rainbow Smelt	314	2.922664	-5.084248
B - 2000 to 2004	All Species where total length >250mm	254	3.024035	-5.054921

"A" Size Category

For the A-size category in 2000 and 2001, we assume that the small fish species composition of the fish community in Lake Huron was dominated by alewife. Independent netting information from the United States Geological Survey (USGS) lake-wide trawling program and the UGLMU Offshore Index indicates that adult alewife were observed to be abundant in Lake Huron in 2000 and 2001(figure 6.11). USGS trawling results also suggest that lake-wide adult rainbow smelt abundances may have been suppressed during this period (J. Schaeffer USGS, person. comm.). Assuming that the majority of the backscattered energy observed within this size class was primarily from alewife targets, we estimated the mean round weight (RWT) of all fish within this size class for each survey frame using a length-weight relationship parameterized for alewife (table 6.12 & 6.13).

For this size category in 2002, we assume that the pelagic small fish community in Lake Huron was in a state of transition. Estimates of alewife CUE from the USGS lake-wide trawling program suggest that recruitment from the 2000 year class was poor and suggests that the number of adult (age 2+) alewife in 2002 was low. Strong young of year production in 2001 and a strong 2003 year class suggests that a large proportion of the adult alewife sampled in 2002 were likely yearling (age 1). With the apparent suppression of one or more alewife year classes in 2002, the trawl data also indicates that rainbow smelt populations were increasing in response to the fluctuating alewife numbers during this time (figure 6.11). The observation of exceptionally strong year classes of rainbow smelt in 2003 and 2004 suggest that populations of spawning adults in 2002 may have been relatively high in some areas of the lake. These observations suggest that the pelagic fish community in 2002 was not dominated by one species but likely included relatively high numbers of rainbow smelt and other small pelagic fish species that were released from competition with alewife. Therefore we estimated the mean round weight (RWT) of all fish within this size class for each survey frame in 2002 using a length-weight relationship parameterized for alewife, rainbow smelt and lake chub (*C. plumbus*) (table 6.12 & 6.13).

By 2003 and 2004 it was clear that the alewife populations of Lake Huron were in severe decline. Independent netting programs such as the UGLMU IA Offshore project (Table 6.14) and the USGS trawling surveys (Figure 6.11) reported that catches of alewife had decreased to near 0 by 2004. Although observations from the USGS trawl survey did suggest strong recruitment potential from the 2003 year class, over-winter survival was very low as a result of extended ice coverage and abnormally cold temperatures during the winter and spring of 2003/04. Other factors including increased predation pressure from Chinook salmon, impacts from exotic invaders and predation from avian predators all likely contributed to declines in alewife numbers.

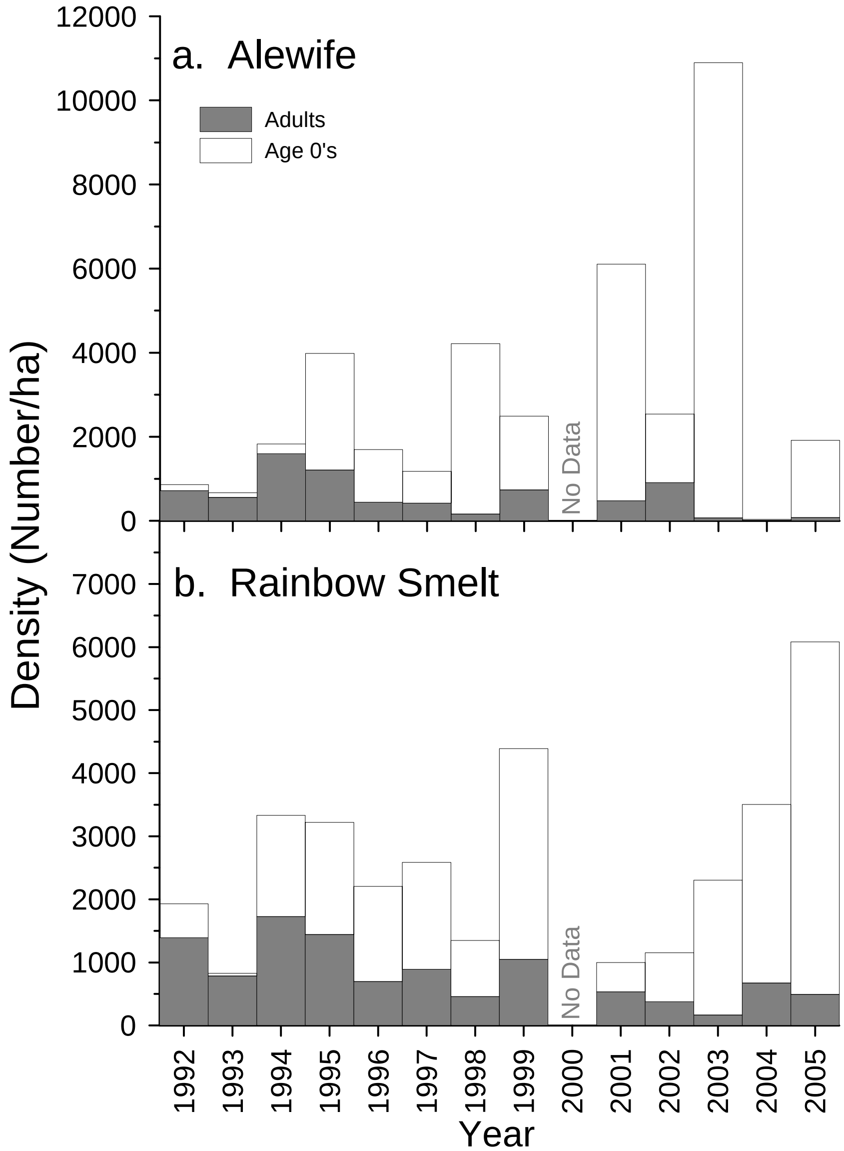

Figure 6.11 a & b. CPUE of adult and young of the year alewife and rainbow smelt caught in trawls on Lake Huron by USGS survey vessels. Data from "E.F. Roseman, J.S. Schaeffer, J.R. French, T.P. O'Brien, and C.S Faul. 2005. Status and trends of the Lake Huron deepwater demersal fish community, 2005. USGS Report." *No data collected – estimated alewife CPE from other data sources is provided.

For the "A" size category in 2003 and 2004, we assume that alewife were no longer a major component of the pelagic fish community. Instead, we assume the pelagic fish community within this size class was predominately composed of rainbow smelt. Although other small fish species such as trout perch, lake chub (*C. plumbeus*), lake herring, and alewife were observed within the catch of the 2004 Coastal Gill Net Program, rainbow smelt was observed to be the most abundant species caught within the small mesh gear. Therefore we estimated the mean round weight (RWT) of all fish within this size class for each survey frame in 2003 and 2004 using a length-weight relationship parameterized for rainbow smelt (table 6.12 & 6.13).

Table 6.14. Observed CUE (catch per effective netting night) of a selection of species caught within the UGLMU Offshore index netting project at Clapperton Island (Frame 5). Data shown are for those fish caught from the "GL32" gear only. Note that the greatest changes in CUE of alewife, lake chub, and yellow perch occurred between 2002 and 2003. There is no significant difference between the average CUE observed in 2003 and 2004 for the 8 species.

YEAR	Alewife	Bloater	Lake Chub	Lake Herring	Lake Whitefish	Rainbow Smelt	Trout-perch	Yellow Perch
2002	12.43	0.00	0.00	5.14	0.14	1.43	0.86	40.43
2003	0.21	0.00	0.57	5.79	3.29	1.86	0.43	6.71
2004	0.06	0.00	0.78	6.89	5.78	0.94	1.33	8.89

"B" Size Category

For the "B" size category (>250 mm and <=500mm), we estimated the mean round weight (*RWT*) of all fish within this size class for each survey frame using a length-weight relationship parameterized for all fish caught in the 2004 Coastal Gill Net Program with a total length greater than 250mm (table 6.12 & 6.13). Observation of the catch in 2004 suggest that the fish community within this size class were dominated by coregonid, *Salvelinus* and catastomid species and we assume that this has remained unchanged throughout the duration of the Hydroacoustic Survey program.

"C" Size Category

For the "C" size category (>500mm), we estimated the *RWT* (and "σ") directly from catch information provided by the 2004 Coastal Gill Netting Project. We used the mean round weight of all fish captured with a total length of greater than 500mm as an estimate of *RWT* for all survey frames in 2000-02. The *RWT* parameters for 2003 and 2004 were estimated from frame specific calculations of the mean round weight (table 6.12 & 6.13).

Estimates of Fish Density and Biomass

Substituting our estimates of the mean backscattering cross-section (σ_i), the partitioned integrated backscattered energy (E_i) and the mean round weight (RWT_i) for each of the 3 size classes into the echo integration equation we estimated the fish density and standing fish biomass for each analysis cell on a numbers or weight per m^2. This estimate is expressed in numbers or kilograms per hectare by multiplying the m^2 term by 10,000. The sum of the estimated fish density or biomass across fish size classes A, B, and C provides an estimate of the total biomass or fish density per unit area for every ~60m EDSU.

7.0 Quantitative Nearshore Electrofishing (2000–2005)

Electrofishing is a method of sampling fish by using electrical current and is particularly effective in shallow littoral zones of lakes and rivers (Reynolds 1983). Current density, the amount of current that passes through a 1 cm^2 plane (units = amperes/cm^2), is the most important parameter in assessing the effectiveness of electrofishing. Current density is a function of the voltage gradient (volts/cm) and the resistance of the water. Resistance is inversely related to conductivity. For the type of open-water nearshore electrofishing used in this study, the voltage gradient is particularly important and varies not only with conductivity but also with type of substrate.

Electrofishing effort is usually described in terms of shocker time or distance travelled rather than in absolute terms. The quantitative electrofishing technique used here involves adjusting operating conditions so that fish in the water column are immobilized, neither attracted into nor repelled from a measured transect. This quantitative electrofishing method is different. Effort is measured by area, using a transect of fixed width (1.5 m) and length (usually 200 m). The fish within the trailers that mark the width of the transect are dip-netted and provide a very precise quantitative measure of fish numbers and biomass on an area basis. To measure absolute abundance, missed fish are carefully enumerated and included in the electrofishing catch. These quantitative electrofishing techniques have been described in detail (Casselman and Grant 1998) and used quite extensively, including in a successful litigation associated with destructive fish habitat alteration (Casselman and Grant 1998).

This quantitative electrofishing technique was used to determine fish abundance in the nearshore waters of the seven frames (Figure 7.1). In 2000, contractual arrangements allowed for only two frames (1 and 2) to be sampled. In 2001 to 2005, all seven frames were sampled by this technique. An additional intervening area was sampled between frames 1 and 2 to permit a balanced study of nearshore fish consumption by nesting cormorants and nearshore fish abundance (Casselman and Marcogliese 2006 in preparation). Comparable electrofishing effort was also used in this intervening grid. In 2001-2005, 49 fishing sites (7 per frame) were surveyed. Maps and location coordinates for each site and frame are shown in Appendix 12. Electrofishing sites were distributed nearshore across the frames; nesting colonies were often uniformly distributed across the frame offshore.

Prior to establishing the electrofishing sites, habitats were surveyed to locate sites that had quite consistent types of habitat over their entire length. Habitats were selected that were not only typical of the frame but also similar across frames in their proportion of inorganic and organic substrate, particle size, and cover (Table 7.1). Habitats across the frames were similar and quite comparable. This meant that the fish communities sampled across the grids were generally comparable.

GPS was used to document the site and the electrofishing transects (Appendix 12). All transects involved electrofishing approximately parallel to shore and were in a uniform and comparable type of habitat. Although most habitats were associated with inorganic substrate, similar proportions of organic and vegetative areas were sampled in each frame. Most transects (6 of the 7) were 200 m in length, but one 100-m transect was sampled in each frame. This was done to balance habitat type and effort. Amount and size of inorganic substrate and amount of organic substrate were estimated visually for each site (Table 7.1). Typically, most sites had high percentages of inorganic substrate (>70%), with frame 3 having the lowest percentage of this substrate category (<70%). Inorganic substrates are composed of gravel, rock, and boulder, representing some degree of wave action along the shore. Total area sampled per frame was 3,900 m^2 (Table 7.2). The total area covered in the electrofishing survey in all seven sample frames was 27,300 m^2.

Electrofishing is often conducted at night (Casselman and Grant 1998), because somewhat larger fish move inshore at night and some species that are offshore in the daytime also move inshore at night (Casselman and Grant 1998). Night electrofishing in the nearshore waters of Georgian Bay and Lake Huron was far too dangerous to be attempted routinely. In this study, all the electrofishing sites were sampled during the daytime. However, for two years at the beginning of the study, night electrofishing was done and was compared with daytime electrofishing in exactly the same transects. Correlations were developed so that daytime catches could be converted to nighttime catches in terms of numbers and biomass. Nighttime catches were estimated for all transects, and nearshore fish abundance was described as the mean for the daytime and estimated nighttime catches. Fixed sites and transects were chosen as part of the electrofishing design because they provided very consistent habitat and a better comparison among grids and over time.

Electrofishing was conducted from mid-August to mid-September each year. Water temperature over that time was most consistent (mean = 19.8°C, Table 7.1), relatively high, and ideal for drawing fish off the bottom and out of cover so that they could be easily dip-netted. Also, late summer and early fall was chosen as the electrofishing period because nesting is finished by that time and the young cormorants have fledged, so the total impact of predation by nesting cormorants foraging on the inshore fish community would have been realized. Fish biomass at that time of year would be typical of fall and winter abundance and could be used to estimate fish production the following spring and summer.

Electrofishing was conducted on both sides of the boat, providing two transects at each site. The outside transect was slightly deeper than the inside one. Electrofishing was conducted down to a depth of approximately 3 m. Average depth of the transect was measured, using depths measured at the start, middle, and end of the 200-m transects and the start and end of the 100-m transects (frame mean = 1.35 m, Table 7.1). Habitat was documented (frame mean = 74% inorganic, rubble size 71% <60 cm, Table 7.1), conductivity was measured (mean = 166 μS), and amperage (mean = 6.4, Table 7.2) and electrofishing times (mean = 825 s, Table 7.2) were recorded. Although there were some environmental and electrofishing differences among frames and years, the main operational adjustments involved ensuring that operating conditions immobilized the fish in the transects. Although some differences were statistically significant, these differences were usually quite small and, when compared among sites and years, were usually not large enough to be considered technically or biologically significant.

Immobilized fish in the transects were dip-netted into a live well and processed at the end of the transect. All fish were identified to species and measured (mm) and weighed (g) before being released. A few fish were retained for age assessment and research purposes. Each dip netter kept track of fish that were missed in the transect by species and size categories. An observer in the back of the boat kept an independent estimate of missed fish. When results differed, the average was used. For each transect, the species that were captured were used to estimate size of the missed fish more precisely. Information on missed fish was combined with actual catches to provide an estimate of the electrofishing catch. Although species catch per unit effort was available and detailed analysis was possible, generally the species were simply combined to estimate overall fish abundance. Absolute abundance was calculating by using means for day and night catches, whereas relative indices of abundance, as analyzed in the staircase design, used just daytime catches. Catches were log-transformed to calculate geometric means for each frame and year and were reported as number and biomass (kg) per hectare (Casselman and Grant 1998).

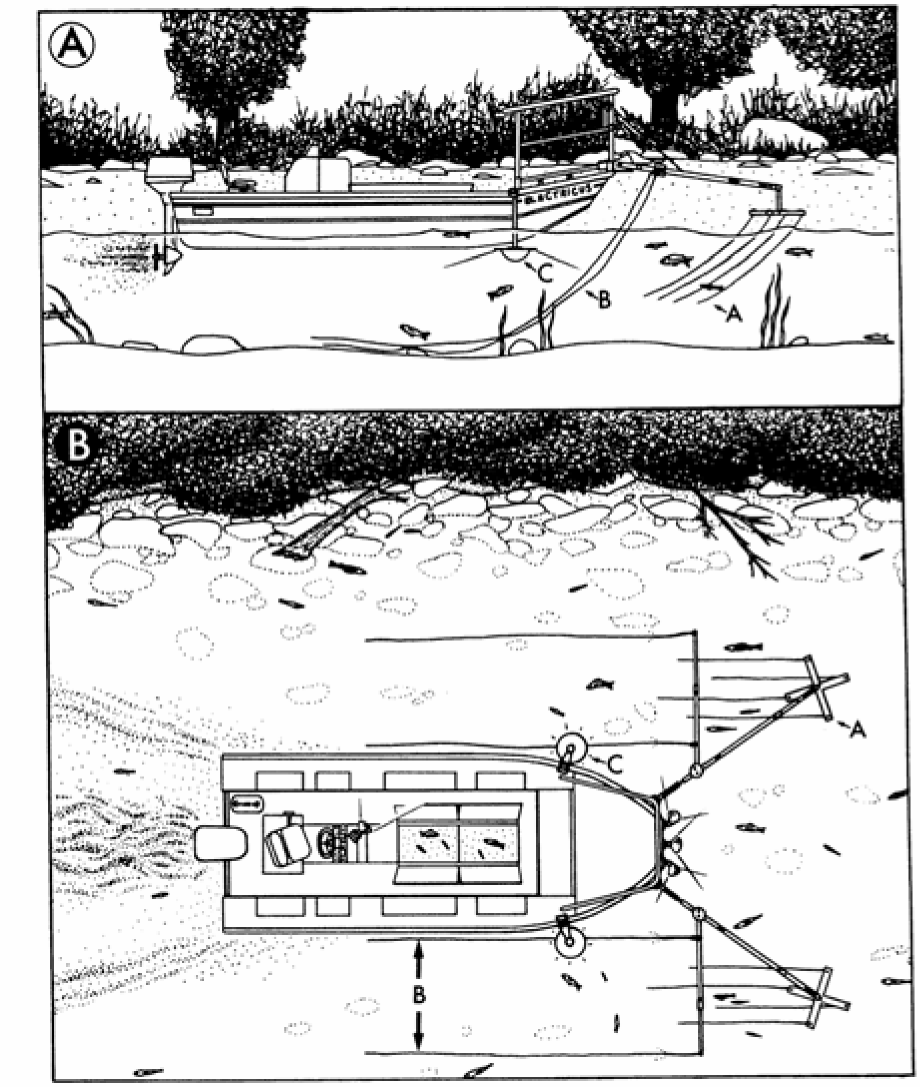

Figure 7.1. Side (A) and overhead (B) schematic view of boat-mounted electrofishing system used in study of inshore fish community in Lake Huron. In the illustrations, A indicates the anodes, B is the trailers marking the width of the electrofishing transect on either side of the boat, and C identifies the lights for night electrofishing. The cathodes were associated with either the hull (in this illustration) or droppers along the side of the hull midway along the boat. (From Casselman and Marcogliese 2006 in preparation.)

Table 7.1. Environmental and habitat conditions of electrofishing sites among frames, Georgian Bay (GB) and North Channe (NC), 2000 to 2004. ANOVA , LSD, and Kruskal-Wallis AOV tests were used to determine whether means were significantly different among frames. Conductivity is expressed as microsiemens (μS).

							Inorganic substrate[d]	
Frame	Area	Location	Sites	Depth (m)[a]	Temp. (°C)[b]	Cond. (μS)[c]	%	<60 cm (%)
1	GB	Parry Sound	7	1.28 ± 0.13[2,3]	20.7 ± 0.7[3]	175.4 ± 1.9[4]	72 ±10[1,2,3]	82 ± 07[2]
2	GB	Point au Baril	7	1.48 ± 0.13[24]	19.8 ± 0.4[2,3]	172.9 ± 2.2[4]	84 ± 10[2,3]	72 ± 08[1,2]
3	GB	Britt	7	1.68 ± 0.15[5]	22.8 ± 1.3[4]	153.7 ± 12.3[1]	54 ± 14[1]	48 ± 12[1]
	GB	Snug Harbour[e]	5	1.53 ± 0.12[4,5]	19.7 ± 0.7[2,3]	170.3 ± 2.0[3,4]	57 ± 18[1,2]	70 ± 13[1,2]
Georgian Bay			26	1.48 ± 0.07	20.7 ± 0.4	168.7 ± 3.2	68 ± 06	69 ± 05
4	NC	Little Current	7	1.43 ± 0.14[3,4]	19.0 ± 1.0[2]	174.7 ± 2.0[4]	84 ± 12[2,3]	67 ± 12[1,2]
5	NC	Spanish	7	1.28 ± 0.14[2,3]	21.0 ± 0.1[3]	158.8 ± 4.6[1,2]	68 ± 16[1,2,3]	64 ± 13[1,2]
6	NC	Spragge	7	1.14 ± 0.14[1,2]	20.1 ± 1.0[2,3]	154.4 ± 4.2[1]	77 ± 14[2,3]	73 ± 10[1,2]
7	NC	Thessalon	7	1.01 ± 0.10[1]	15.0 ± 1.9[1]	164.3 ± 3.2[2,3]	93 ± 08[3]	89 ± 04[2]
North Channel			28	1.22 ± 0.07	18.8 ± 0.7	163.0 ± 2.2	81 ± 06	73 ± 05
Combined			54	1.35 ± 0.05	19.8 ± 0.4	166.0 ± 2.0	74 ± 05	71 ± 04

[a,b,c] Mean depth, temperature, and conductivity significantly different among frames (*P*<0.0001).
[d] Mean inorganic substrate significantly different among frames (P<0.0002).
[e] Intervening area used for assessing impact of nesting cormorant fish consumption on the nearshore fish community.
[1,2,3,4] Homogeneous groups in which means were not significantly different.

Table 7.2. Mean electrofishing effort by grid, described in amperage, electrofishing time (seconds), and rate of sampling (m.s^{-1}), Georgian Bay (GB) and North Channel (NC), 2000 to 2004. ANOVA, and LSD tests were used to determine whether means were significantly different among frames.

Frame	Area	Location	Sites	Area (m^2)	Amperage[a]	Seconds	Sampling rate (m.s^{-1}) [b]
1	GB	Parry Sound	7	3,900	6.27 ± 0.29[1,2]	782 ± 70	0.24 ± 0.02[2,3]
2	GB	Point au Baril	7	3,900	6.38 ± 0.31[2]	788 ± 68	0.25 ± 0.02[2,3]
3	GB	Brott	7	3,900	6.52 ± 0.38[2]	750 ± 55	0.25 ± 0.02[3]
	GB	Snug Harbour[c]	5	2,700	6.59 ± 0.39[2]	794 ± 85	0.23 ± 0.03[1,2,3]
Georgian Bay			26	14,400	6.42 ± 0.16	779 ± 34	0.24 ± 0.01
4	NC	Little Current	7	3,900	6.71 ± 0.29[2]	872 ± 84	0.22 ± 0.01[1]
5	NC	Spanish	7	3,900	6.71 ± 0.45[2]	871 ± 100	0.22 ± 0.02[1,2]
6	NC	Spragge	7	3,900	6.22 ± 0.39[1,2]	892 ± 90	0.22 ± 0.02[1]
7	NC	Thessalon	7	3,900	5.89 ± 0.43[1]	868 ± 83	0.22 ± 0.01[1]
North Channel			28	15,600	6.38 ± 0.20	876 ± 43	0.22 ± 0.01
Combined			54	30,000	6.40 ± 0.13	825 ± 27	0.23 ± 0.01

[a] Mean amperage significantly different among frames (*P*=0.0215).
[b] Mean rate of sampling (m.s^{-1}) significantly different among frames (*P*=0.0195).
[c] Intervening area used for assessing impact of nesting cormorant fish consumption on the nearshore fish community.
[1,2,3] Homogeneous groups in which means were not significantly different.

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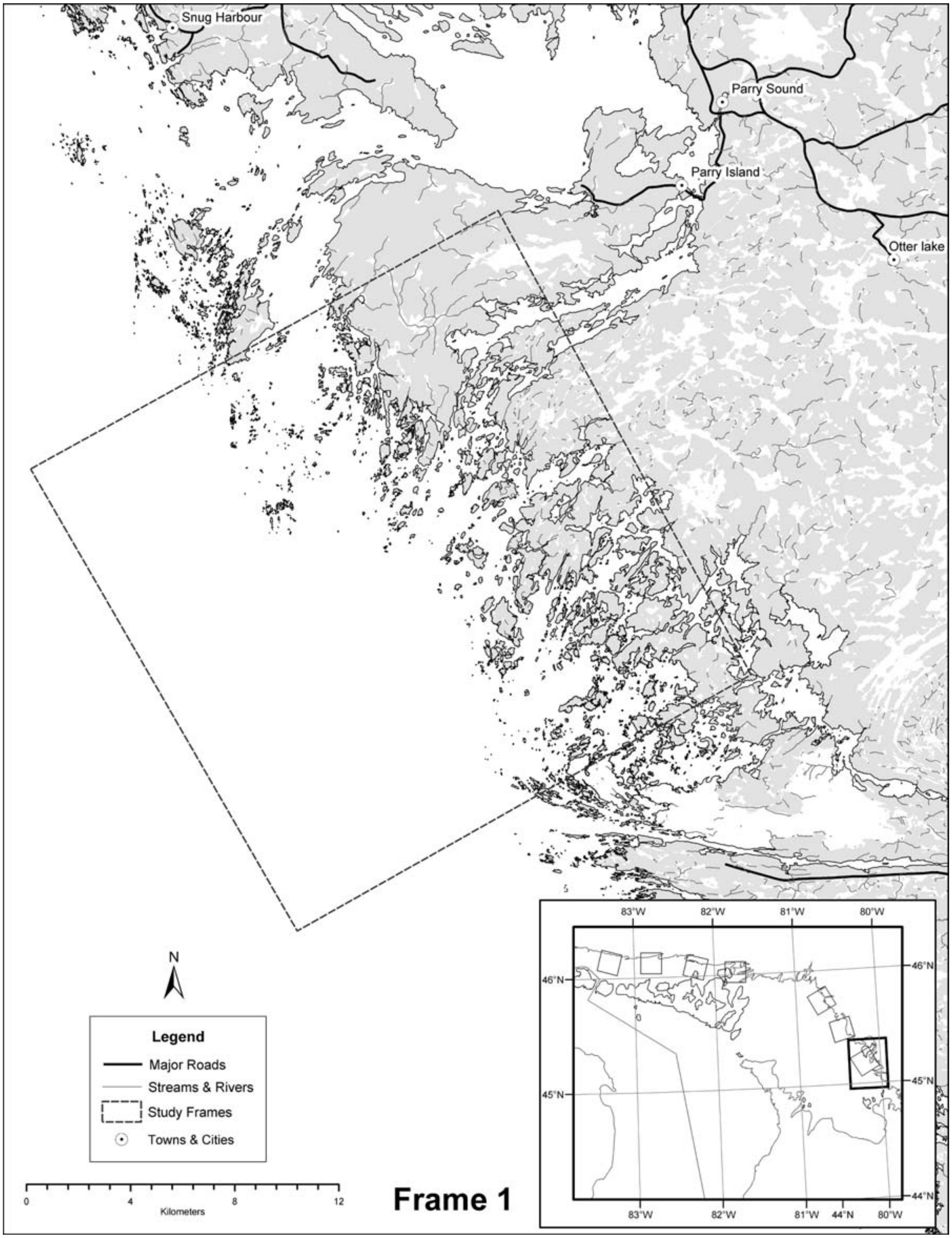
List of Appendices

Appendix 1

GPS coordinates identifying the corner coordinates of the seven sample frames and detail maps showing frame location relative to the Lake Huron shoreline

Latitude and longitude in decimal degrees (NAD83) of the corners of each of the sample frames

	Corner Coordinates (DD NAD83)			
Frame	NE	NW	SE	SW
1	45.30964 -80.14023	45.22291 -80.36991	45.15036 -80.02029	45.06293 -80.24117
2	45.58895 -80.35684	45.54302 -80.60581	45.41329 -80.29699	45.36750 -80.54752
3	45.86149 -80.63159	45.77593 -80.85936	45.70202 -80.50859	45.61484 -80.73807
4	46.11117 -81.60178	46.11692 -81.86124	45.92933 -81.61418	45.93756 -81.87189
5	46.14242 -82.07092	46.19158 -82.32281	45.96670 -82.14179	46.01560 -82.39184
6	46.21363 -82.65150	46.21947 -82.91363	46.03219 -82.66029	46.03795 -82.91936
7	46.20394 -83.15026	46.25130 -83.40039	46.02797 -83.21394	46.07543 -83.46596


Snug Harbour
Parry Sound
Parry Island
Otter lake
N
Legend
Major Roads
Streams & Rivers
Study Frames
Towns & Cities
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4
8
12
Kilometers
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82°W
81°W
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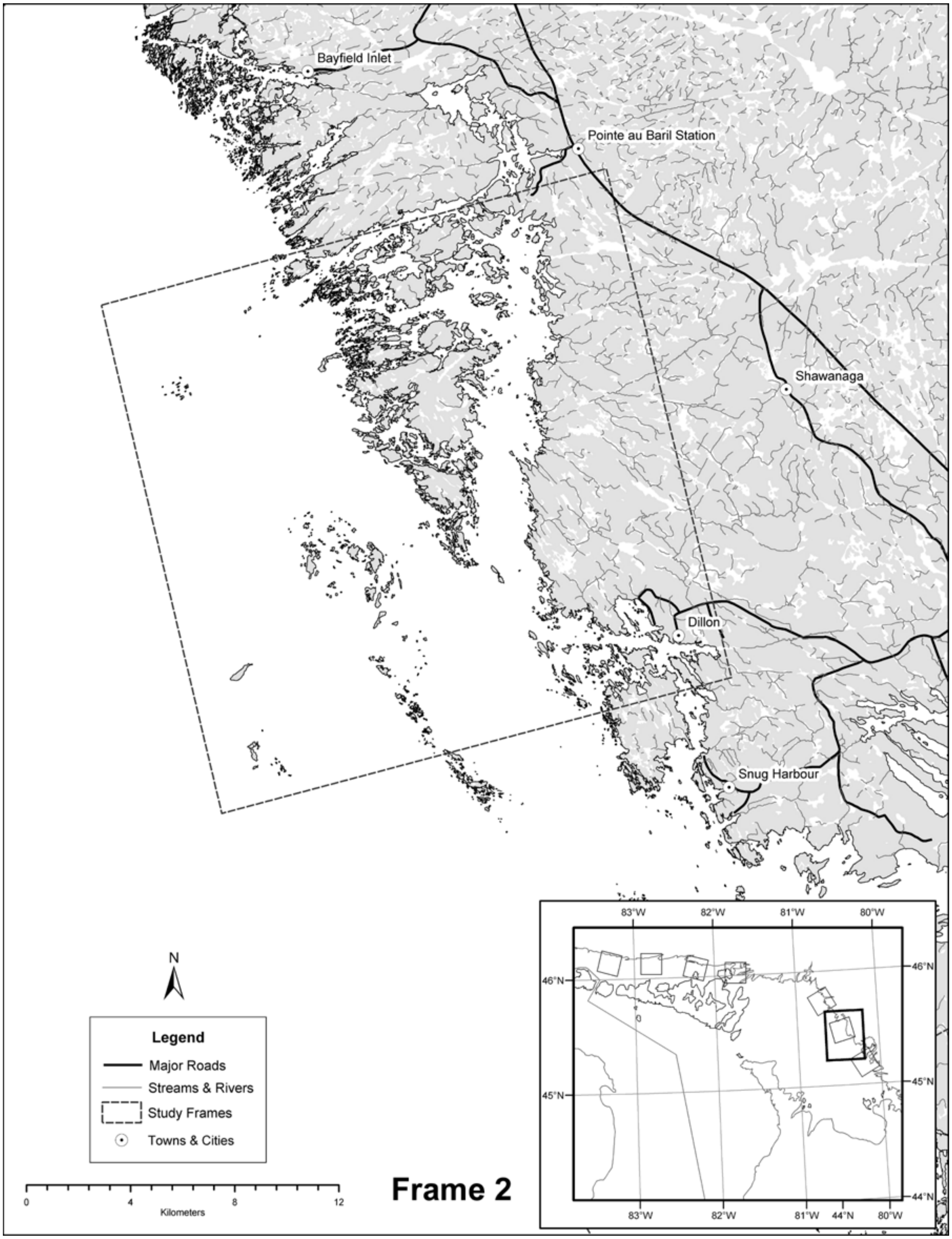
46°N
45°N
44°N


Bayfield Inlet
Pointe au Baril Station
Shawanaga
Dillon
Snug Harbour
N
Legend
Major Roads
Streams & Rivers
Study Frames
Towns & Cities
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4
8
12
Kilometers
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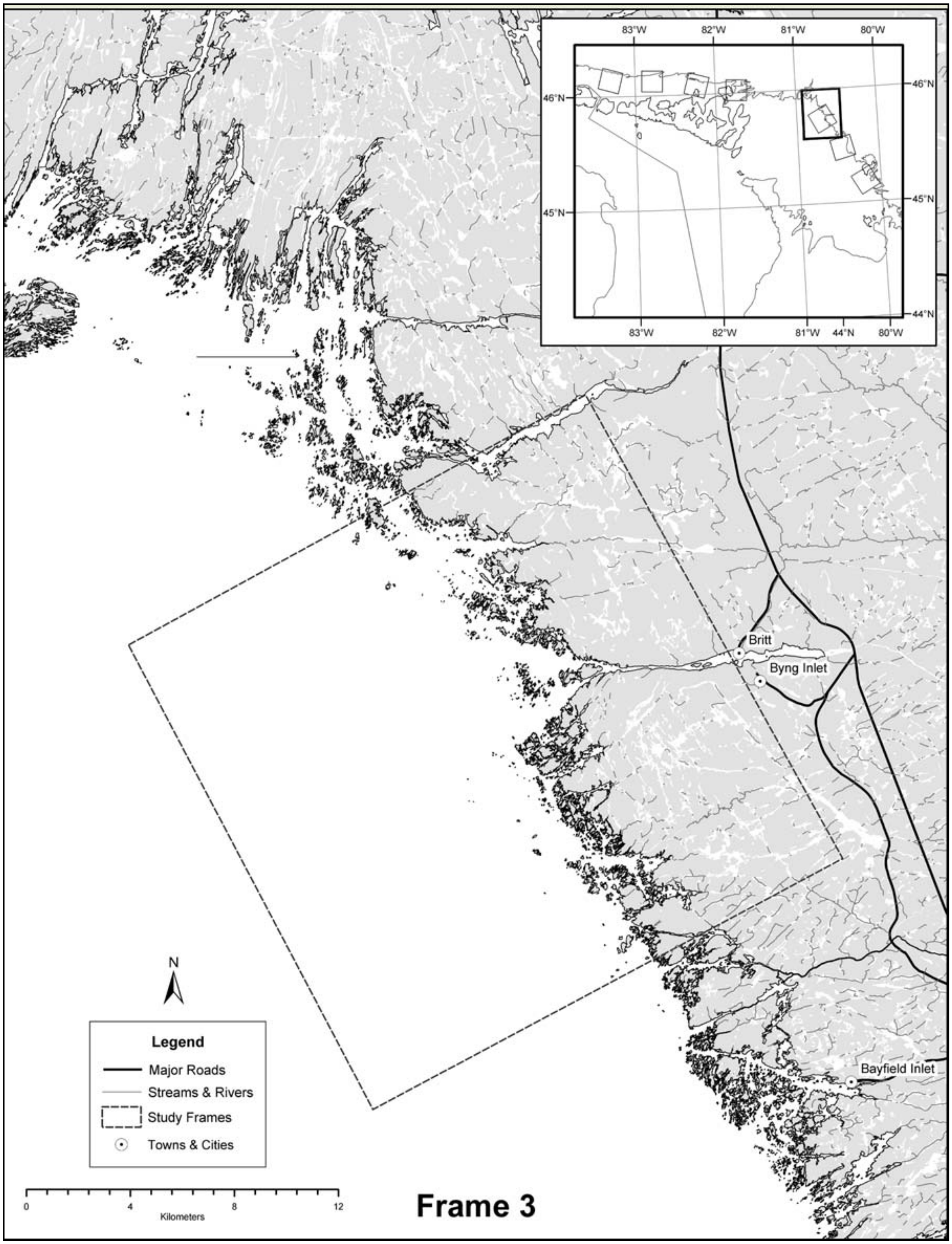
81°W
80°W
46°N
45°N
44°N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82°W
81°W
80°W
46°N
45°N
44°N
Britt
Byng Inlet
Bayfield Inlet
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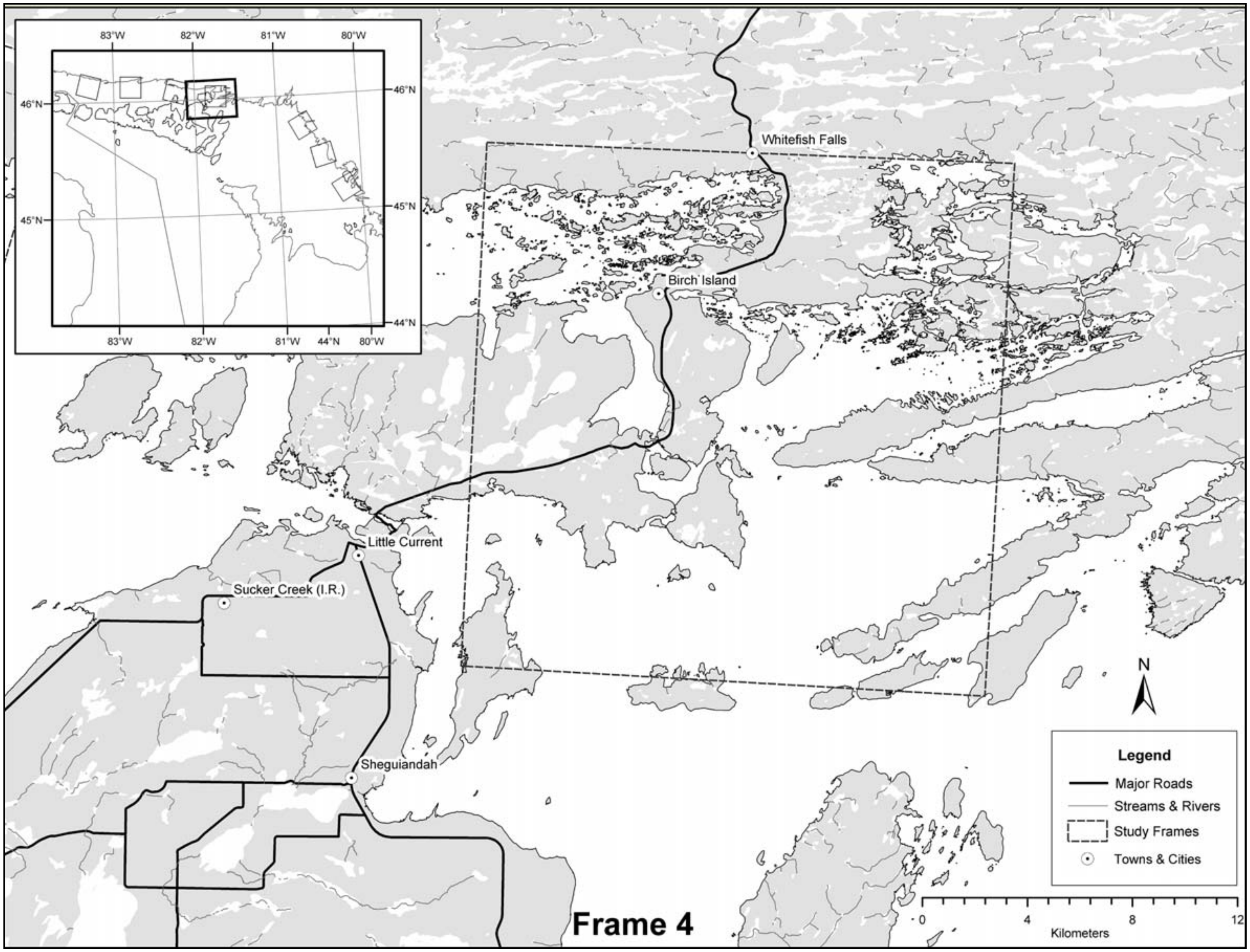
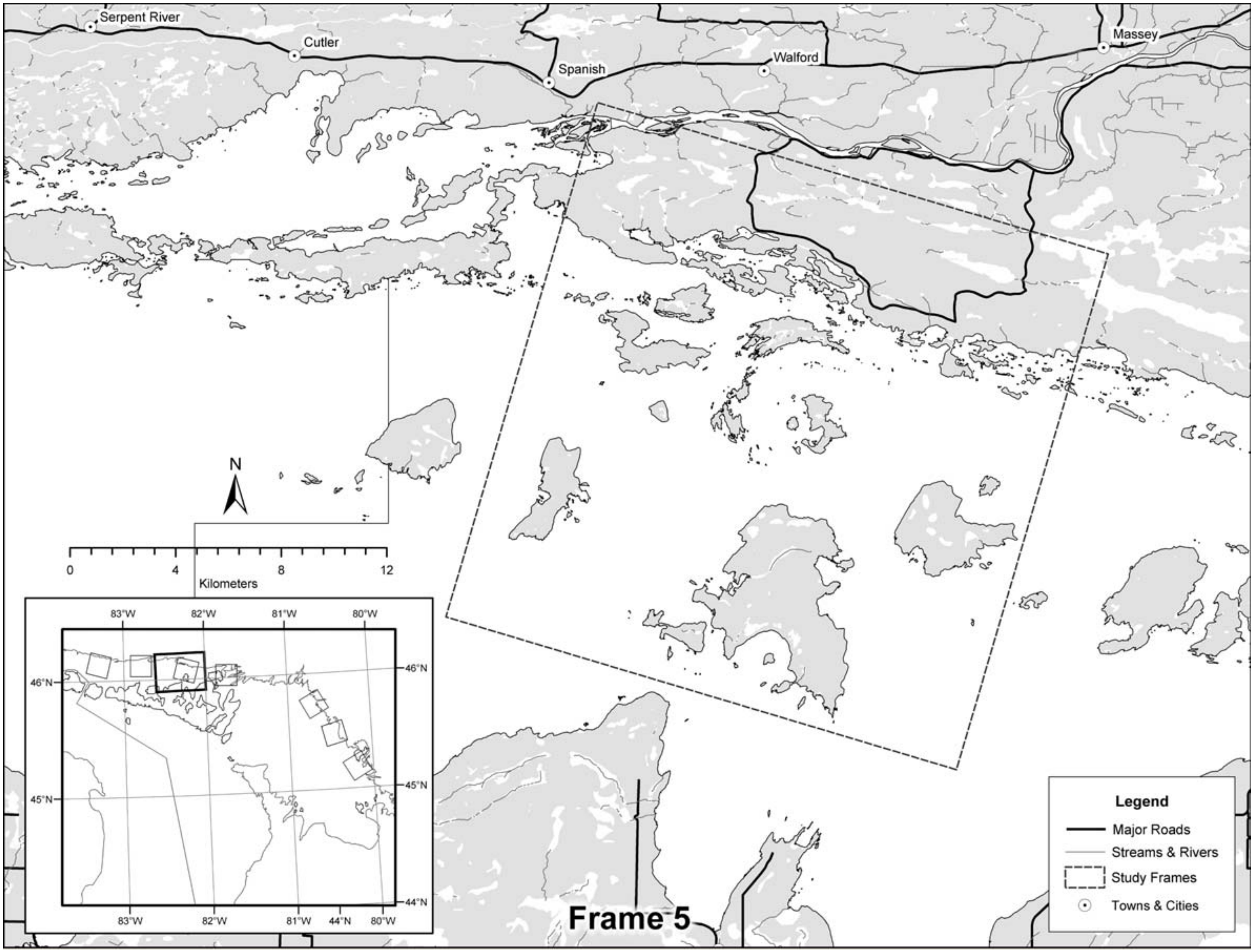
Legend
Major Roads
Streams & Rivers
Study Frames
Towns & Cities
0
4
8
12
Kilometers
Frame 3


83°W
82°W
81°W
80°W
46°N
45°N
44°N
Whitefish Falls
Birch Island
Little Current
Sucker Creek (I.R.)
Sheguiandah
N
Legend
Major Roads
Streams & Rivers
Study Frames
Towns & Cities
0
4
8
12
Kilometers
Frame 4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Cutler
Spanish
Walford
Massey
N
0
4
8
12
Kilometers
83°W
82°W
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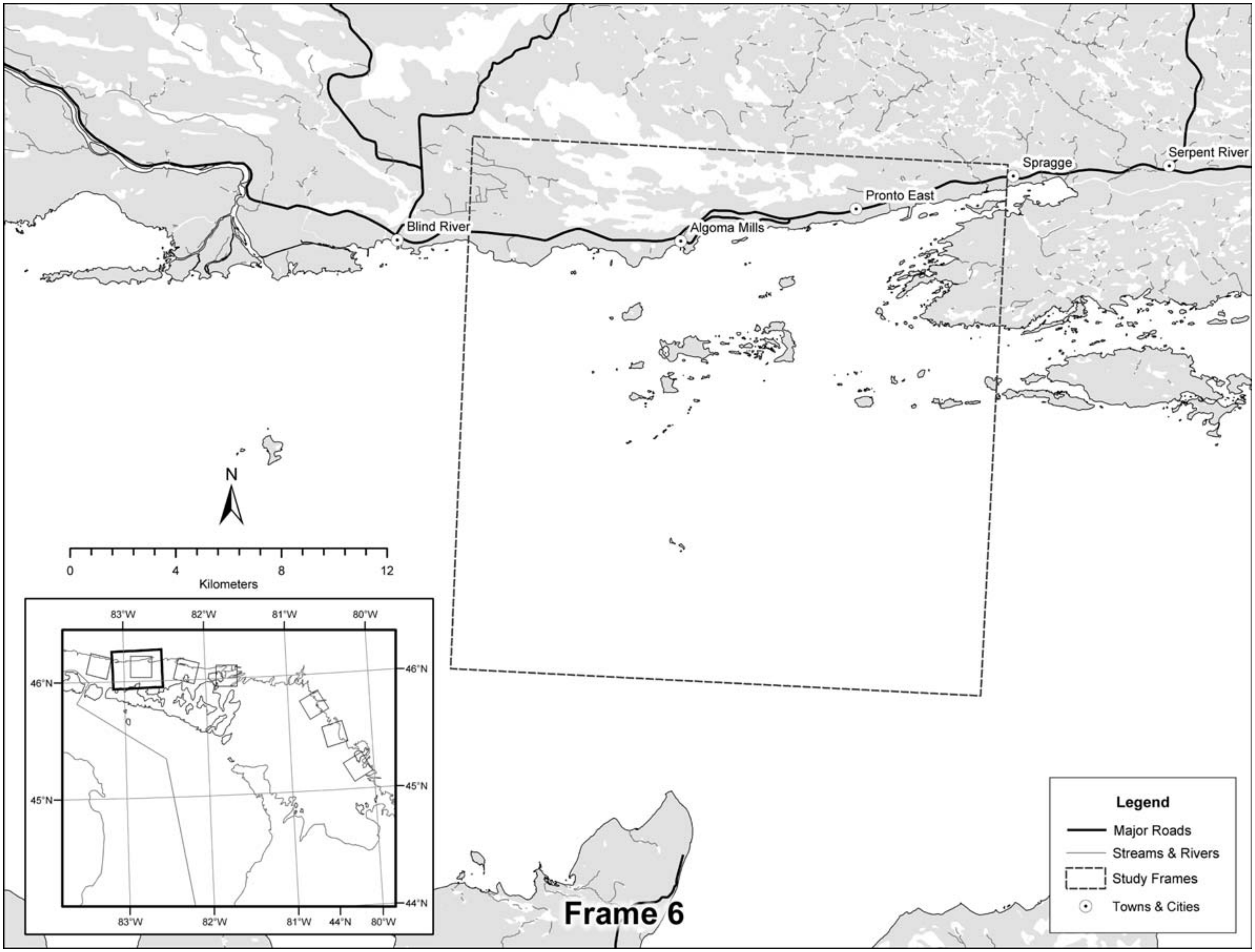
46°N
45°N
44°N
Legend
Major Roads
Streams & Rivers
Study Frames
Towns & Cities
Frame 5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Spragge
Pronto East
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8
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Kilometers
83°W
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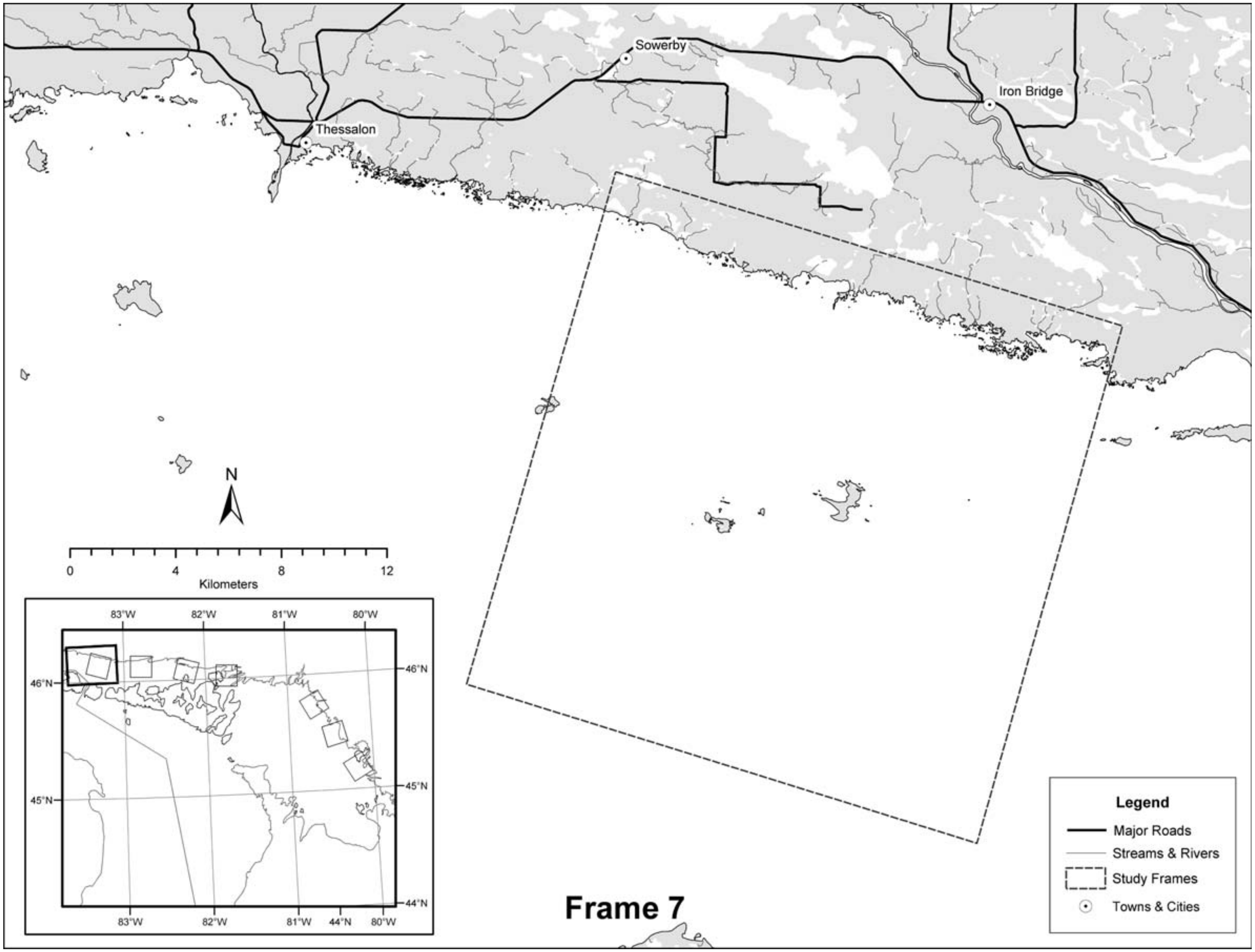
Legend
Major Roads
Streams & Rivers
Study Frames
Towns & Cities
Frame 6


Sowerby
Iron Bridge
Thessalon
N
0
4
8
12
Kilometers
83°W
82°W
81°W
80°W
46°N
45°N
44°N
Legend
Major Roads
Streams & Rivers
Study Frames
Towns & Cities
Frame 7

Appendix 2

Coordinates, site descriptions, nest counts (2000 – 2005) and maps of the location of double-crested cormorant colonies in the North Channel, Georgian Bay and Main Body of Lake Huron

Area	Colony Number	Latitude	Longitude	Site Description	2000	2001	2002	2003	2004	2005
Georgian Bay	1	44.5373	-80.2577	Nottawasaga Island	558		0	922	793	670
	2	44.9518	-80.0697	South Watcher Island	1839			1682	841	659
	3	44.9654	-80.0651	North Watcher Island	72			0	0	0
	4	45.0360	-80.3364	Thumb Rock	28			4	0	0
	5	45.0445	-80.3302	Block Island	16			85	102	127
	6	45.1408	-80.1428	Island SSE of Haystack Rock & SW of Double Isl.	92	142	43	204	134	192
	7	45.1931	-80.1969	Caleb Island (islet to the South)	418	495	396	413	269	439
	8	45.1958	-80.1947	Island NE of Caleb Island	0		0	0	0	0
	9	45.2308	-80.2692	South Tribune Island	49	52	0	213	166	198
	10	45.2294	-80.2694	North Tribune Island	234	277	197	0	0	0
	11	45.2313	-80.2626	3 islands East of the Tribune Islands	459		316			
	12.1	45.2356	-80.2598	Chancellor Island (and rock to the west)		422	243	151	103	108
	12.2	45.2367	-80.2611	Chancellor Island West				102	62	79
	13	45.3702	-80.0924	Gull Island	11		0	29	48	59
	14	45.3766	-80.1496	New Rock to the NW of Gull Island						
	15	45.3206	-80.3042	Island SE of Hoopers Island	324		291	369	278	291
	16	45.3317	-80.3450	Snake Island	73		74	46	37	10
	17	45.3850	-80.5167	Wallis Rocks	271	312	133	196	78	47
	18	45.3925	-80.5314	North Island of South Limestone Islands	222	273	63	134	372	307
	18.1	45.4078	-80.4508	Rock SE of Wallbank		68	155	184	157	179
	18.2	45.4193	-80.4459	Limestone Island # 2						19
	18.3	45.4177	-80.4486	Limestone Island # 3						59
	19			Birnie Is. (up to 7 islands in 2000)	652		153			
	19.1	45.4273	-80.4488	Island SE of Garland Island		137		121	115	202
	20	45.4528	-80.5022	Southwest Island	560	539	227	375	208	216
	21	45.4639	-80.5122	Colin Rock (South Colin Rock)	191		80	0	76	128
	22	45.4650	-80.5128	Duncan Rock (NE of Colin Rock)	63	237	27	165	0	0
	23	45.5147	-80.5636	Main Blackbill Island	118	206	89	248	108	241
	24	45.6503	-80.5985	Black Rock	2			7	23	33
	25	45.7036	-80.6578	Norgate Rocks	678	595	462	810	577	571

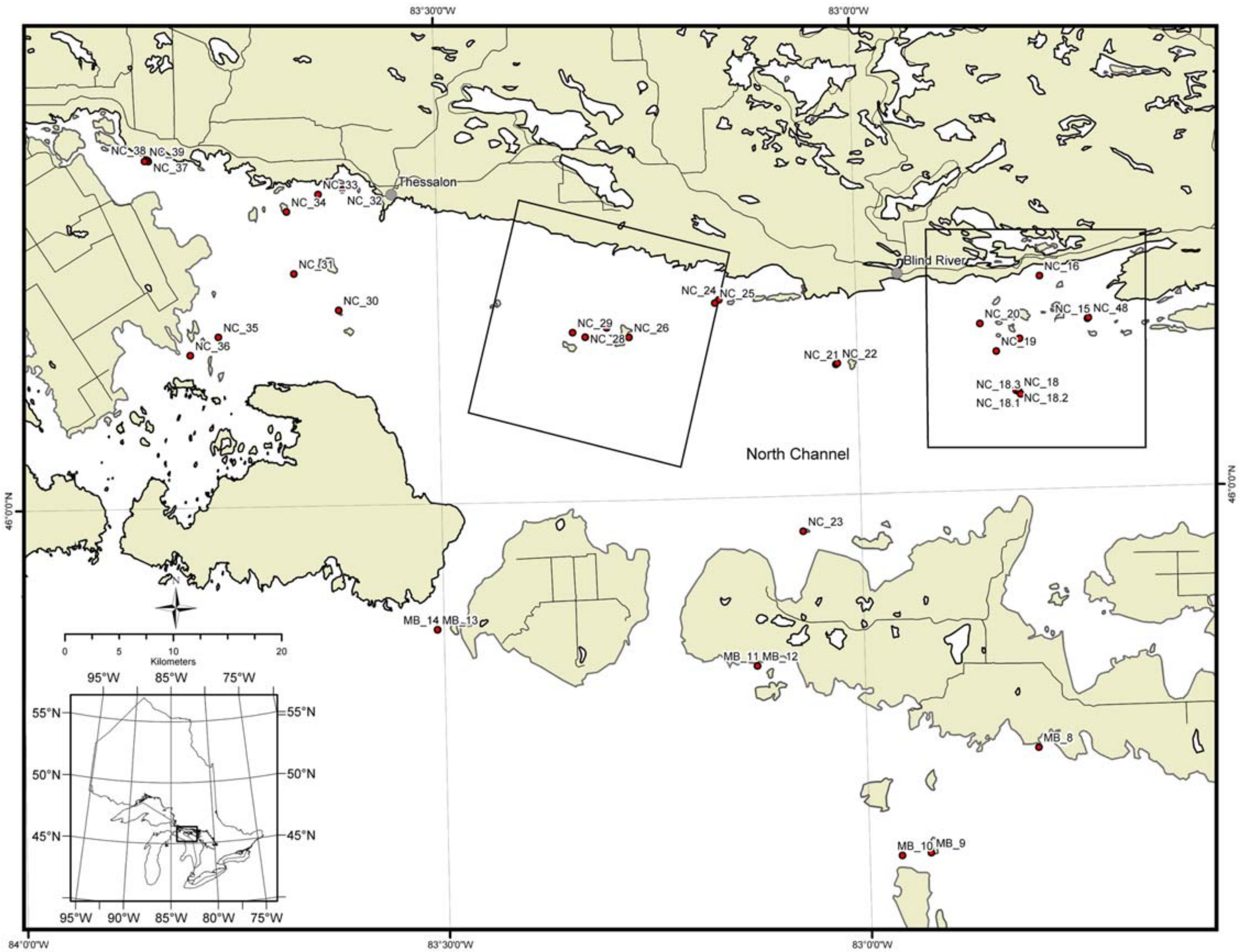
Area	Colony Number	Latitude	Longitude	Site Description	2000	2001	2002	2003	2004	2005
Georgian Bay	26	45.7961	-80.7269	East Flat Rock (Island East of Flat Rock)	0	0	0	0	0	0
	27	45.7953	-80.7303	West Flat Rock (Flat Rock)	506	543	183	445	284	387
	28	45.8631	-80.7904	Elgin Rock	0			0	329	344
	28.1	45.8478	-80.7979	Solitary Rock				145		78
	29	45.8745	-80.8553	Southeast Rock	585			236	405	305
	30	45.8809	-80.8611	Largest of the Gull Rocks	30			198	167	159
	30.1	45.8809	-80.8654	Gull Rocks				124	114	113
	31	45.8958	-80.9408	Castle Rock	120			136	87	118
	32	45.8839	-80.9649	Rock to the SE of Southwest Rock	0			0	0	0
	33	45.8847	-80.9654	Southwest Rock (The Bustards)	455			225	201	184
	34	45.8542	-81.2753	Gull Island	1757			572	577	721
	35	45.9245	-81.3343	Southwest Hawk Island	91			117	95	71
	35.1	45.9246	-81.3353	SW Hawk Island # 2						65
	36	45.8579	-81.3549	Papoose Island	474			0	0	0
	37	45.8330	-81.4813	West Rock	260		157	241	101	116
	38	45.9373	-81.5550	Kokanongwi Shingle	40	262		798	244	293
	39.1	45.8494	-81.6286	East and / or West Mound Island	130			0	0	35
	39.2	45.8530	-81.6290	Shoal NNE of Mound Island					0	0
	40	45.6259	-81.6539	West point of Rabbit Island	0			0	0	0
	41	45.5761	-81.6236	Erie Shingle	182			216	170	197
	42	45.4361	-81.7403	James Island	242			763	489	586
	43	45.4378	-81.4680	Halfmoon Island	298			271	280	292
	44	45.3415	-81.6260	Snake Island and NW Shoal	141			329	274	282
	45	44.9785	-81.4004	Barrier Island	51			194	196	158
Main Body	1	44.4890	-81.4004	Chantry Island	1429			1814	1783	1860
	2	44.7728	-81.3304	Fishing Island #30 = Isl. SSW of W Isl. Of Argyle Is.	173			179	57	183
	3	44.8096	-81.3521	Fishing Island #42 = Cavalier Island	867			1004	798	1193
	4	44.9651	-81.4231	Mad Reef.	436			906	653	794
	5	45.5378	-81.9248	Mayflower Island	381			151	0	0
	6	45.6323	-82.2268	Island. E of Everett Reefs.	148			0	0	0

Area	Colony Number	Latitude	Longitude	Site Description	2000	2001	2002	2003	2004	2005
Main Body	7	45.6367	-82.2410	Everett Reefs.	0			411	199	255
	8	45.7861	-82.7969	Buller Reef.	35			145	165	417
	9	45.7009	-82.9280	SW end of Middle Duck Island	0			0	0	0
	10	45.6992	-82.9622	Manitoba Reef.	501			631	349	459
	11	45.8599	-83.1284	Middle Island Of the Island NW of Steevens Isl.	41			0	0	0
	12	45.8599	-83.1282	W I. of the islands NW of Steevens I.	51			0	0	0
	13	45.8959	-83.5075	Wheeler Reef.	361			324	69	110
	19			White Rock						100
Main Body, US	14			Little Saddlebag Island, US	481					
	15			Crow Island, US	211					
	16			Goose Island, US	3056					
	17			St. Martin Shoal, US.	956					
North Channel	1	46.0375	-81.6333	1.2 km S of Parsday Crag Island	42	0		0	0	0
	2	45.9389	-81.7333	Heywood Rock	162	178	153	97	92	83
	3	45.9659	-81.7757	Island SW of Mary Island (SW of West Mary Isl.)	533	422	532	544	333	415
	4	46.0822	-81.8897	Island NNE of Carpmael Island (Whitby Island)	240	219	114	63	63	48
	5	46.0694	-81.8972	Carpmael Island	226	216	216	318	312	389
	6	46.0708	-81.9078	West Rock of Gordon Rock	47	45	29	86	120	58
	7	46.0883	-82.0492	Nisbet Rock	0	0		0	0	0
	8	46.0167	-82.1344	Elm Island	746	748	411	440	346	277
	9	46.1022	-82.1756	East Rock	0	0		0	0	0
	10	46.0964	-82.3183	Gull Rocks	329	382	196	216	122	95
	11	46.1328	-82.3375	West Rock of Hiesordt Rocks	90	118	71	96	97	126
	12	46.0492	-82.4339	North Rock of Howland Rocks	10	0	51	146	234	162
	12.1	46.0475	-82.4339	Howland Rock S.		52			0	0
	13	46.0625	-82.4750	Egg Island	635	682	200	99	62	93
	13.1	45.9833	-82.2399	Meredith Rock				203	183	276
	14	46.1217	-82.5110	Mouse Island	292			302	222	335
	15	46.1411	-82.7242	Middle Island of Robb Rocks (W Rocks)	511	644	452	221	29	245
	16	46.1778	-82.7800	West Island of Magazine Island	154	174	151	225	136	257

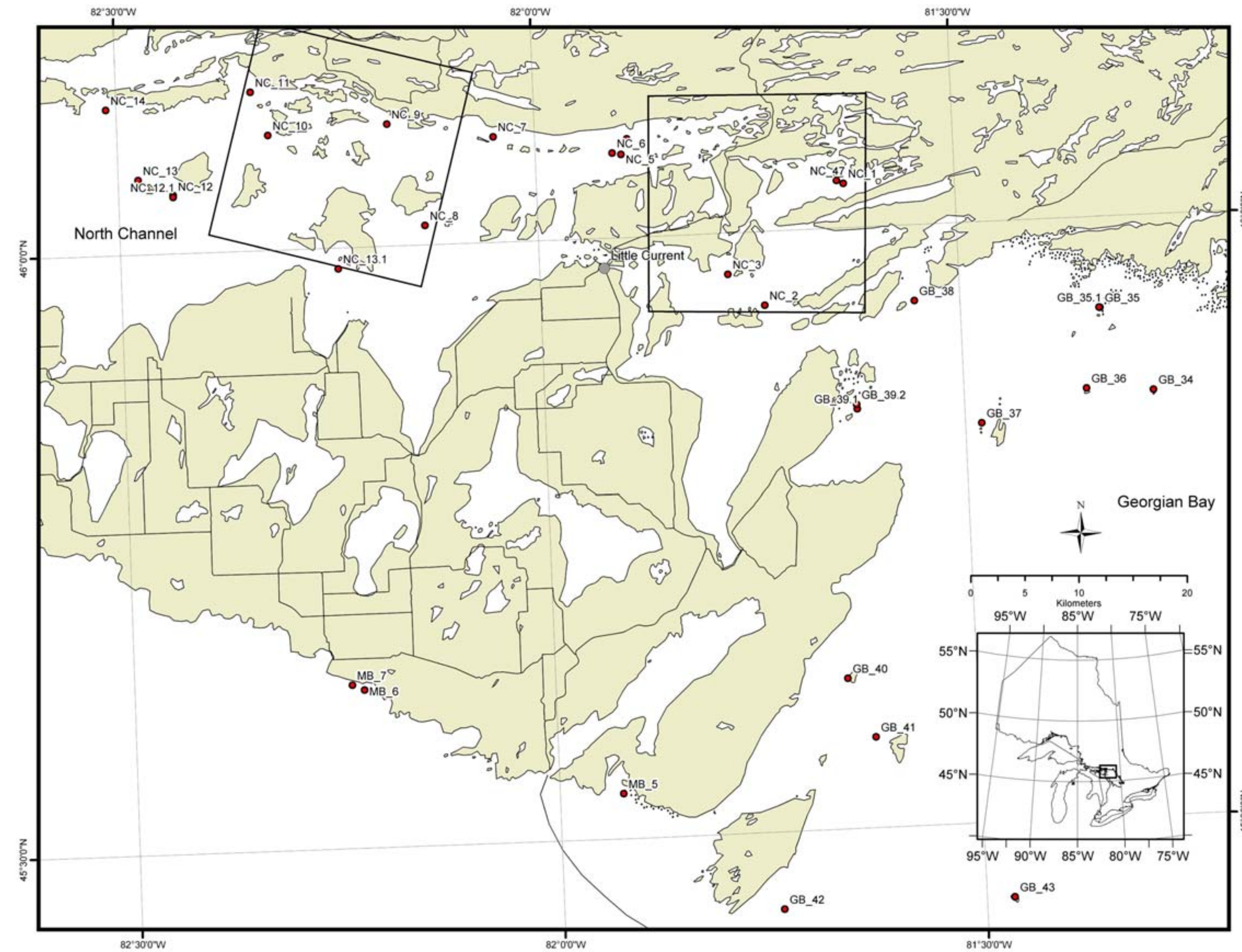
Area	Colony Number	Latitude	Longitude	Site Description	2000	2001	2002	2003	2004	2005
North Channel	17	46.1261	-82.8058	North Island of Fortin Rocks	116	102	82	0	26	48
	18	46.0818	-82.8083	The Cousins Island	853	1199	921			
	18.1	46.0829	-82.8118	Northwest Cousins Island				505	162	257
	18.2	46.0818	-82.8083	NE Island of the Cousins				165	76	88
	18.3	46.0798	-82.8064	Rock S of Cousins				369	162	88
	19	46.1161	-82.8342	Black Rock (between Cousins Islands & Doucet)	5	76		0	0	0
	20	46.1394	-82.8528	Doucet Rock	314	323	306	402	180	225
	21	46.1085	-83.0260	West Island	1835		1834	1314	739	759
	22	46.1095	-83.0241	Island West of West Island	52		87	131	227	20
	23	45.9710	-83.0701	Batture Island	278			444	188	390
	24	46.1646	-83.1639	Talon Rock	3			12	13	0
	25	46.1621	-83.1687	Rock West of Talon Rock	0			0	0	0
	26	46.1352	-83.2721	Herbert Island	991	1396	991	912	387	274
	27	46.1436	-83.2987	West Rock of Ivor Rocks	402	392	340	387	387	206
	28	46.1361	-83.3244	Middle Grant Island	543	1190	713	647	0	363
	29	46.1401	-83.3394	Bird Island	305	496	199	201	0	0
	30	46.1626	-83.6184	Gull Island	760			308	218	157
	31	46.1935	-83.6711	Kangaroo Rock	167			95	68	43
	32	46.2629	-83.6113	Kalulah Rock	163			243	106	157
	33	46.2593	-83.6405	Africa Rock	563			743	431	476
	34	46.2452	-83.6787	Island SE of Birch Island	159			215	86	92
	35	46.1419	-83.7625	Perrique Island	354			525	288	184
	36	46.1270	-83.7965	Salt Island	542			822	732	539
	37	46.2890	-83.8430	Island NE of McPhail Rock	0			0	0	0
	38	46.2903	-83.8454	Island N of McPhail Rock. (One Tree Isl.)	4			0	0	0
	39	46.2892	-83.8476	Island W of McPhail Rock (Duncan Rock)	15			31	29	75
	47	46.0401	-81.6414	NW Parsday					11	64
	48	46.1418	-82.7230	East Robb Rock					244	0
North Channel, US	40			Propellor Island (U.S.)					0	
	41			East Pipe Twin Island (U.S.)					170	

Area	Colony Number	Latitude	Longitude	Site Description	2000	2001	2002	2003	2004	2005
North Channel, US	42			West Pipe Twin Island (U.S.)					489	
	43			Little Cass Island (U.S.)					280	
	44			Two Tree Island (U.S.)	54				274	
	45			Rock Island (U.S.)					196	
	46			Gem Island (U.S.)						

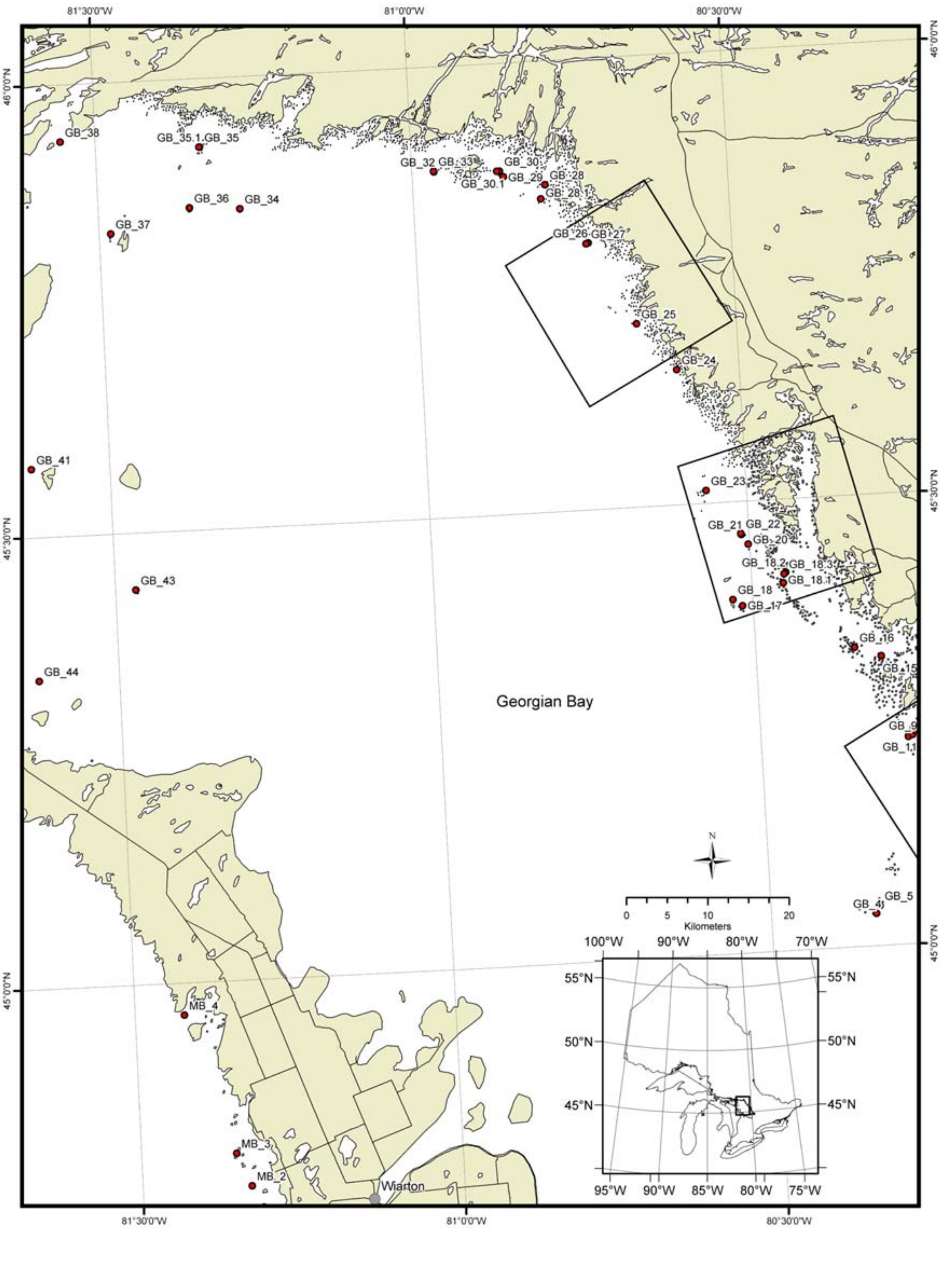
Appendix 2 Figure 1. Map of cormorant colony locations in the western end of the North Channel of Lake Huron



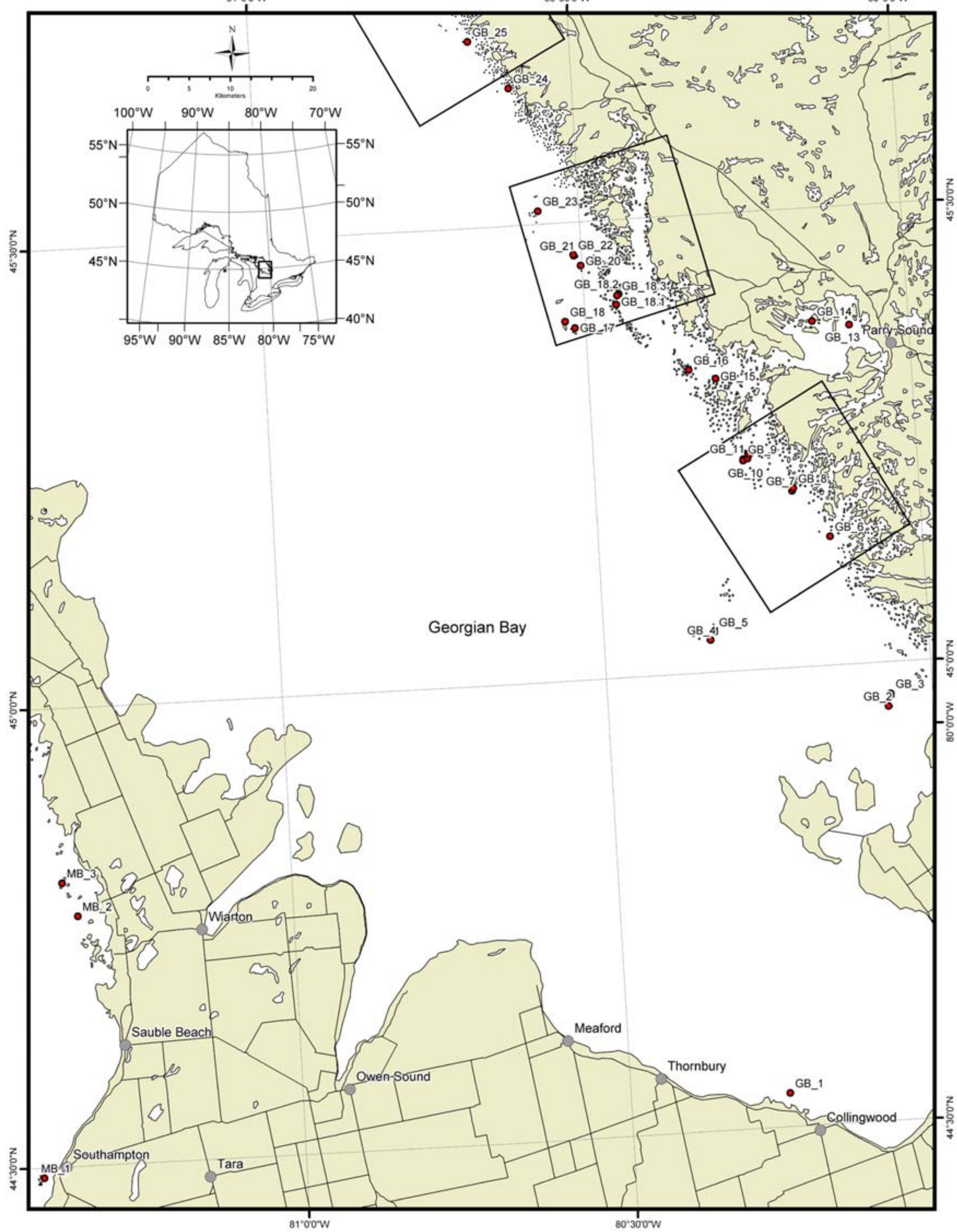
Appendix 2 Figure 2 . Map of cormorant colony locations in the eastern end of the North Channel of Lake Huron



Appendix 2 Figure 3. Map of cormorant colony locations in the northern end of Georgian Bay, Lake Huron



Appendix 2 Figure 4. Map of cormorant colony locations in the Southern end of Georgian Bay, Lake Huron



Appendix 3

GPS coordinates maps of aerial survey routes for each study frame

Latitude and longitude of eight waypoints along each aerial survey transect (decimal degrees NAD83)

		Waypoint Latitude and Longitude (DD NAD83)								
Frame	**Transect**	**Inshore**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Offshore**
		45.30241	45.29091	45.27942	45.26791	45.25640	45.24487	45.23335	45.22181	45.21027
1	1	-80.14540	-80.17395	-80.20249	-80.23101	-80.25952	-80.28803	-80.31652	-80.34499	-80.37346
		45.28611	45.27456	45.26307	45.25157	45.24006	45.22854	45.21702	45.20549	45.19395
1	2	-80.13290	-80.15379	-80.18232	-80.21084	-80.23935	-80.26785	-80.29633	-80.32481	-80.35327
		45.27071	45.26007	45.24858	45.23708	45.22557	45.21406	45.20254	45.19101	45.17948
1	3	-80.12038	-80.14126	-80.16979	-80.19830	-80.22681	-80.25530	-80.28378	-80.31225	-80.34071
		45.25530	45.24466	45.23317	45.22168	45.21018	45.19867	45.18715	45.17563	45.16410
1	4	-80.10660	-80.12748	-80.15600	-80.18451	-80.21301	-80.24149	-80.26997	-80.29843	-80.32689
		45.23900	45.22926	45.21778	45.20629	45.19479	45.18328	45.17177	45.16025	45.14872
1	5	-80.09412	-80.11497	-80.14349	-80.17199	-80.20049	-80.22897	-80.25744	-80.28590	-80.31435
		45.22449	45.21296	45.20148	45.18999	45.17850	45.16699	45.15548	45.14396	45.13244
1	6	-80.08034	-80.10249	-80.13100	-80.15950	-80.18799	-80.21646	-80.24493	-80.27338	-80.30182
		45.20818	45.19755	45.18607	45.17459	45.16309	45.15159	45.14009	45.12857	45.11705
1	7	-80.06786	-80.08873	-80.11723	-80.14573	-80.17421	-80.20268	-80.23114	-80.25959	-80.28803
		45.19278	45.18215	45.17067	45.15919	45.14770	45.13620	45.12470	45.11319	45.10167
1	8	-80.05539	-80.07625	-80.10475	-80.13323	-80.16171	-80.19018	-80.21863	-80.24708	-80.27551
		45.17646	45.16674	45.15527	45.14379	45.13230	45.12081	45.10931	45.09780	45.08629
1	9	-80.04166	-80.06377	-80.09226	-80.12075	-80.14922	-80.17768	-80.20613	-80.23457	-80.26300
		45.16105	45.15133	45.13986	45.12838	45.11690	45.10541	45.09391	45.08241	45.07089
1	10	-80.02919	-80.05003	-80.07852	-80.10700	-80.13546	-80.16392	-80.19236	-80.22080	-80.24922
		45.57924	45.57367	45.56809	45.56251	45.55692	45.55132	45.54570	45.54009	45.53446
2	1	-80.35783	-80.38898	-80.42011	-80.45125	-80.48237	-80.51349	-80.54460	-80.57571	-80.60681
		45.56120	45.55743	45.55185	45.54627	45.54068	45.53508	45.52947	45.52386	45.51823
2	2	-80.35163	-80.38147	-80.41259	-80.44372	-80.47483	-80.50594	-80.53705	-80.56815	-80.59924
		45.54406	45.53940	45.53382	45.52824	45.52265	45.51706	45.51144	45.50583	45.50021
2	3	-80.34542	-80.37526	-80.40638	-80.43749	-80.46860	-80.49970	-80.53080	-80.56189	-80.59297
		45.52693	45.52226	45.51668	45.51111	45.50552	45.49993	45.49432	45.48871	45.48308
2	4	-80.34050	-80.36905	-80.40016	-80.43126	-80.46236	-80.49345	-80.52454	-80.55562	-80.58669
		45.50979	45.50513	45.49956	45.49398	45.48839	45.48280	45.47719	45.47159	45.46596
2	5	-80.33430	-80.36412	-80.39522	-80.42631	-80.45740	-80.48849	-80.51957	-80.55064	-80.58170
		45.49175	45.48709	45.48152	45.47595	45.47036	45.46477	45.45916	45.45356	45.44794
2	6	-80.32683	-80.35792	-80.38901	-80.42010	-80.45118	-80.48226	-80.51332	-80.54439	-80.57544
		45.47461	45.46906	45.46348	45.45791	45.45233	45.44674	45.44114	45.43553	45.42991
2	7	-80.32064	-80.35173	-80.38281	-80.41389	-80.44496	-80.47603	-80.50709	-80.53814	-80.56918
		45.45657	45.45282	45.44725	45.44168	45.43609	45.43051	45.42491	45.41930	45.41368
2	8	-80.31446	-80.34552	-80.37660	-80.40767	-80.43873	-80.46978	-80.50084	-80.53188	-80.56292
		45.43854	45.43479	45.42922	45.42365	45.41807	45.41248	45.40688	45.40128	45.39566
2	9	-80.30957	-80.34062	-80.37168	-80.40274	-80.43379	-80.46484	-80.49588	-80.52692	-80.55795
		45.42139	45.41765	45.41208	45.40652	45.40093	45.39535	45.38975	45.38415	45.37854
2	10	-80.30211	-80.33443	-80.36548	-80.39653	-80.42758	-80.45861	-80.48965	-80.52067	-80.55169

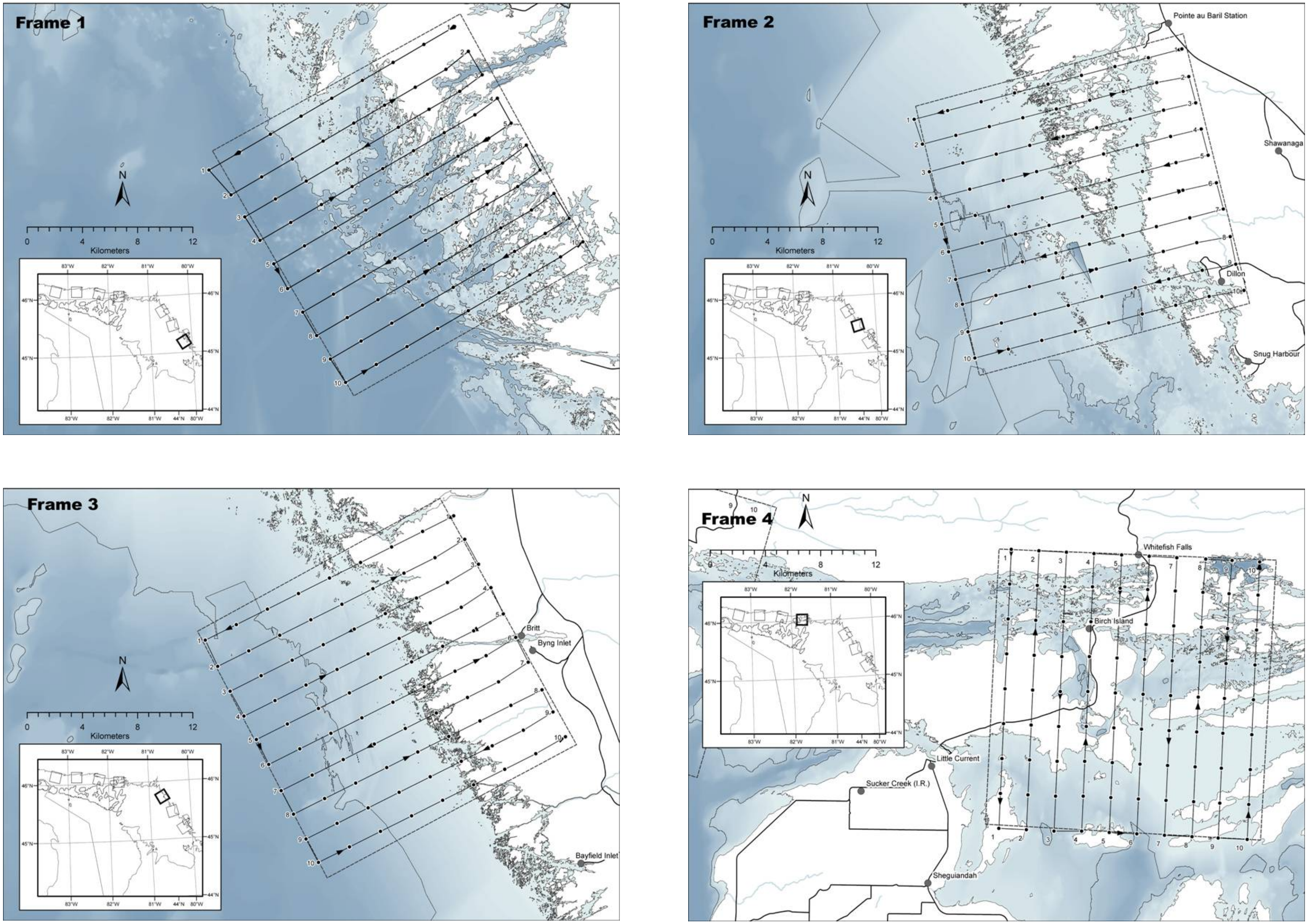
Waypoint Latitude and Longitude (DD NAD83)

Frame	Transect	Inshore	1	2	3	4	5	6	7	Offshore
		45.85043	45.84040	45.83036	45.82031	45.81026	45.80020	45.79013	45.78005	45.76996
3	1	-80.62004	-80.64909	-80.67812	-80.70714	-80.73615	-80.76515	-80.79415	-80.82313	-80.85210
		45.83510	45.82326	45.81323	45.80318	45.79313	45.78307	45.77300	45.76293	45.75285
3	2	-80.60985	-80.63761	-80.66663	-80.69565	-80.72465	-80.75365	-80.78263	-80.81161	-80.84057
		45.81885	45.80703	45.79699	45.78695	45.77690	45.76684	45.75678	45.74671	45.73663
3	3	-80.59709	-80.62613	-80.65515	-80.68416	-80.71316	-80.74215	-80.77112	-80.80009	-80.82905
		45.80351	45.79078	45.78075	45.77071	45.76067	45.75061	45.74055	45.73048	45.72041
3	4	-80.58562	-80.61337	-80.64239	-80.67139	-80.70038	-80.72936	-80.75833	-80.78730	-80.81625
		45.78637	45.77544	45.76541	45.75538	45.74533	45.73528	45.72523	45.71516	45.70509
3	5	-80.57417	-80.60190	-80.63091	-80.65991	-80.68889	-80.71787	-80.74683	-80.77579	-80.80473
		45.77102	45.75920	45.74917	45.73914	45.72910	45.71905	45.70900	45.69894	45.68887
3	6	-80.56271	-80.59045	-80.61945	-80.64844	-80.67742	-80.70639	-80.73535	-80.76429	-80.79323
		45.75478	45.74206	45.73203	45.72200	45.71197	45.70192	45.69187	45.68181	45.67174
3	7	-80.55126	-80.57900	-80.60800	-80.63698	-80.66595	-80.69492	-80.72387	-80.75281	-80.78174
		45.73672	45.72671	45.71669	45.70667	45.69663	45.68659	45.67654	45.66648	45.65642
3	8	-80.53855	-80.56755	-80.59654	-80.62552	-80.65448	-80.68344	-80.71239	-80.74132	-80.77025
		45.72228	45.71047	45.70045	45.69043	45.68039	45.67035	45.66031	45.65025	45.64019
3	9	-80.52839	-80.55611	-80.58510	-80.61407	-80.64303	-80.67198	-80.70092	-80.72985	-80.75877
		45.70603	45.69512	45.68511	45.67508	45.66506	45.65502	45.64498	45.63492	45.62487
3	10	-80.51697	-80.54468	-80.57365	-80.60262	-80.63157	-80.66052	-80.68945	-80.71837	-80.74729
		46.11701	46.09444	46.07168	46.04893	46.02617	46.00342	45.98065	45.95790	45.93514
4	1	-81.85028	-81.85138	-81.85249	-81.85359	-81.85470	-81.85580	-81.85690	-81.85800	-81.85910
		46.11630	46.09373	46.07097	46.04822	46.02546	46.00271	45.97995	45.95719	45.93443
4	2	-81.82438	-81.82550	-81.82662	-81.82773	-81.82885	-81.82995	-81.83107	-81.83218	-81.83329
		46.11559	46.09302	46.07026	46.04750	46.02474	46.00199	45.97923	45.95648	45.93372
4	3	-81.79849	-81.79961	-81.80075	-81.80187	-81.80300	-81.80411	-81.80524	-81.80636	-81.80749
		46.11486	46.09319	46.07043	46.04768	46.02492	46.00217	45.97941	45.95666	45.93390
4	4	-81.77260	-81.77374	-81.77489	-81.77602	-81.77716	-81.77829	-81.77943	-81.78055	-81.78169
		46.11414	46.09247	46.06971	46.04695	46.02419	46.00144	45.97868	45.95593	45.93317
4	5	-81.74671	-81.74786	-81.74902	-81.75016	-81.75131	-81.75245	-81.75360	-81.75473	-81.75588
		46.11340	46.09173	46.06897	46.04622	46.02346	46.00071	45.97795	45.95520	45.93244
4	6	-81.72081	-81.72198	-81.72314	-81.72429	-81.72546	-81.72661	-81.72777	-81.72891	-81.73007
		46.11266	46.09099	46.06823	46.04548	46.02272	45.99997	45.97721	45.95446	45.93170
4	7	-81.69492	-81.69610	-81.69727	-81.69843	-81.69961	-81.70077	-81.70194	-81.70310	-81.70427
		46.11193	46.09025	46.06749	46.04474	46.02198	45.99923	45.97647	45.95372	45.93096
4	8	-81.66774	-81.67022	-81.67140	-81.67258	-81.67376	-81.67493	-81.67611	-81.67728	-81.67846
		46.11117	46.08949	46.06673	46.04398	46.02122	45.99847	45.97571	45.95296	45.93020
4	9	-81.64314	-81.64563	-81.64683	-81.64801	-81.64920	-81.65038	-81.65158	-81.65275	-81.65394
		46.11041	46.08874	46.06598	46.04323	46.02047	45.99772	45.97496	45.95221	45.92945
4	10	-81.61725	-81.61846	-81.61967	-81.62086	-81.62206	-81.62326	-81.62446	-81.62565	-81.62685

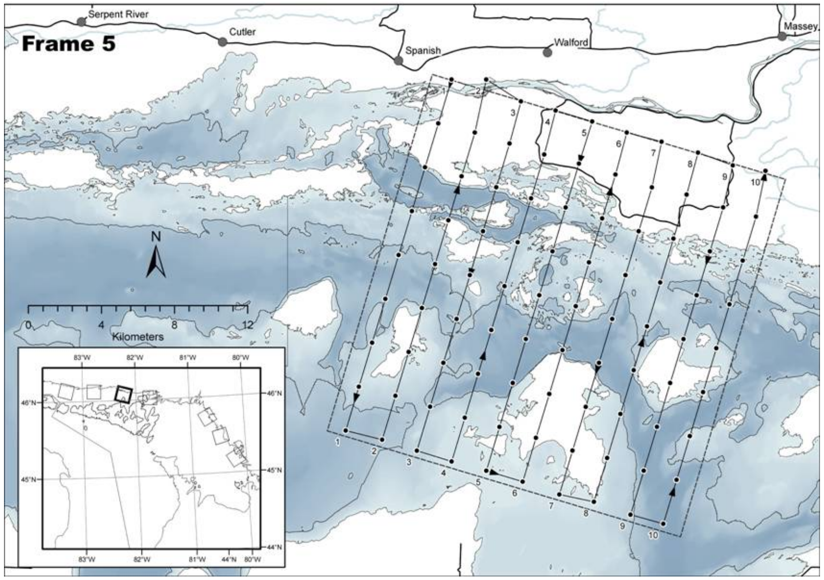
		Waypoint Latitude and Longitude (DD NAD83)								
Frame	**Transect**	**Inshore**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Offshore**
		46.18918	46.16747	46.14577	46.12407	46.10237	46.08067	46.05896	46.03725	46.01555
5	1	-82.30884	-82.31771	-82.32658	-82.33545	-82.34430	-82.35315	-82.36200	-82.37083	-82.37966
		46.18946	46.16327	46.14157	46.11987	46.09817	46.07647	46.05477	46.03306	46.01136
5	2	-82.28422	-82.29171	-82.30059	-82.30946	-82.31833	-82.32719	-82.33604	-82.34488	-82.35372
		46.17894	46.15815	46.13645	46.11475	46.09305	46.07135	46.04965	46.02795	46.00624
5	3	-82.25936	-82.26698	-82.27587	-82.28475	-82.29363	-82.30249	-82.31135	-82.32021	-82.32906
		46.17471	46.15302	46.13132	46.10962	46.08793	46.06623	46.04453	46.02283	46.00113
5	4	-82.23465	-82.24226	-82.25115	-82.26004	-82.26893	-82.27781	-82.28668	-82.29554	-82.30440
		46.16959	46.14878	46.12709	46.10539	46.08370	46.06200	46.04031	46.01861	45.99691
5	5	-82.20863	-82.21756	-82.22646	-82.23536	-82.24426	-82.25314	-82.26202	-82.27089	-82.27976
		46.16445	46.14366	46.12196	46.10027	46.07858	46.05689	46.03519	46.01349	45.99179
5	6	-82.18390	-82.19155	-82.20046	-82.20937	-82.21828	-82.22717	-82.23606	-82.24494	-82.25382
		46.16020	46.13763	46.11593	46.09424	46.07256	46.05086	46.02917	46.00747	45.98578
5	7	-82.15920	-82.16552	-82.17445	-82.18337	-82.19228	-82.20119	-82.21008	-82.21897	-82.22786
		46.15506	46.13427	46.11258	46.09089	46.06921	46.04752	46.02583	46.00413	45.98244
5	8	-82.13319	-82.14086	-82.14979	-82.15872	-82.16764	-82.17655	-82.18546	-82.19436	-82.20325
		46.14900	46.12823	46.10654	46.08485	46.06317	46.04148	46.01979	45.99810	45.97641
5	9	-82.10846	-82.11484	-82.12379	-82.13272	-82.14165	-82.15058	-82.15949	-82.16840	-82.17731
		46.14653	46.12396	46.10227	46.08058	46.05890	46.03722	46.01553	45.99384	45.97215
5	10	-82.08511	-82.09146	-82.10041	-82.10936	-82.11829	-82.12723	-82.13615	-82.14507	-82.15398
		46.21959	46.19682	46.17408	46.15134	46.12860	46.10586	46.08311	46.06038	46.03763
6	1	-82.89952	-82.90068	-82.90184	-82.90300	-82.90415	-82.90531	-82.90647	-82.90762	-82.90878
		46.21822	46.19635	46.17361	46.15087	46.12812	46.10539	46.08264	46.05991	46.03716
6	2	-82.87354	-82.87474	-82.87591	-82.87708	-82.87825	-82.87942	-82.88058	-82.88175	-82.88292
		46.21775	46.19497	46.17223	46.14949	46.12675	46.10401	46.08127	46.05853	46.03579
6	3	-82.84759	-82.84877	-82.84995	-82.85113	-82.85231	-82.85349	-82.85467	-82.85585	-82.85702
		46.21726	46.19449	46.17175	46.14901	46.12627	46.10353	46.08078	46.05805	46.03530
6	4	-82.82164	-82.82284	-82.82403	-82.82522	-82.82641	-82.82760	-82.82879	-82.82997	-82.83116
		46.21587	46.19400	46.17126	46.14852	46.12578	46.10304	46.08030	46.05756	46.03481
6	5	-82.79567	-82.79690	-82.79810	-82.79930	-82.80050	-82.80170	-82.80290	-82.80410	-82.80530
		46.21538	46.19351	46.17076	46.14803	46.12528	46.10255	46.07980	46.05707	46.03432
6	6	-82.76972	-82.77096	-82.77218	-82.77339	-82.77460	-82.77581	-82.77702	-82.77823	-82.77944
		46.21488	46.19211	46.16936	46.14663	46.12388	46.10115	46.07840	46.05567	46.03292
6	7	-82.74377	-82.74500	-82.74622	-82.74744	-82.74867	-82.74989	-82.75111	-82.75233	-82.75355
		46.21437	46.19160	46.16885	46.14612	46.12337	46.10064	46.07789	46.05516	46.03241
6	8	-82.71783	-82.71906	-82.72030	-82.72153	-82.72276	-82.72400	-82.72523	-82.72646	-82.72769
		46.21296	46.19019	46.16744	46.14471	46.12196	46.09923	46.07648	46.05375	46.03100
6	9	-82.69186	-82.69310	-82.69435	-82.69559	-82.69683	-82.69808	-82.69932	-82.70056	-82.70180
		46.21244	46.18967	46.16692	46.14419	46.12144	46.09871	46.07596	46.05323	46.03048
6	10	-82.66591	-82.66717	-82.66842	-82.66968	-82.67093	-82.67219	-82.67344	-82.67469	-82.67594

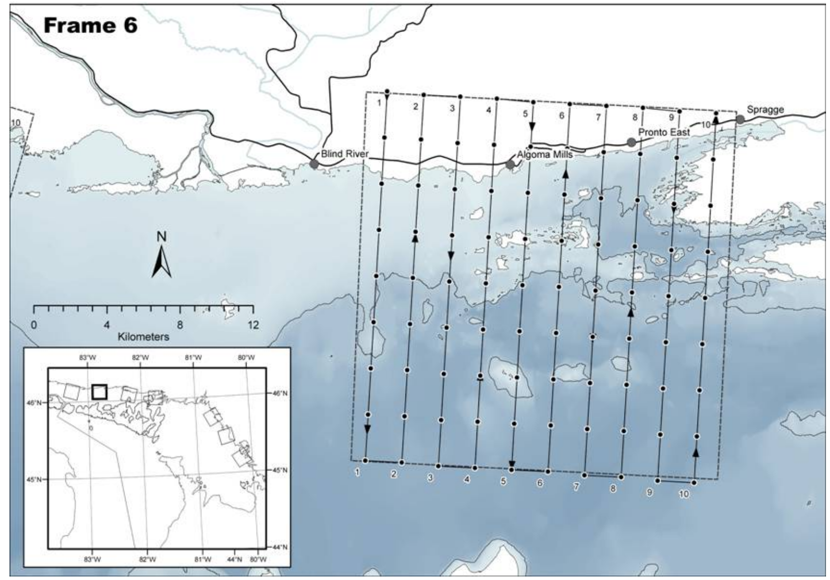
		Waypoint Latitude and Longitude (DD NAD83)								
Frame	**Transect**	**Inshore**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Offshore**
		46.24820	46.22595	46.20424	46.18253	46.16081	46.13911	46.11739	46.09568	46.07396
7	1	-83.38959	-83.39802	-83.40648	-83.41492	-83.42336	-83.43180	-83.44022	-83.44864	-83.45706
		46.24334	46.22110	46.19938	46.17768	46.15596	46.13426	46.11254	46.09083	46.06912
7	2	-83.36343	-83.37188	-83.38034	-83.38880	-83.39725	-83.40569	-83.41413	-83.42256	-83.43098
		46.23845	46.21621	46.19450	46.17280	46.15108	46.12938	46.10766	46.08596	46.06424
7	3	-83.33858	-83.34703	-83.35551	-83.36397	-83.37243	-83.38088	-83.38933	-83.39777	-83.40620
		46.23446	46.21132	46.18961	46.16791	46.14619	46.12449	46.10278	46.08107	46.05936
7	4	-83.31377	-83.32219	-83.33067	-83.33915	-83.34762	-83.35608	-83.36453	-83.37298	-83.38142
		46.22866	46.20732	46.18561	46.16391	46.14220	46.12050	46.09879	46.07708	46.05537
7	5	-83.28888	-83.29739	-83.30588	-83.31437	-83.32284	-83.33132	-83.33978	-83.34824	-83.35669
		46.22465	46.20242	46.18071	46.15901	46.13730	46.11560	46.09389	46.07219	46.05048
7	6	-83.26408	-83.27256	-83.28106	-83.28955	-83.29804	-83.30652	-83.31499	-83.32346	-83.33192
		46.21974	46.19751	46.17580	46.15410	46.13240	46.11070	46.08899	46.06729	46.04558
7	7	-83.23924	-83.24773	-83.25624	-83.26474	-83.27324	-83.28173	-83.29021	-83.29869	-83.30716
		46.21483	46.19262	46.17091	46.14922	46.12751	46.10582	46.08411	46.06241	46.04071
7	8	-83.21441	-83.22161	-83.23013	-83.23864	-83.24715	-83.25565	-83.26414	-83.27263	-83.28111
		46.20993	46.18770	46.16600	46.14430	46.12260	46.10090	46.07920	46.05750	46.03580
7	9	-83.18828	-83.19679	-83.20532	-83.21384	-83.22236	-83.23086	-83.23936	-83.24786	-83.25635
		46.20500	46.18367	46.16197	46.14028	46.11858	46.09688	46.07518	46.05349	46.03178
7	10	-83.16346	-83.17201	-83.18055	-83.18908	-83.19760	-83.20612	-83.21463	-83.22314	-83.23163

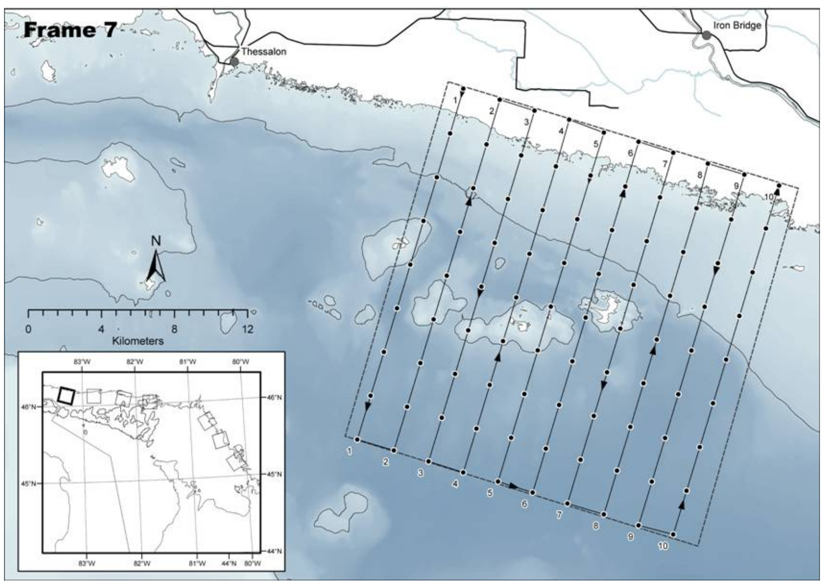
Appendix 3 Figure 1. Maps showing location of aerial survey transects relative to the study frame location (Frames 1-4)



Appendix 3 Figure 2. Maps showing location of aerial survey transects relative to the study frame location (Frames 5-7)





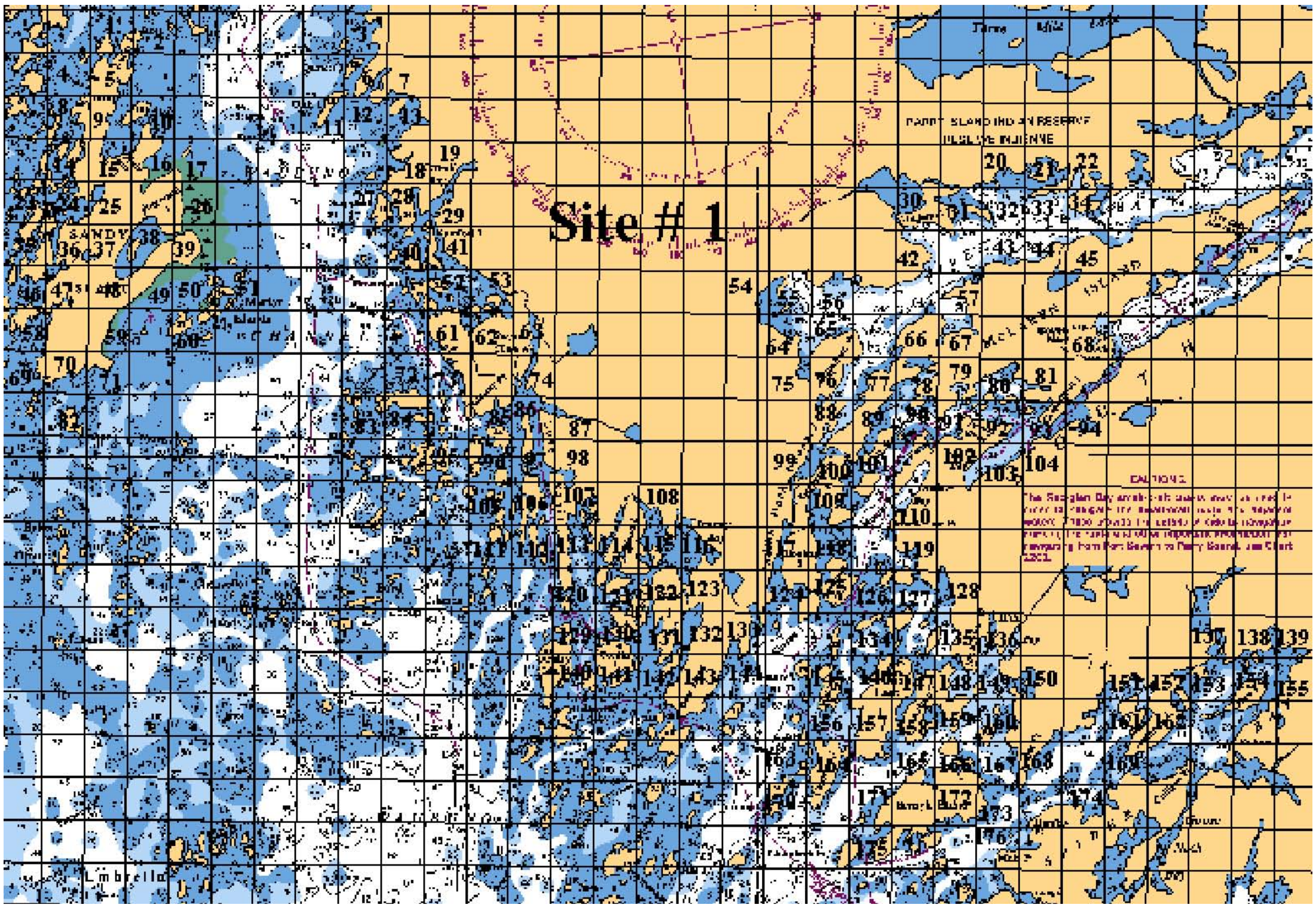


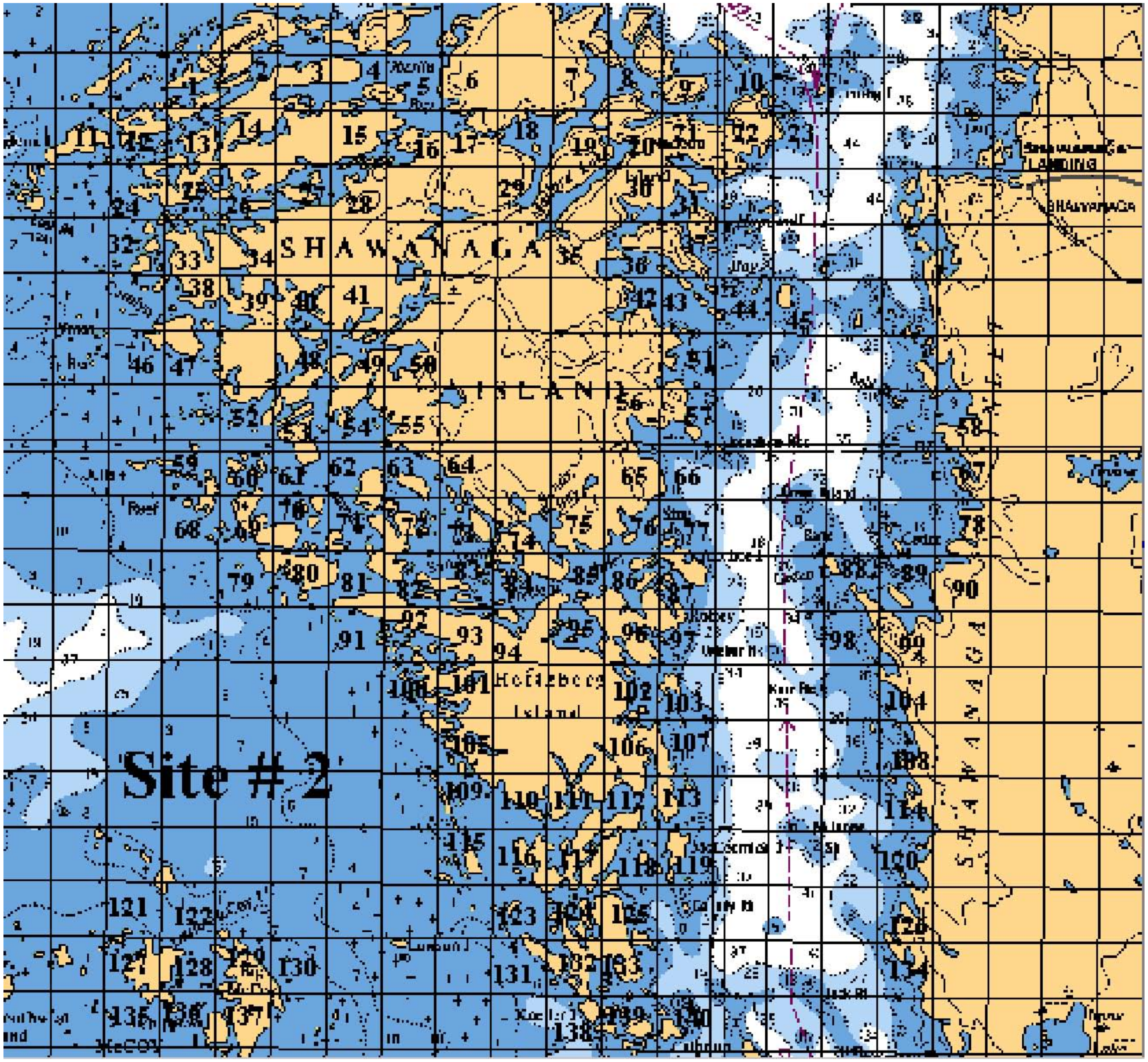
Ontario

Appendix 4:

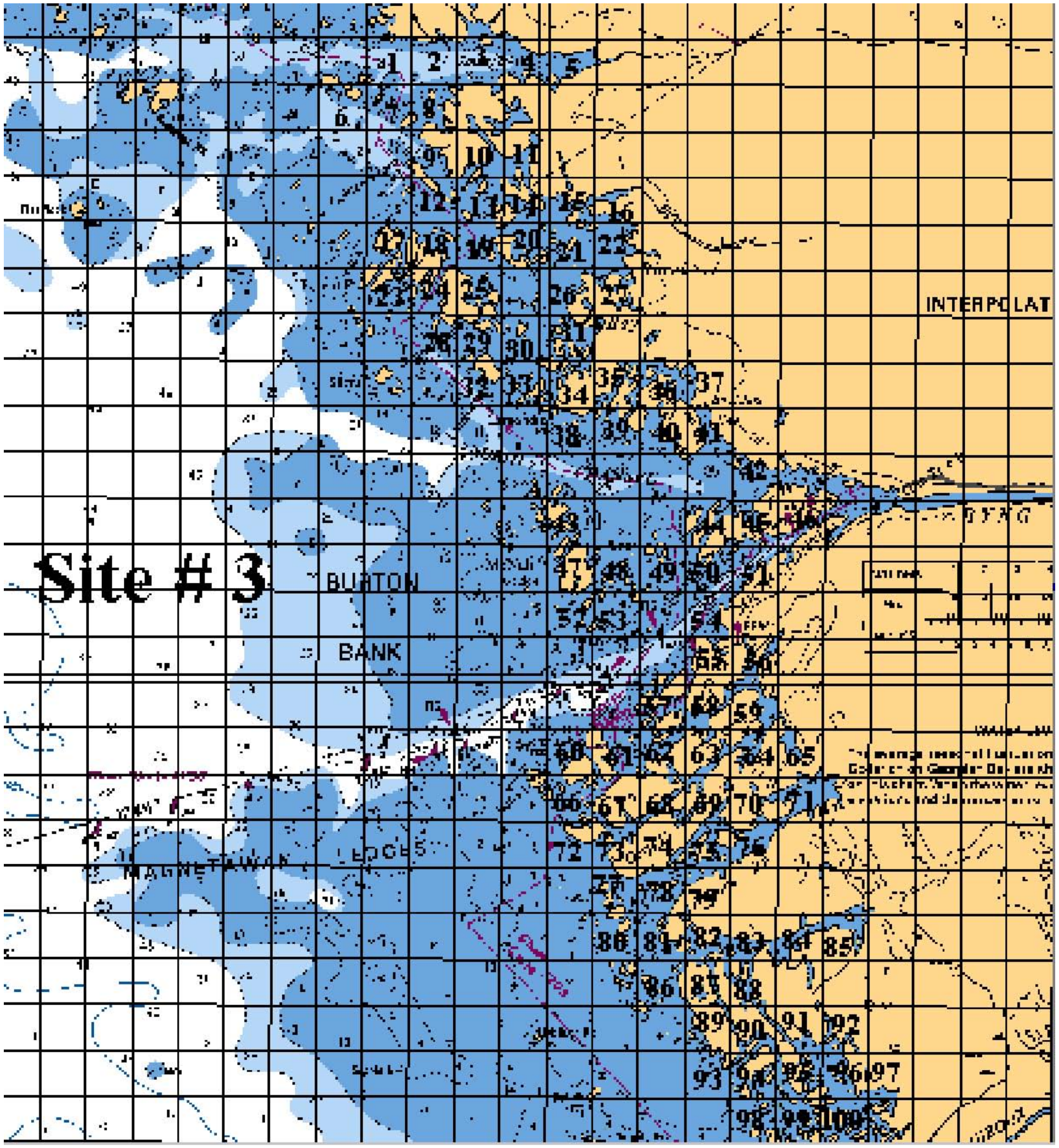
Maps of Nearshore Community Trapnet Index Netting random site selection grid

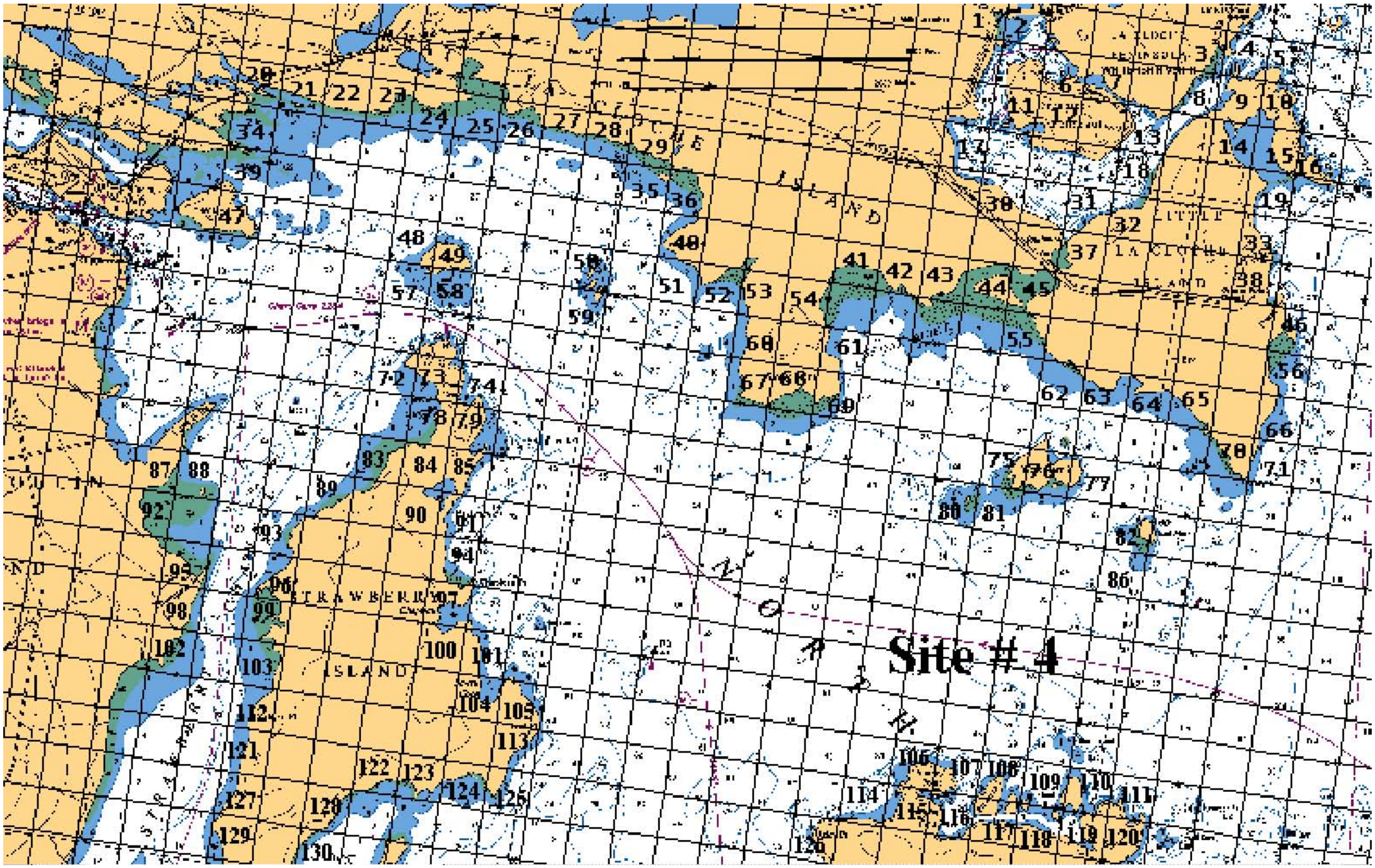
The following maps were used to randomly select the Nearshore Community Trap Net Index netting sites. Those 500m x 500m grids that intersect an accessible shoreline were assigned a site location number or "SILOC". Field crews randomly selected 15 to 30 SILOC grids for setting the nets before heading into the field.

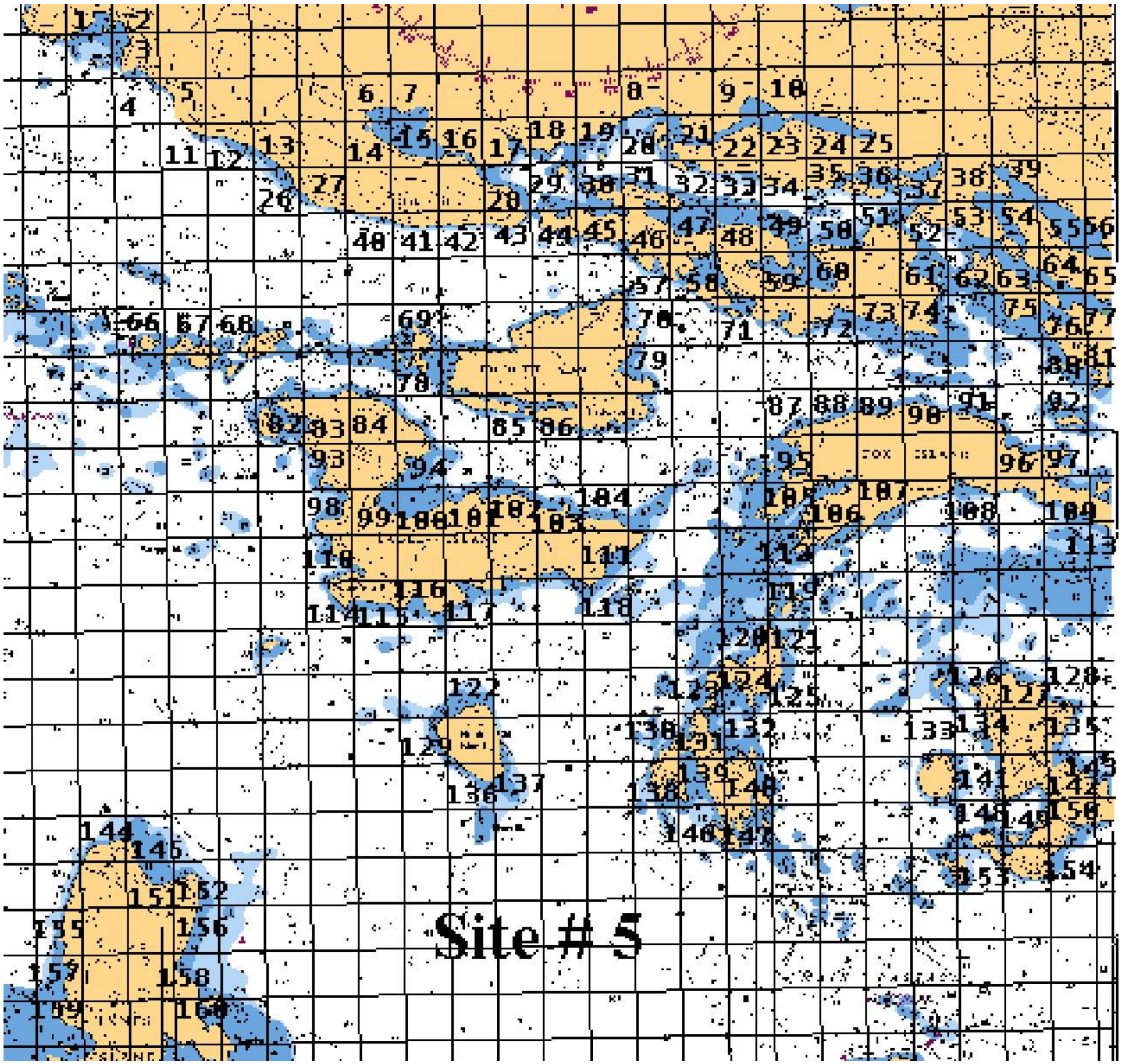


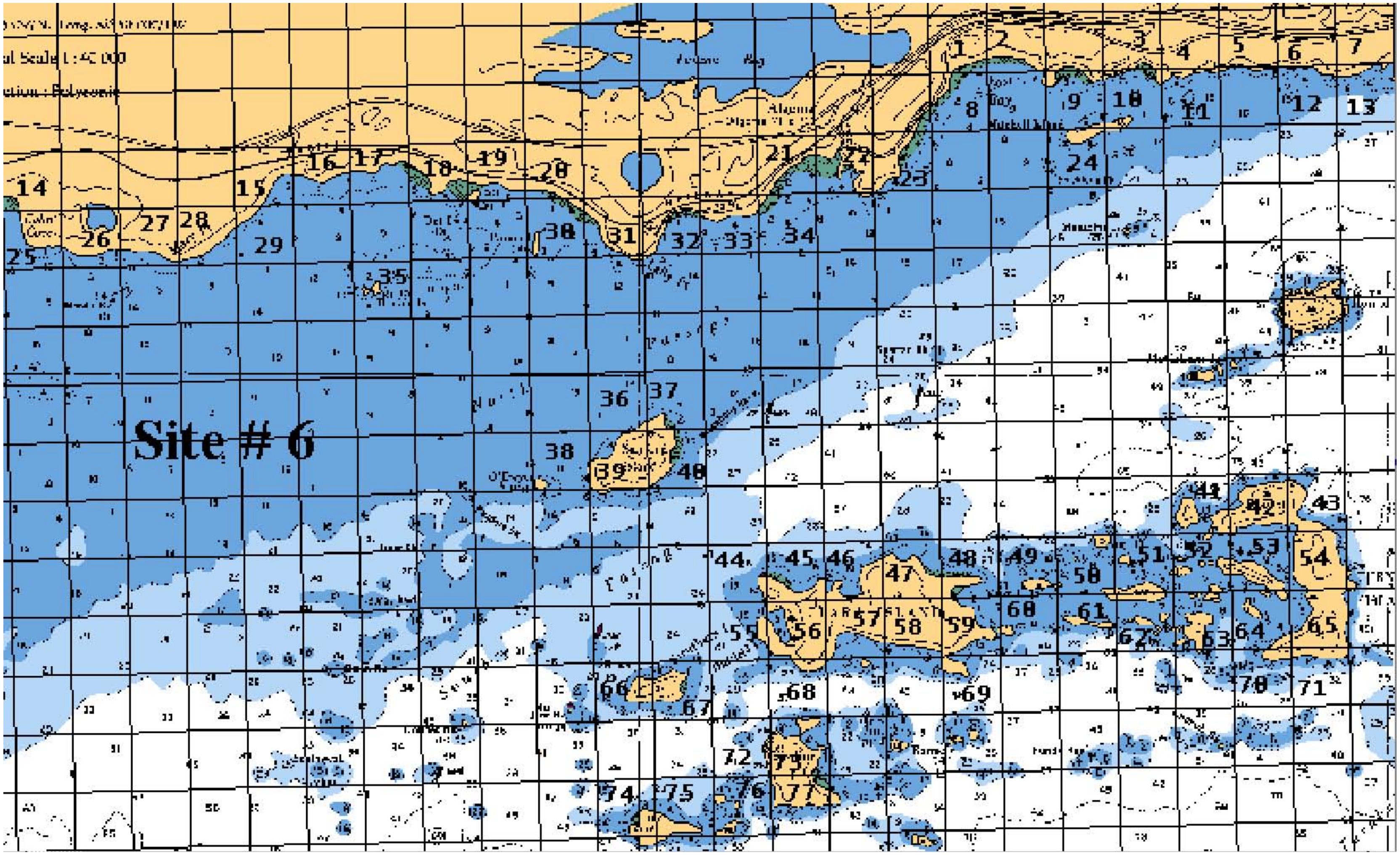


SHAWANAGA
INLAND
Site # 2
SHAWANAGA LANDING


Site # 3
BURTON
BANK
INTERPOLAT


Site # 4


Site # 5


Site # 6
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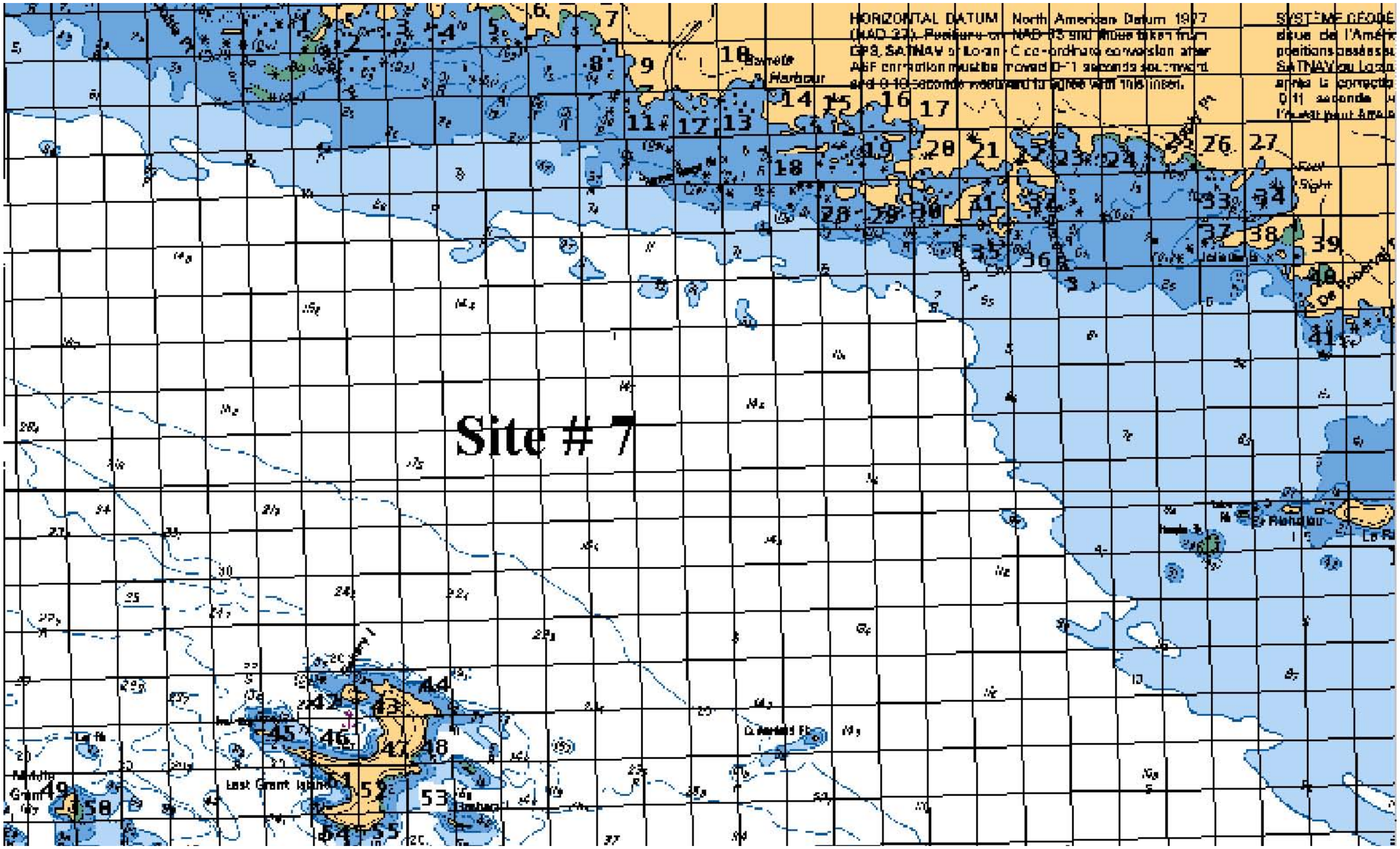

Site # 7

Appendix 5

Summary of the sample number, spatial location, random site selection grid number (SILOC), and effort duration by year and frame for 530 trap netting events in the program.

2000

Frame 1 (Sept. 28 - Oct. 1)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
101	13	45.27967	-80.12067	23.14
102	13	45.27700	-80.13934	23.59
103	46	45.26217	-80.13883	23.50
104	49	45.25867	-80.15933	23.68
105	94	45.23767	-80.13850	19.83
106	10	45.23167	-80.13100	19.74
107	12	45.21450	-80.13150	19.64
108	11	45.22033	-80.12200	19.75
109	87	45.23750	-80.15266	20.12
110	83	45.24434	-80.14433	20.07
111	64	45.25983	-80.12750	20.23
112	61	45.25033	-80.12483	20.43
			Total Set Duration (Hrs)	*253.72*
			n	*12*
			Mean Set Duration (Hrs)	*21.14*

Frame 2 (Sept. 20 - Sept. 27)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
201	7	45.52934	-80.42750	17.10
202	14	45.52517	-80.44150	17.27
203	29	45.51583	-80.41833	19.07
204	43	45.50417	-80.42017	19.28
205	12	45.52483	-80.41116	22.39
206	13	45.52117	-80.42150	22.29
207	44	45.49983	-80.42583	21.04
208	60	45.48817	-80.42783	21.10
209	10	45.50667	-80.39167	18.50
210	10	45.49917	-80.39233	18.98
211	10	45.48950	-80.39350	19.30
212	10	45.48750	-80.40117	19.52
213	81	45.46900	-80.42133	20.26
214	72	45.47650	-80.42316	20.54
215	70	45.48217	-80.42617	20.74
216	59	45.48883	-80.42067	20.99
			Total Set Duration (Hrs)	*318.37*
			n	*16*
			Mean Set Duration (Hrs)	*19.90*

2000

Frame 3 (Sept. 12 - Sept. 20)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
301	4	45.81033	-80.66500	23.94
302	94	45.81033	-80.66033	24.35
303	3	45.80783	-80.67416	24.88
304	14	45.79417	-80.67000	22.16
305	10	45.82000	-80.73250	20.76
306	10	45.82600	-80.73566	20.92
307	96	45.82700	-80.72000	21.18
308	22	45.78817	-80.67533	22.26
309	99	45.81733	-80.70983	20.54
310	10	45.81650	-80.69117	20.71
311	26	45.78083	-80.67167	20.26
312	34	45.76800	-80.63550	20.30
313	45	45.75400	-80.64083	21.97
314	52	45.74317	-80.64917	21.93
315	57	45.73550	-80.66133	22.00
316	44	45.76100	-80.64233	22.00
			Total Set Duration (Hrs)	*350.16*
			n	*16*
			Mean Set Duration (Hrs)	*21.89*

Frame 4 (Aug. 31 - Sept. 8)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
401	66	45.98483	-81.88766	21.64
402	86	45.96983	-81.86083	21.70
403	87	45.96250	-81.86117	21.55
405	99	45.94700	-81.87500	22.31
406	10	45.93917	-81.75166	16.78
407	11	45.93317	-81.75100	17.07
408	10	45.93783	-81.77033	17.23
409	96	45.95733	-81.84783	18.67
410	11	45.93267	-81.78183	21.71
411	12	45.92800	-81.84317	23.83
412	10	45.94033	-81.83867	22.20
413	84	45.96800	-81.85017	17.94
414	13	45.92484	-81.77734	21.30
415	11	45.93217	-81.77116	20.52
416	12	45.91800	-81.86300	18.56
417	10	45.93267	-81.87500	18.58
			Total Set Duration (Hrs)	*321.59*
			n	*16*
			Mean Set Duration (Hrs)	*20.10*

2000

Frame 5 (Aug. 15 - Aug. 30)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Dec. Deg. W NAD83)	Set Duration (Hrs)
501	83	46.12050	-82.31500	22.52
502	81	46.11783	-82.31450	22.71
503	76	46.10033	-82.29750	23.14
504	13	46.08433	-82.28467	23.75
505	72	46.10117	-82.27367	26.42
506	70	46.10750	-82.26633	26.58
507	87	46.11567	-82.24367	26.95
508	49	46.12800	-82.21033	27.98
509	55	46.12700	-82.24000	18.06
510	48	46.12867	-82.20100	17.86
511	46	46.13417	-82.20250	19.06
512	26	46.12283	-82.26800	20.35
513	42	46.13517	-82.23534	20.93
514	23	46.13733	-82.25367	21.28
515	26	46.14083	-82.26933	22.18
516	29	46.14183	-82.28800	22.87
			Total Set Duration (Hrs)	*362.64*
			n	*16*
			Mean Set Duration (Hrs)	*22.67*

Frame 6 (Aug. 10 - Aug. 14)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Dec. Deg. W NAD83)	Set Duration (Hrs)
601	20	46.17950	-82.91084	22.65
602	22	46.17717	-82.90350	23.42
603	38	46.15850	-82.83967	24.60
604	34	46.16217	-82.82850	25.09
605	23	46.17617	-82.89333	21.65
606	16	46.18050	-82.85683	22.43
607	41	46.15867	-82.82967	22.77
608	46	46.15067	-82.81667	22.88
609	33	46.17867	-82.82050	21.13
610	50	46.14600	-82.80917	22.03
611	10	46.18616	-82.80100	21.71
612	30	46.17550	-82.83250	22.31
613	61	46.13883	-82.81433	22.42
614	42	46.14967	-82.79650	22.71
615	1	46.19017	-82.79550	22.54
616	26	46.17750	-82.87717	22.45
			Total Set Duration (Hrs)	*362.79*
			n	*16*
			Mean Set Duration (Hrs)	*22.67*

2000

Frame 7 (July 31 - Aug. 5)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
701	16	46.19717	-83.17533	17.38
702	20	46.19517	-83.19167	17.19
703	23	46.19267	-83.20316	19.99
704	10	46.19367	-83.21067	20.21
705	3	46.20967	-83.26517	20.74
706	2	46.21217	-83.27000	20.93
707	22	46.19383	-83.21716	20.41
708	23	46.19584	-83.22050	20.48
709	1	46.21200	-83.27700	23.94
710	27	46.20900	-83.28183	24.56
711	8	46.19817	-83.22784	23.92
712	6	46.20083	-83.23833	24.24
713	4	46.20933	-83.25667	22.22
714	25	46.18983	-83.16467	21.63
715	17	46.19917	-83.18083	18.34
716	15	46.19550	-83.16933	18.89
			Total Set Duration (Hrs)	*335.07*
			n	*16*
			Mean Set Duration (Hrs)	*20.94*

2001

Frame 1 (Aug. 24 - Aug. 28)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
96	44	45.27500	-80.13617	22.67
97	61	45.25517	-80.15517	21.43
98	12	45.20383	-80.15166	17.66
99	12	45.20550	-80.13950	18.97
100	51	45.25683	-80.22117	22.56
101	10	45.22433	-80.15434	23.09
102	46	45.26217	-80.13883	24.27
103	67	45.25050	-80.12434	21.33
104	34	45.27050	-80.21350	23.37
105	74	45.25050	-80.20383	21.68
106	13	45.27733	-80.11650	22.82
107	18	45.28117	-80.21967	23.18
108	77	45.24133	-80.20050	23.10
109	13	45.22433	-80.17367	20.58
			Total Set Duration (Hrs)	*306.71*
			n	*14*
			Mean Set Duration (Hrs)	*21.91*

Frame 2 (Aug. 20 - Aug. 24)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
80	9	45.52667	-80.41683	23.56
81	15	45.52617	-80.45133	21.67
82	61	45.48750	-80.43833	19.26
83	98	45.45733	-80.39367	17.04
84	99	45.45167	-80.47000	23.50
85	52	45.49233	-80.45617	23.95
86	23	45.51883	-80.46917	23.68
87	12	45.52267	-80.41783	20.75
88	78	45.47117	-80.43633	22.41
89	67	45.48967	-80.46584	22.11
90	7	45.52900	-80.42717	22.36
91	10	45.50717	-80.39133	22.05
92	82	45.46633	-80.42150	24.19
93	73	45.47217	-80.42500	21.87
94	31	45.51233	-80.42700	21.94
95	56	45.49450	-80.42700	20.17
			Total Set Duration (Hrs)	*350.51*
			n	*16*
			Mean Set Duration (Hrs)	*21.91*

2001

Frame 3 (Aug. 10 - Aug. 14)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
63	45	45.75400	-80.64083	16.02
64	32	45.77234	-80.64384	21.11
65	26	45.78100	-80.67333	22.17
66	20	45.78500	-80.67783	22.73
67	62	45.73083	-80.64117	18.42
68	53	45.74350	-80.64933	19.06
69	14	45.79367	-80.67133	19.34
70	23	45.78517	-80.66317	19.20
71	76	45.70900	-80.63633	22.55
72	57	45.73983	-80.65800	22.56
73	8	45.80800	-80.69417	22.42
74	21	45.78483	-80.67067	22.95
75	56	45.74283	-80.65933	22.81
76	43	45.76083	-80.65067	22.32
77	4	45.81067	-80.66900	21.91
78	34	45.77000	-80.63633	21.31
			Total Set Duration (Hrs)	*336.88*
			n	*16*
			Mean Set Duration (Hrs)	*21.06*

Frame 4 (July 23 - July 28)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
33	14	46.00450	-81.73933	17.19
34	11	45.93533	-81.75350	18.43
35	36	45.98900	-81.82300	38.89
36	64	45.98117	-81.86050	41.19
37	76	45.97717	-81.73367	26.22
38	11	45.93184	-81.83450	24.69
39	57	45.98417	-81.79017	21.68
40	40	45.99283	-81.83317	21.68
41	11	45.93267	-81.78150	23.78
42	12	45.92600	-81.87517	20.96
43	89	45.96433	-81.75117	26.38
44	66	45.98533	-81.88800	21.61
45	97	45.94584	-81.84550	21.20
46	13	45.92450	-81.77983	22.25
47	94	45.94633	-81.87583	23.14
48	61	45.98267	-81.81983	20.85
			Total Set Duration (Hrs)	*390.14*
			n	*16*
			Mean Set Duration (Hrs)	*24.38*

2001

Frame 5 (July 28 - Aug. 10)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
49	32	46.15450	-82.33884	19.99
50	11	46.08050	-82.25000	17.93
51	48	46.12833	-82.20084	19.37
52	16	46.13717	-82.20367	20.69
53	60	46.12366	-82.29633	22.38
54	11	46.08133	-82.24850	20.57
55	20	46.14183	-82.23300	22.65
56	53	46.12767	-82.23967	21.16
57	12	46.08250	-82.26133	22.79
58	83	46.12033	-82.31500	20.83
59	18	46.14083	-82.21267	22.97
60	59	46.12450	-82.28767	23.50
61	70	46.10700	-82.26600	21.69
62	12	46.14683	-82.26017	21.71
			Total Set Duration (Hrs)	*298.23*
			n	*14*
			Mean Set Duration (Hrs)	*21.30*

Frame 6 (July 14 - July 18)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
16	26	46.17767	-82.87817	17.94
17	16	46.18200	-82.86600	19.12
18	13	46.18050	-82.81883	20.47
19	53	46.14500	-82.79733	20.54
20	50	46.14617	-82.80883	22.13
21	28	46.18117	-82.84800	22.38
22	33	46.17883	-82.82417	22.27
23	56	46.15450	-82.75967	22.30
24	62	46.13900	-82.81633	22.96
25	17	46.18017	-82.87450	23.23
26	31	46.17550	-82.83250	22.94
27	45	46.15017	-82.80867	23.07
28	58	46.15017	-82.75933	22.39
30	15	46.18250	-82.86234	24.39
31	6	46.18950	-82.78950	22.60
32	49	46.14800	-82.82000	18.72
			Total Set Duration (Hrs)	*347.45*
			n	*16*
			Mean Set Duration (Hrs)	*21.72*

2001
Frame 7 (July 9 - July 14)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
1	2	46.21200	-83.27750	19.43
2	4	46.21183	-83.26984	19.32
3	7	46.20950	-83.25684	22.16
4	9	46.19833	-83.22816	39.98
5	20	46.19267	-83.20133	21.87
6	14	46.19567	-83.16917	22.81
7	9	46.13800	-83.28083	41.15
8	31	46.14034	-83.27184	23.15
9	16	46.19217	-83.17067	27.29
10	11	46.19100	-83.21867	23.09
11	25	46.18700	-83.15500	24.75
12	40	46.13334	-83.33667	22.92
13	3	46.20883	-83.26083	21.56
14	27	46.18400	-83.14833	21.99
15	18	46.19817	-83.18467	21.40
			Total Set Duration (Hrs)	372.87
			n	*15*
			Mean Set Duration (Hrs)	*24.86*

2002

Frame 1 (Aug. 19 - Aug. 20)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
91	126	45.23717	-80.15317	23.61
92	147	45.22600	-80.14183	22.25
93	95	45.25100	-80.21450	20.62
94	9	45.28733	-80.22900	17.17
95	59	45.26033	-80.26250	18.08
96	53	45.26733	-80.20400	22.41
97	69	45.25817	-80.27600	22.45
98	116	45.23917	-80.17433	22.47
99	152	45.22317	-80.10733	24.14
100	134	45.23233	-80.15033	24.25
101	97	45.25033	-80.20367	24.28
102	129	45.23083	-80.19483	23.38
103	143	45.22450	-80.17416	22.95
104	171	45.21183	-80.15067	21.07
105	94	45.25600	-80.11550	21.50
			Total Set Duration (Hrs)	330.63
			n	*15*
			Mean Set Duration (Hrs)	*22.04*

Frame 2 (Aug. 8 - Aug. 11)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
76	21	45.52700	-80.41917	24.05
77	36	45.51567	-80.42850	22.44
78	67	45.50717	-80.39150	20.30
79	133	45.45683	-80.42700	17.79
80	124	45.46233	-80.43333	18.39
81	109	45.47300	-80.44450	23.96
82	116	45.46500	-80.43967	22.13
83	86	45.48800	-80.42650	23.59
84	19	45.52467	-80.43584	23.10
85	13	45.52683	-80.47767	22.83
86	102	45.48000	-80.42667	23.42
87	104	45.48000	-80.39600	22.44
88	56	45.50100	-80.42717	22.42
89	10	45.52950	-80.41133	22.50
90	4	45.52850	-80.45667	21.74
			Total Set Duration (Hrs)	331.10
			n	*15*
			Mean Set Duration (Hrs)	*22.07*

2002

Frame 3 (Aug. 5 - Aug. 8)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
61	8	45.80617	-80.68100	19.97
62	32	45.78000	-80.68750	20.27
63	41	45.77517	-80.64250	21.41
64	62	45.74350	-80.64950	21.81
65	66	45.73933	-80.65933	22.56
66	5	45.80933	-80.66000	22.10
67	31	45.78417	-80.67683	22.21
68	54	45.75400	-80.64017	21.70
69	94	45.70883	-80.63667	21.68
70	60	45.74250	-80.65950	21.98
71	12	45.79583	-80.67800	24.62
72	25	45.78883	-80.67433	24.53
73	42	45.76750	-80.63633	23.91
74	81	45.72283	-80.64767	19.57
75	53	45.75733	-80.65434	19.74
			Total Set Duration (Hrs)	*328.06*
			n	*15*
			Mean Set Duration (Hrs)	*21.87*

Frame 4 (July 29 - Aug. 1)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
46	74	45.96733	-81.85017	25.45
47	97	45.94617	-81.84566	22.72
48	104	45.93983	-81.83817	21.89
49	61	45.97900	-81.79933	20.02
50	66	45.97783	-81.73450	18.15
51	18	45.99783	-81.75816	25.18
52	107	45.93767	-81.77084	24.89
53	87	45.95500	-81.89034	24.81
54	26	45.99550	-81.84383	19.09
55	124	45.92750	-81.84534	21.70
56	36	45.98833	-81.82317	22.05
57	119	45.93350	-81.75017	21.39
58	109	45.93583	-81.75900	21.78
59	112	45.93350	-81.87300	20.90
60	96	45.94567	-81.87550	20.60
			Total Set Duration (Hrs)	*330.62*
			n	*15*
			Mean Set Duration (Hrs)	*22.04*

2002

Frame 5` (July 22 - July 25)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
31	3	46.15434	-82.33900	16.44
32	19	46.14483	-82.27367	21.03
33	88	46.11850	-82.23250	17.18
34	92	46.11983	-82.20433	17.94
35	55	46.13433	-82.20533	18.82
36	131	46.08484	-82.25833	22.65
37	86	46.11917	-82.27983	22.77
38	73	46.12767	-82.23417	24.45
39	63	46.13183	-82.21250	21.77
40	9	46.14533	-82.25600	23.29
41	104	46.10700	-82.26617	22.03
42	99	46.10883	-82.29984	20.47
43	58	46.13100	-82.25784	20.61
44	44	46.13766	-82.27734	21.15
			Total Set Duration (Hrs)	*290.60*
			n	*14*
			Mean Set Duration (Hrs)	*20.76*

Frame 6 (July 12 - July 15)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
16	28	46.17667	-82.88050	17.97
17	15	46.18033	-82.87500	18.73
18	21	46.18017	-82.81850	19.26
19	45	46.14983	-82.81600	20.01
20	48	46.14933	-82.79716	21.01
21	25	46.17567	-82.88633	23.14
22	18	46.18067	-82.85683	23.39
23	10	46.18550	-82.78450	23.72
24	77	46.13517	-82.81284	23.74
25	54	46.15400	-82.76033	23.61
26	40	46.16317	-82.83000	21.92
27	8	46.18717	-82.80016	19.93
28	46	46.15050	-82.80867	20.43
29	58	46.14567	-82.80634	19.60
30	52	46.15083	-82.76984	18.94
			Total Set Duration (Hrs)	*315.40*
			n	*15*
			Mean Set Duration (Hrs)	*21.03*

2002

Frame 7 (July 9 - July 12)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
1	54	46.13467	-83.28284	21.90
2	42	46.14700	-83.28267	22.48
3	8	46.20700	-83.25083	22.68
4	11	46.20233	-83.23317	23.28
5	25	46.19700	-83.17516	24.50
6	52	46.13883	-83.27834	23.05
7	47	46.14150	-83.28333	22.29
8	13	46.20117	-83.23016	23.20
9	28	46.19600	-83.21800	22.77
10	22	46.19567	-83.18767	22.59
11	4	46.21400	-83.27200	23.29
12	7	46.20950	-83.25350	23.37
13	18	46.19833	-83.22767	20.68
14	30	46.19316	-83.20650	21.35
15	37	46.19167	-83.16717	21.15
			Total Set Duration (Hrs)	*338.58*
			n	*15*
			Mean Set Duration (Hrs)	*22.57*

2003

Frame 1 (Aug. 13 - Aug. 16)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
91	98	45.24750	-80.19500	21.35
92	11	45.28567	-80.23000	22.13
93	10	45.28500	-80.25633	23.53
94	59	45.26067	-80.26217	24.33
95	70	45.25783	-80.27116	25.62
96	11	45.24417	-80.18200	17.87
97	12	45.23383	-80.18616	18.02
98	14	45.22433	-80.17367	18.92
99	17	45.21233	-80.15017	19.70
100	17	45.21450	-80.13133	20.02
101	13	45.23117	-80.12750	18.47
102	94	45.25134	-80.11517	17.35
103	89	45.25500	-80.14817	18.18
104	10	45.24767	-80.15884	18.60
105	64	45.25933	-80.15933	19.62
			Total Set Duration (Hrs)	*303.71*
			n	*15*
			Mean Set Duration (Hrs)	*20.25*

Frame 2 (Aug. 7 - Aug. 10)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
76	38	45.51300	-80.48067	21.18
77	52	45.50700	-80.47533	21.40
78	49	45.50783	-80.45883	22.02
79	84	45.48800	-80.43850	22.27
80	86	45.49083	-80.42800	22.70
81	11	45.47133	-80.42117	22.53
82	13	45.45417	-80.42700	21.15
83	10	45.46900	-80.39367	19.52
84	88	45.48750	-80.40117	17.77
85	67	45.49700	-80.39000	15.38
86	96	45.48466	-80.42500	16.77
87	56	45.50183	-80.42216	17.52
88	36	45.51517	-80.42850	18.42
89	10	45.52967	-80.41100	19.28
90	8	45.52867	-80.42550	19.63
			Total Set Duration (Hrs)	*297.54*
			n	*15*
			Mean Set Duration (Hrs)	*19.84*

2003

Frame 3 (July 25 - July 29)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
61	20	45.78850	-80.66833	21.08
62	10	45.79950	-80.67600	21.00
63	4	45.81033	-80.66517	21.10
64	2	45.81183	-80.67583	21.14
65	17	45.79417	-80.68716	21.35
66	62	45.74317	-80.64900	27.22
67	72	45.73567	-80.66167	25.98
68	76	45.73383	-80.63850	24.02
69	80	45.72433	-80.65350	21.98
70	98	45.70350	-80.63233	20.30
71	54	45.75417	-80.64083	17.78
72	47	45.76567	-80.66100	21.33
73	31	45.78550	-80.66350	19.78
74	35	45.77483	-80.65784	17.92
75	41	45.77167	-80.64300	16.32
			Total Set Duration (Hrs)	*318.30*
			n	*15*
			Mean Set Duration (Hrs)	*21.22*

Frame 4 (July 21 - July 24)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
46	61	45.97833	-81.79767	22.31
47	77	45.96850	-81.75950	23.27
48	66	45.97500	-81.73434	22.77
49	52	45.98267	-81.81683	17.18
50	40	45.98817	-81.82484	15.00
51	11	45.93650	-81.74450	16.17
52	10	45.93884	-81.77600	16.63
53	11	45.93100	-81.78217	17.37
54	11	45.93250	-81.83383	17.93
55	13	45.91683	-81.85384	18.30
56	10	45.94300	-81.84150	18.60
57	94	45.95133	-81.84866	18.93
58	74	45.96817	-81.85050	19.23
59	88	45.95500	-81.88683	20.04
60	95	45.94550	-81.87650	20.33
			Total Set Duration (Hrs)	*284.06*
			n	*15*
			Mean Set Duration (Hrs)	*18.94*

2003

Frame 5 (July 16 - July 19)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
31	95	46.11267	-82.24733	16.70
32	11	46.07750	-82.26600	16.78
33	94	46.11400	-82.29833	17.71
34	79	46.12267	-82.26817	18.21
35	45	46.13833	-82.27167	20.64
36	11	46.10150	-82.28983	19.50
37	13	46.08383	-82.28467	19.73
38	72	46.12333	-82.23983	20.28
39	76	46.12783	-82.21250	21.52
40	47	46.13683	-82.25567	23.05
41	65	46.12983	-82.20267	18.70
42	63	46.13283	-82.21484	19.56
43	61	46.12900	-82.22984	19.80
44	51	46.13517	-82.23500	19.49
45	30	46.14100	-82.26917	19.05
			Total Set Duration (Hrs)	*290.72*
			n	*15*
			Mean Set Duration (Hrs)	*19.38*

Frame 6 (July 7 - July 10)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
16	33	46.17850	-82.82200	19.33
17	22	46.18033	-82.80883	20.56
18	10	46.19000	-82.77734	20.64
19	5	46.19000	-82.76266	23.77
20	7	46.18983	-82.75250	24.30
21	37	46.16283	-82.82933	22.31
22	52	46.15150	-82.76950	16.21
23	54	46.15100	-82.76150	17.06
24	59	46.14817	-82.79533	17.53
25	19	46.18067	-82.85516	18.44
26	17	46.18233	-82.86266	17.14
27	15	46.17883	-82.87550	16.36
28	35	46.17317	-82.86500	15.64
29	28	46.17517	-82.88267	14.53
30	26	46.17633	-82.89833	13.73
			Total Set Duration (Hrs)	*277.55*
			n	*15*
			Mean Set Duration (Hrs)	*18.50*

2003

Frame 7 (July 3 - July 7)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
1	26	46.19633	-83.17017	28.00
2	18	46.19683	-83.21600	29.55
3	19	46.19667	-83.20766	27.94
4	8	46.20550	-83.25134	29.76
5	42	46.14867	-83.28900	20.91
6	52	46.13900	-83.27883	27.49
7	38	46.18983	-83.16433	18.39
8	3	46.20900	-83.28067	17.69
9	35	46.19283	-83.20100	21.81
10	6	46.20850	-83.26000	23.00
11	13	46.19867	-83.23050	19.52
12	48	46.14517	-83.27467	23.41
13	29	46.19367	-83.21516	22.24
14	47	46.14233	-83.28300	19.64
15	49	46.13483	-83.34400	19.48
			Total Set Duration (Hrs)	*348.83*
			n	*15*
			Mean Set Duration (Hrs)	*23.26*

2004

Frame 1 (Aug. 16 - Aug. 19)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
91	70	45.25767	-80.27100	18.77
92	16	45.28300	-80.25500	19.75
93	6	45.28750	-80.22633	21.03
94	13	45.28483	-80.21967	22.10
95	41	45.27067	-80.21150	22.53
96	85	45.24800	-80.20367	15.67
97	108	45.24400	-80.18200	16.08
98	143	45.22417	-80.17384	16.92
99	123	45.23317	-80.17567	17.85
100	94	45.25300	-80.11533	20.67
101	167	45.21350	-80.13017	19.18
102	137	45.23150	-80.09983	19.48
103	150	45.22483	-80.12683	20.25
104	100	45.24933	-80.15733	19.60
105	75	45.25883	-80.15950	20.57
			Total Set Duration (Hrs)	*290.45*
			n	*15*
			Mean Set Duration (Hrs)	*19.36*

Frame 2 (Aug. 7 - Aug. 10)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
76	7	45.53000	-80.43150	22.20
77	4	45.52934	-80.45917	22.90
78	16	45.52667	-80.45000	23.12
79	38	45.51383	-80.48000	23.58
80	70	45.49567	-80.46767	24.05
81	84	45.48750	-80.43900	17.92
82	75	45.49133	-80.43183	20.52
83	113	45.47100	-80.42133	20.97
84	118	45.46600	-80.42617	21.37
85	84	45.46050	-80.43733	21.68
86	57	45.50100	-80.42267	20.47
87	87	45.48850	-80.42133	22.08
88	104	45.47833	-80.39550	20.95
89	58	45.50267	-80.39133	22.60
90	10	45.52917	-80.41183	23.50
			Total Set Duration (Hrs)	*327.91*
			n	*15*
			Mean Set Duration (Hrs)	*21.86*

2004

Frame 3 (Aug. 3 - Aug. 6)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
61	29	45.78467	-80.67783	18.35
62	3	45.81183	-80.67583	18.30
63	5	45.81033	-80.66500	19.18
64	16	45.79450	-80.65800	19.65
65	14	45.79617	-80.66500	20.68
66	56	45.75050	-80.63683	23.82
67	64	45.74333	-80.63750	21.22
68	76	45.73450	-80.63700	17.85
69	84	45.72317	-80.63267	15.75
70	99	45.70467	-80.62466	12.72
71	54	45.75417	-80.64133	14.32
72	44	45.76617	-80.64050	14.90
73	39	45.77450	-80.65816	15.48
74	33	45.78033	-80.66967	15.98
75	26	45.78550	-80.66383	16.58
			Total Set Duration (Hrs)	*264.78*
			n	*15*
			Mean Set Duration (Hrs)	*17.65*

Frame 4 (July 23 - July 26)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
46	77	45.96867	-81.76033	22.53
47	56	45.98200	-81.73250	22.52
48	120	45.93517	-81.74416	23.73
49	119	45.93567	-81.75283	23.55
50	114	45.89917	-81.78133	25.53
51	105	45.93500	-81.83134	15.82
52	97	45.94584	-81.84467	16.43
53	91	45.95567	-81.84900	17.03
54	79	45.96684	-81.84700	18.02
55	88	45.95500	-81.88617	18.48
56	47	45.97950	-81.89083	16.37
57	36	45.98817	-81.82433	18.28
58	52	45.98250	-81.81800	19.77
59	67	45.97517	-81.81284	20.57
60	61	45.97817	-81.79733	22.37
			Total Set Duration (Hrs)	*301.00*
			n	*15*
			Mean Set Duration (Hrs)	*20.07*

2004

Frame 5 (July 19 - July 22)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
31	58	46.13217	-82.25517	16.72
32	29	46.13817	-82.27734	18.63
33	31	46.13867	-82.26133	19.28
34	51	46.13483	-82.23967	20.17
35	21	46.14850	-82.26583	22.17
36	48	46.13700	-82.24950	18.32
37	28	46.14517	-82.27333	16.90
38	79	46.12250	-82.26867	18.50
39	101	46.10733	-82.30200	18.60
40	70	46.12300	-82.29716	19.90
41	113	46.10717	-82.20333	24.73
42	81	46.10700	-82.20333	26.17
43	68	46.12500	-82.32484	23.35
44	159	43.06150	-82.34750	15.40
45	160	46.06217	-82.32767	16.80
			Total Set Duration (Hrs)	*295.64*
			n	*15*
			Mean Set Duration (Hrs)	*19.71*

Frame 6 (July 9 - July 12)

Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
16	38	46.16083	-82.83850	16.03
17	33	46.17850	-82.82034	18.43
18	19	46.18000	-82.85100	22.25
19	16	46.18167	-82.86550	22.70
20	29	46.17717	-82.87833	22.87
21	44	46.17517	-82.86750	26.77
22	31	46.17550	-82.83550	17.80
23	25	46.17650	-82.90217	13.12
24	22	46.18150	-82.80450	14.87
25	11	46.19067	-82.76717	15.58
26	43	46.15783	-82.76366	19.63
27	65	46.14083	-82.76000	20.22
28	59	46.14667	-82.77600	22.72
29	57	46.14617	-82.80883	23.52
30	73	46.13567	-82.81367	24.10
			Total Set Duration (Hrs)	*300.61*
			n	*15*
			Mean Set Duration (Hrs)	*20.04*

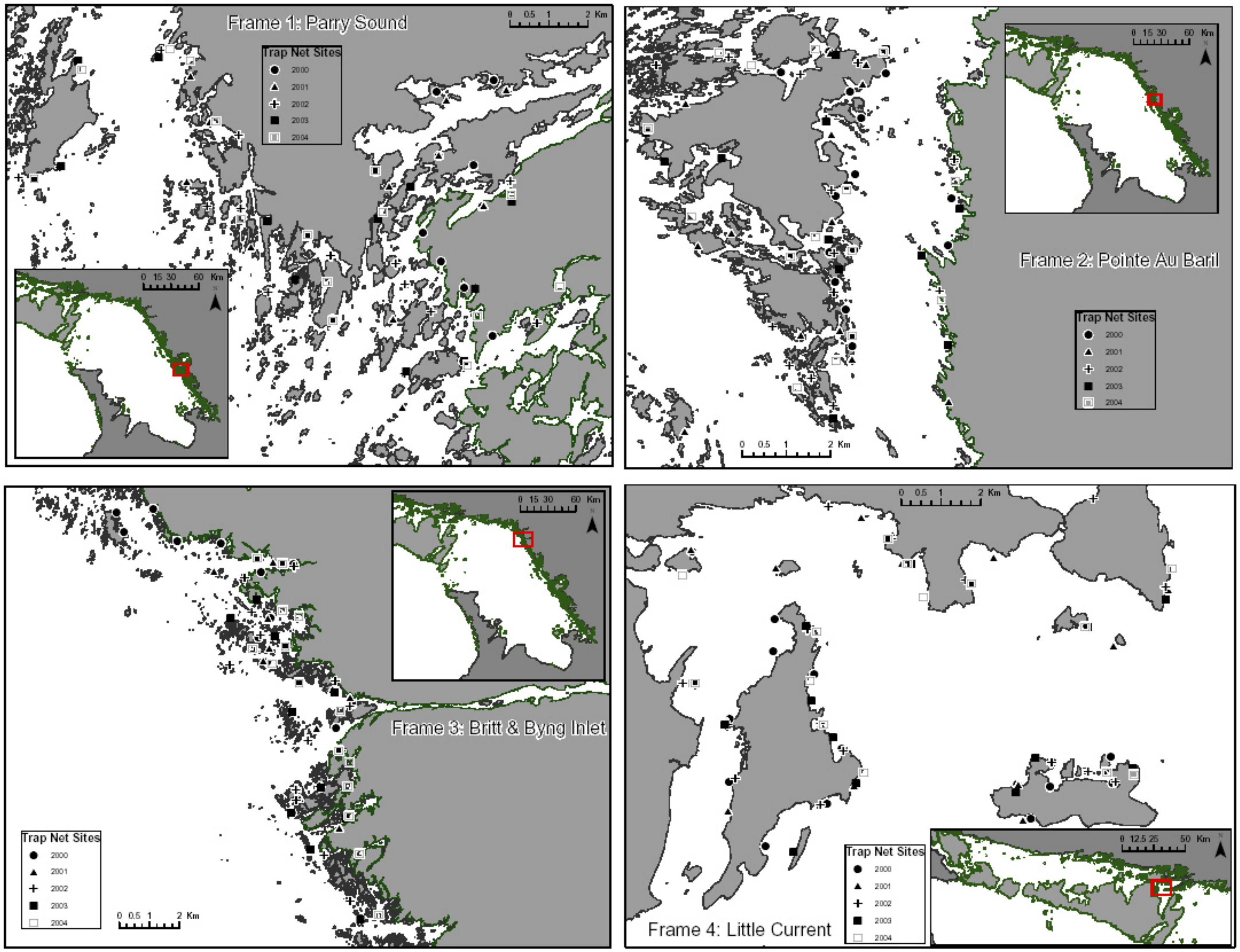
2004

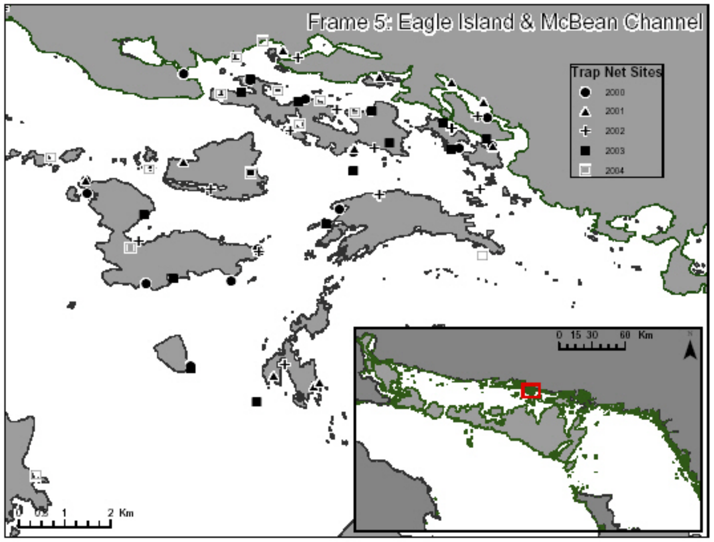
Frame 7 (July 6 - July 9)

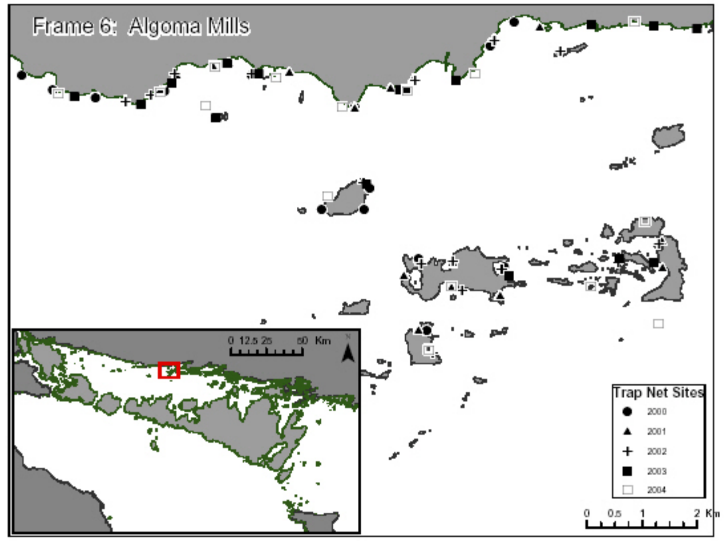
Sample Number	Random Sample Grid	Latitude (Deg. N NAD83)	Longitude (Deg. W NAD83)	Set Duration (Hrs)
1	47	46.14217	-83.28300	22.35
2	51	46.13833	-83.28683	22.08
3	37	46.18833	-83.17450	24.27
4	40	46.18600	-83.15567	24.85
5	26	46.19550	-83.16983	22.15
6	53	46.13933	-83.27683	20.80
7	22	46.19500	-83.19083	21.40
8	29	46.19383	-83.21484	19.85
9	14	46.20133	-83.22784	20.00
10	12	46.20217	-83.24700	20.28
11	42	46.14900	-83.28900	22.87
12	24	46.19750	-83.17516	22.48
13	9	46.20383	-83.24866	19.40
14	6	46.20933	-83.25716	19.42
15	4	46.21117	-83.27517	20.58
			Total Set Duration (Hrs)	*322.78*
			n	*15*
			Mean Set Duration (Hrs)	*21.52*

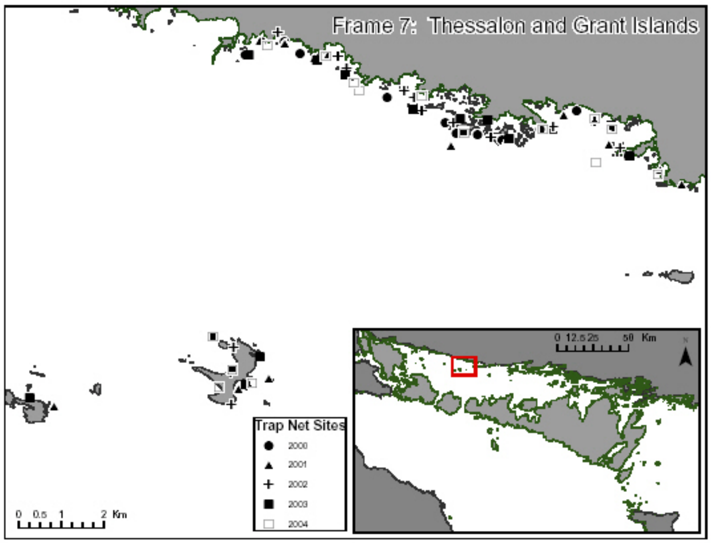
Appendix 6.

Maps showing the locations of all trap net sets relative to the Lake Huron shoreline. Each figure shows the spatial extent of each frame (approximately 20km x 20km).


Frame 1: Parry Sound
Trap Net Sites
2000
2001
2002
2003
2004
Frame 2: Pointe Au Baril
Frame 3: Britt & Byng Inlet
Frame 4: Little Current
0 0.5 1 2 Km
0 15 30 60 Km


Frame 5: Eagle Island & McBean Channel
Trap Net Sites
2000
2001
2002
2003
2004
0 0.5 1 2 Km
0 15 30 60 Km


Frame 6: Algoma Mills
Trap Net Sites
2000
2001
2002
2003
2004
0 0.5 1 2 Km
0 12.5 25 50 Km


Frame 7: Thessalon and Grant Islands
Trap Net Sites
2000
2001
2002
2003
2004
0 0.5 1 2 Km
0 12.5 25 50 Km

Appendix 7.

Data dictionary for Nearshore Community Trap Net Index Program 2000-2004.

Appendix 7. Table 1. Field names used in Nearshore Community Trap Net Index Program 2000-2004

EFFDTO	Ctrl-D for Current Date
FRM or SITE	Frame (1-7)
SILOC	Random Grid Number
SAM	Sample Number
SUB_1	Substrate Type
SUB_2	% Composition (Total for SAM =100)

FN121-Effort Data

SAM	Carried
SILOC	Carried
XLEADUSE	150
GRDEP	Bottom depth at Gap
LAT	Degrees Decimal Minutes WGS84
LONG	Degrees Decimal Minutes WGS84
EFFDT0	Date Set - CTRL D for current time
EFFTM0	Time Set-CTRL T for current time.
EFFDT1	Date Lift - CTRL D for current time
EFFTM1	Time Lift-CTRL T for current time.
SITP	F2 to see lookup
EFFST	"1" = Good, "2"=Compromised
AIRTEM1	Air Temperature (^{o}C)
SITEM1	Surface Water Temperature (^{o}C)
WIND	Direction-Knots on lift
CLOUD_PC	% Cloud Cover on lift
PRECIP	F2 to see lookup

SAM	Carried
FRM or SITE	Carried
SPC	F2 to see lookup
CATCNT	Total Catch
RCPCNT	Number of NODC Fish

FN125 - Biological Sampling

SAM	Carried
FRM	Carried
SPC	Species
FISH	AutoNumber
NODA	Applied Lower Caudal=A
NODC	Capture Lower Caudal=A
RWT	Round Weight (g)
FLEN	Fork Length (mm)
TLEN	Total Length (mm)
AGEST	1=Scales, D=Operculum
TAGID	
TAGDOC	
TAGSTAT	
Comment5	Slash marks, Lamprey, etc

Appendix 7 Table 2: Field Descriptions - A glossary of field names with a description of the associated definitions and coding. Most field definitions are directly from the OMNR FISHNET Data Dictionary however other "User Defined" fields are also included.

Table: FN121

Field Name	Field Description and Definition
YEAR	Year the project was conducted.
PRJ_CD	Project Code - A code assigned to a fisheries project by the unit (office) conducting the work.
SAM	Sample Id - A code that uniquely identifies a fishing sample or trap net lift.
SITE	Site Id or frame number (1 to 7)
SILOC	Site Location - Random site selection grid (500m x 500m) number from random selection map.
GRID	Grid Code - Equivalent UGLMU 5^{o} commercial fishing grid. See the "LOCATION" table in LookUp_Tables. mdb
AREA	Area Id - User-assigned ID for an arbitrarily defined (surface) area of a waterbody (e.g. major basin). One of several fields that may be used to identify spatial strata. Standard "Assessment Area" used by the UGLMU office. See the "LOCATION" table in LookUp_Tables. mdb
EFF	Effort Id - Identifies an effort unit within a sampling occasion. Its use varies depending on the context.
GR	Gear Id - TP04 = UGLMU standard 6ft Trap Net
GRDEP	Gear Depth (m) - The depth (in metres) at which the bottom of the gear was set. This field can apply to fishing gear, water sampling gear, benthic samplers, etc.
XLEADUSE	Length of leader (TP) - Added for Arunas Liskauskas - Walleye Trapnet studies. Field required by NSCIN protocol. [Harry 30-JUN-1998]
DD_LAT	Latitude - GPS Coordinate North. Format is in Decimal Degrees for plotting in GIS
DD_LON	Longitude - GPS Coordinate West. Format is in Decimal Degrees for plotting in GIS
XY_TYPE	GPS or UTM coordinate type - DDM = Degree Decimal Minutes, DD = Decimal Degrees
LAT	Latitude - GPS Coordinate North. See XY_Type for format
LON	Longitude - GPS Coordinate West. See XY_Type for format
LATLONG	Latitude-Longitude - Datalogger field. Requires XY_Type to interpret.
LATDD	Latitude - GPS Coordinate North. Format is in Decimal Degrees for plotting in GIS. Same as DD_LAT
LONDD	Longitude - GPS Coordinate West. Format is in Decimal Degrees for plotting in GIS. Same as DD_LON
EFFDT0	Effort Start Date - The date when a fishing effort begins.
EFFTM0	Effort Start Time - The time when a fishing effort begins. In this case, time the trap net was set.
EFFDT1	Effort End Date - The date when a fishing effort ends. The date of which the trap net was lifted.
EFFTM1	Effort End Time - The time when a fishing effort ends. In this case, time the trap net was lifted.
EFFDUR	Effort Duration (hr) - The duration (in hours) of a fishing episode. That is, the temporal dimension of effort.
SITP	Site Type - A user-assigned code that classifies sites into different types. Also see the SUBSTRATE table. The codes are as follows; 1 = Gravel/Pebble/Sand Mix, 2 = Boulder/Rubble/Cobble Mix, 3 = Sand, 4 = Soft Mix, 5 = Bedrock, 6 = Other.

EFFST	Effort Status - An element used in index fishing surveys to flag sampling occasions when fishing success may have been compromised by problems with the gear or how it was set. A code of '1' implies a "good" effort.
AIRTEM1	Air Temperature - Air temperature (in degrees Celsius) at the sampling site at the time when fishing ends.
SITEM1	Site Temperature - Surface water temperature (in degrees Celsius) at the sampling site at EFFTM1 (i.e. lift time).
WIND	Wind Direction SpeedWind direction expressed in degrees and wind speed in knots.
CLOUD_PC	Cloud Cover Percent - Cloud cover, expressed as a percent.
PRECIP	Precipitation - The type of precipitation, fog or mist at the time of fishing; 00=none, 65=heavy rain, 10=mist, 71=light snow, 40=fog, 75=heavy snow, 50=Drizzle, 60 = Rain, 95=Thunderstorm
COMMENT1	Comments- Various comments from the field crew

Table: Substrate

Field Name	Field Description and Definition
YEAR	Year the project was conducted.
PRJ_CD	Project Code - A code assigned to a fisheries project by the unit (office) conducting the work.
SAM	Sample Id - A code that uniquely identifies a fishing sample or trap net lift.
BOT_1	Bottom substrate classification - BO=Boulder, BR=Bedrock, CL=Clay, DE=Detritus, GP=Gravel/Pebble, MA=Marl, MU=Muck, RC=Rubble/Cobble, SA=Sand, SI=Silt
BOT_2	Percent bottom substrate composition - Value to describe the proportion of each substrate type. One SAM may have more than one entry but all values should sum to 100.

Table: FN123

Field Name	Field Description and Definition
YEAR	Year the project was conducted.
PRJ_CD	Project Code - A code assigned to a fisheries project by the unit (office) conducting the work.
SAM	Sample Id - A code that uniquely identifies a fishing sample or trap net lift.
SPC	Species Code - A code identifying species (or other taxonomic grouping) for a fish. See SPC table in LookUp_Tables.mdb
CATCNT	Catch Count (#) - The observed number of fish caught.
RCPCNT	Recapture Count - The number of fish recaptured (i.e. caught and observed with a particular mark).
BIOCNT	Biosample Count - The number of fish biosampled. Biosampling is defined as sampling attributes other than size.
RLSCNT	Release Count - The number of fish released alive.
KILCNT	Kill Count - The number of fish killed.

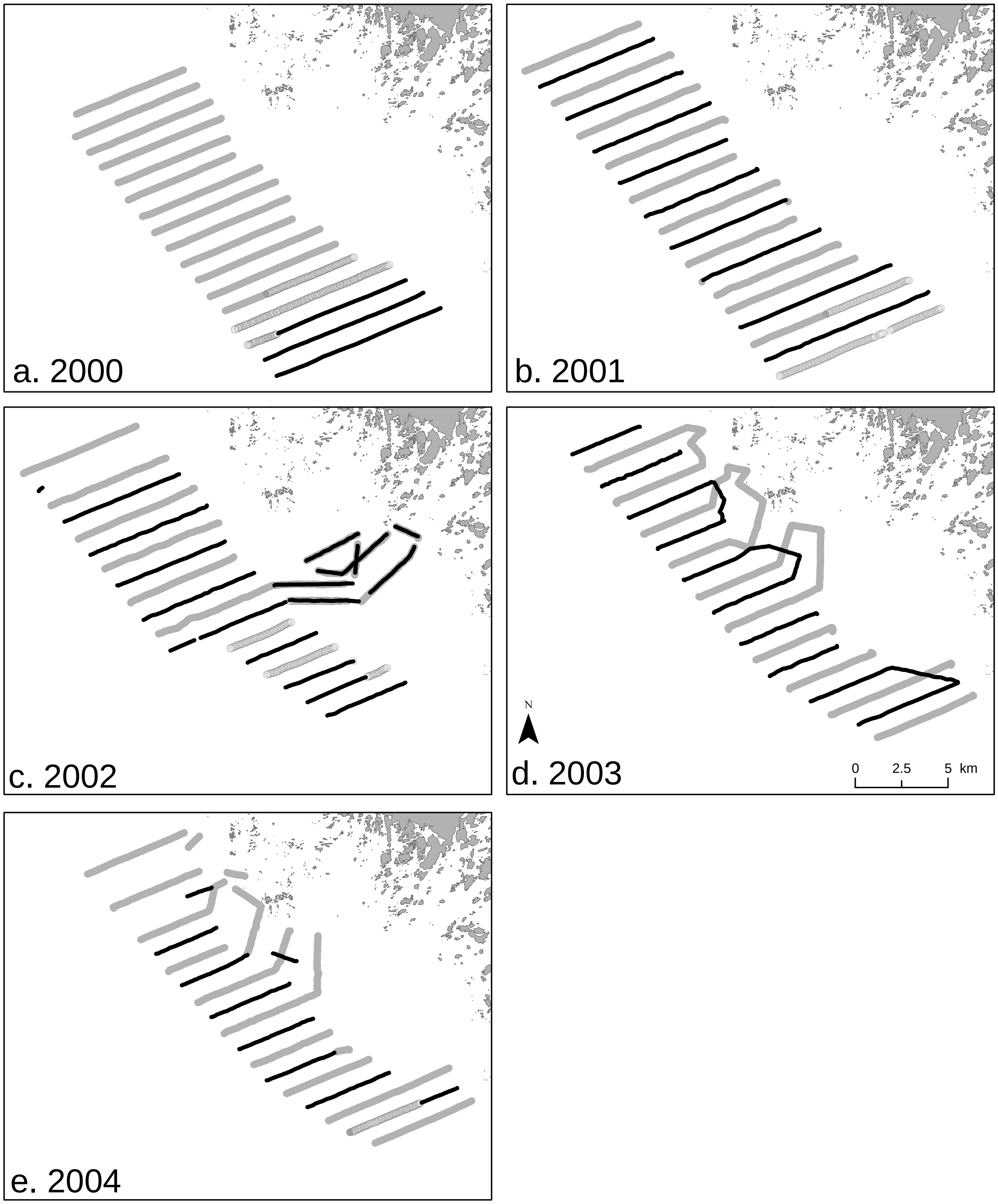
Table: FN125

Field Name	Field Description and Definition
PRJ_CD	Project Code - A code assigned to a fisheries project by the unit (office) conducting the work.
YEAR	Year the project was conducted.
SAM	Sample Id - A code that uniquely identifies a fishing sample or trap net lift.

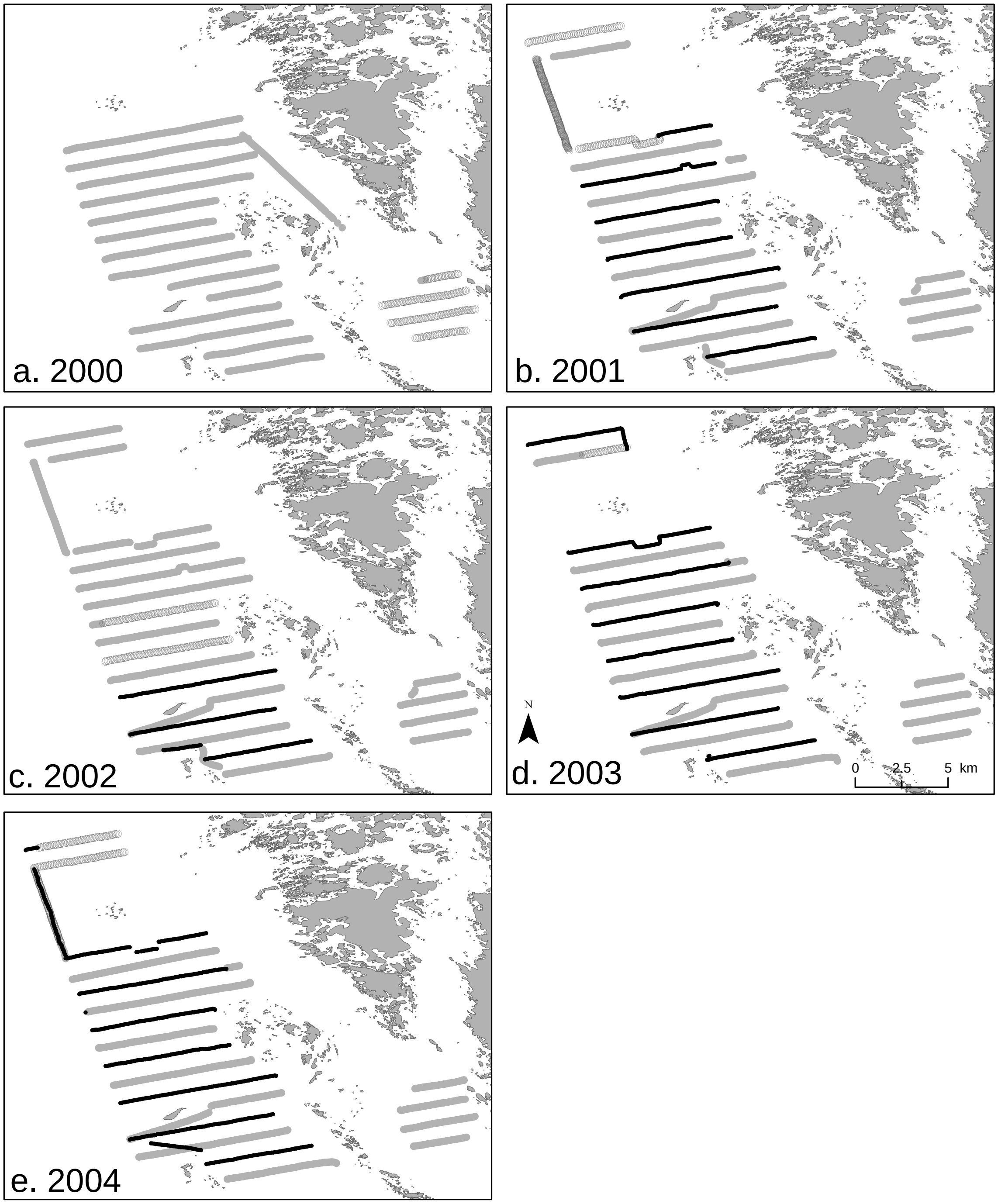
SPC	Species Code - A code identifying species (or other taxonomic grouping) for a fish. See SPC table in LookUp_Tables.mdb
EFF	Effort Id - Identifies an effort unit within a sampling occasion. Its use varies depending on the context.
GRP	Group Id - User-assigned code used in conjunction with SPC to identify groups of fish within a species that are sampled independently. All fish in the project are defined as GRP="00"
FISH	Fish Id - A serial number or other code assigned to an individual fish for identification purposes. When combined with other primary key fields in the FISH file, this element must uniquely identify a FISH record.
AGE	Fish Age (yr) - Calendar age (in years) assigned to a fish, based on the method documented by XAGEM
XAGEM	Age Assigned Method - A two digit code which identifies how an age is assigned to each biological sample. The first digit represents the individual who assigned the age and the second digit represents how the age was obtained. First digit D - Janet Sheridan (contractor), Second digit blank - no age was sought for this species, 0 - attempted to age, but was unsuccessful, 1 - scale, B - Operculae.
AGEST	Age Structures Sampled - Code listing calcified structures collected for the purpose of age determination. As many as 4 structures may be listed. 0 = No structure sampled, 1 = Scale, and B=Operculae
CONF	Confidence - The degree of certainty associated with interpretation of age from a calcified structure. Ranges from 1 (very uncertain) to 9 (certain).
CLIPC	Clips on Capture - Code the locations of up to 5 clips observed on capture (i.e. pre-existing clips). : No data, 0: No clip, 1: Right Pectoral, 2: Left Pectoral, 3: Right Pelvic, 4: Left Pelvic, 5: Adipose, 6: Anal
NODA	Nodules Applied -Identifies a nodule (punch) pattern applied to a fish on capture. See NODC for the coding scheme.
NODC	Nodules on Capture - Identifies a nodule or punch pattern observed on capture (i.e. pre-existing nodules).
FLEN	Fork Length- The fork length (in millimetres) of a fish, measured from the tip of the snout to the fork in the caudal fin.
FLEN_25MM_BIN	Grouping assigned to record based on observed FLEN. Used for creating histograms in Grapher.
LIFESTAGE	Lifestage assigned to individual based on FLEN. See table "TL_LIFESTAGE".
TLEN	Total Length (mm) - The total length (in millimetres) of a fish, as measured from the tip of the snout to the furthest extremity of the caudal fin.
RWT	Round Weight (g) - The round weight (in grams) of a fish.
XLAM	Lamprey Marks - Lamprey mark code for sampled fish. Four digit code convention is 1234 where: 1 = total no. of wounds, 2 = total no. of scars, 3 = no. of large wounds (>=25 mm in diameter), 4 = no. of small wounds (<25 mm in diameter).
TAGID	Tag Identification - The serial number recorded on a fish tag. Its status (Applied or Captured) is indicated using TAGSTAT.
TAGDOC	Tag Documentation - Describes the tagging device in place on a fish, identifying its type, position, origin, and colour. 25012 = Tube Vinyl, Flesh of Back, OMNR, Yellow
TAGSTAT	Tag Status - Indicates whether a tag existed on 'C'apture or was 'A'pplied.
GROUP	
FATE	Fish Fate Code - First character is a code indicating whether a fish was killed or released. K=Killed, R=Released Alive
Comment5	Comments- Various comments from the field crew

Appendix 8

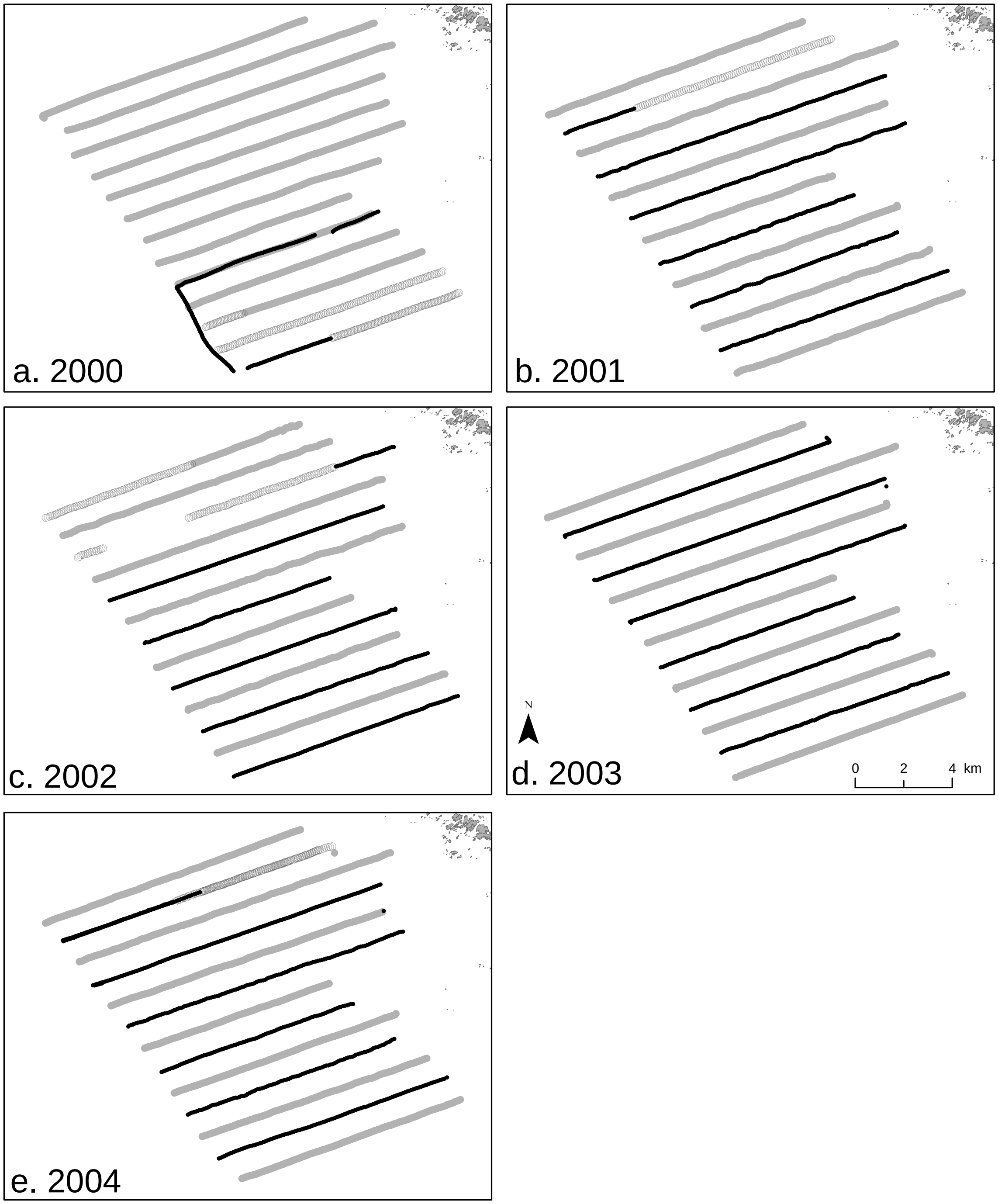
Maps of the locations of 2000-04 Hydroacoustic Survey Transects (Day and Night)



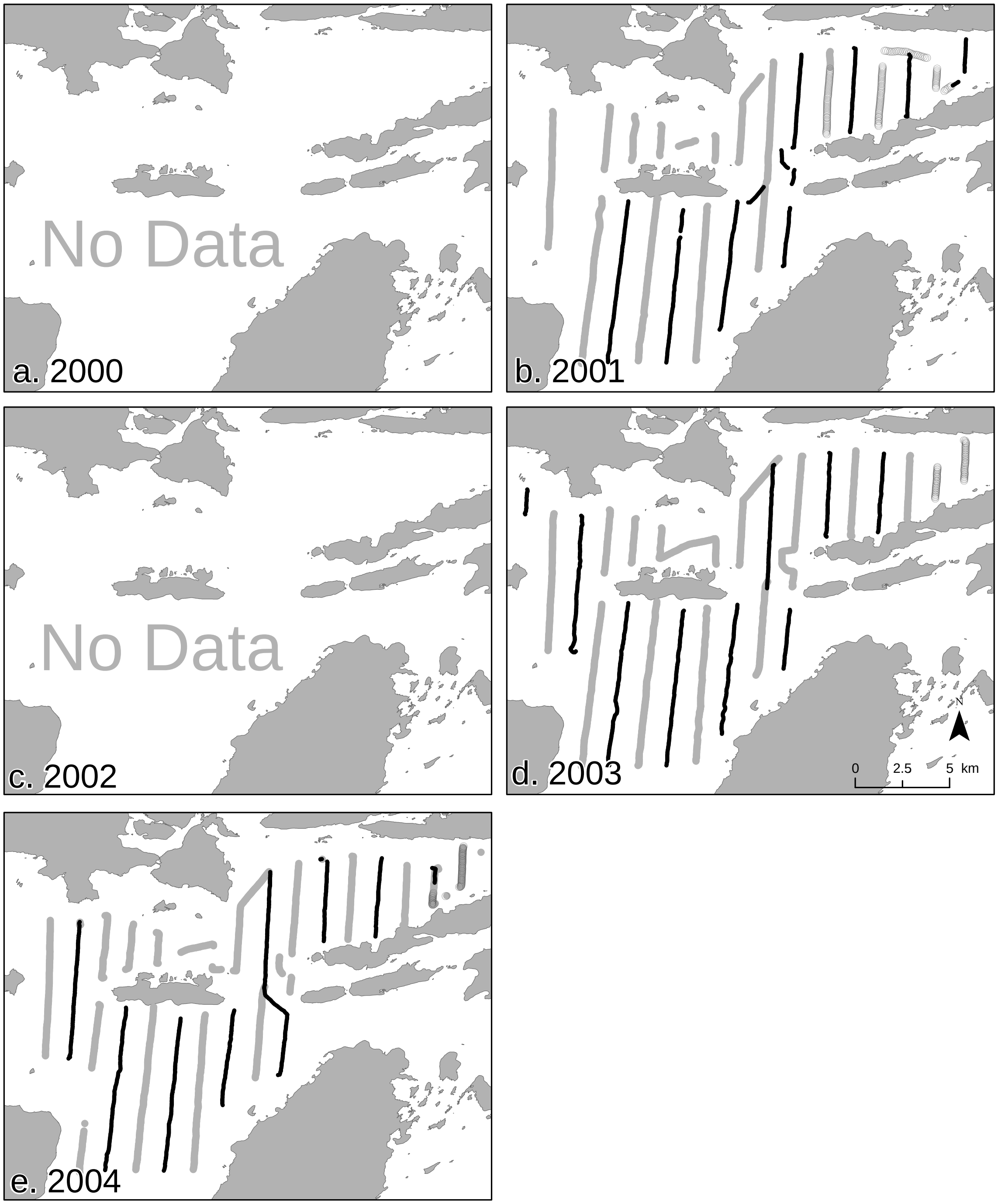
Appendix 8 - Frame 1 (S. Parry Sound & Frying Pan Islands) survey transects of the Hydroacoustic Survey Program for a. 2000, b. 2001, c. 2002 & d. 2003 & e. 2004. Light shaded lines indicate those transects completed within day light hours, dark grey open circles are evening crepuscular transects, and the black lines indicate those transects completed during the night-time. Note that the survey transects in 2002, 2003 and 2004 were modified from the 2000-01.



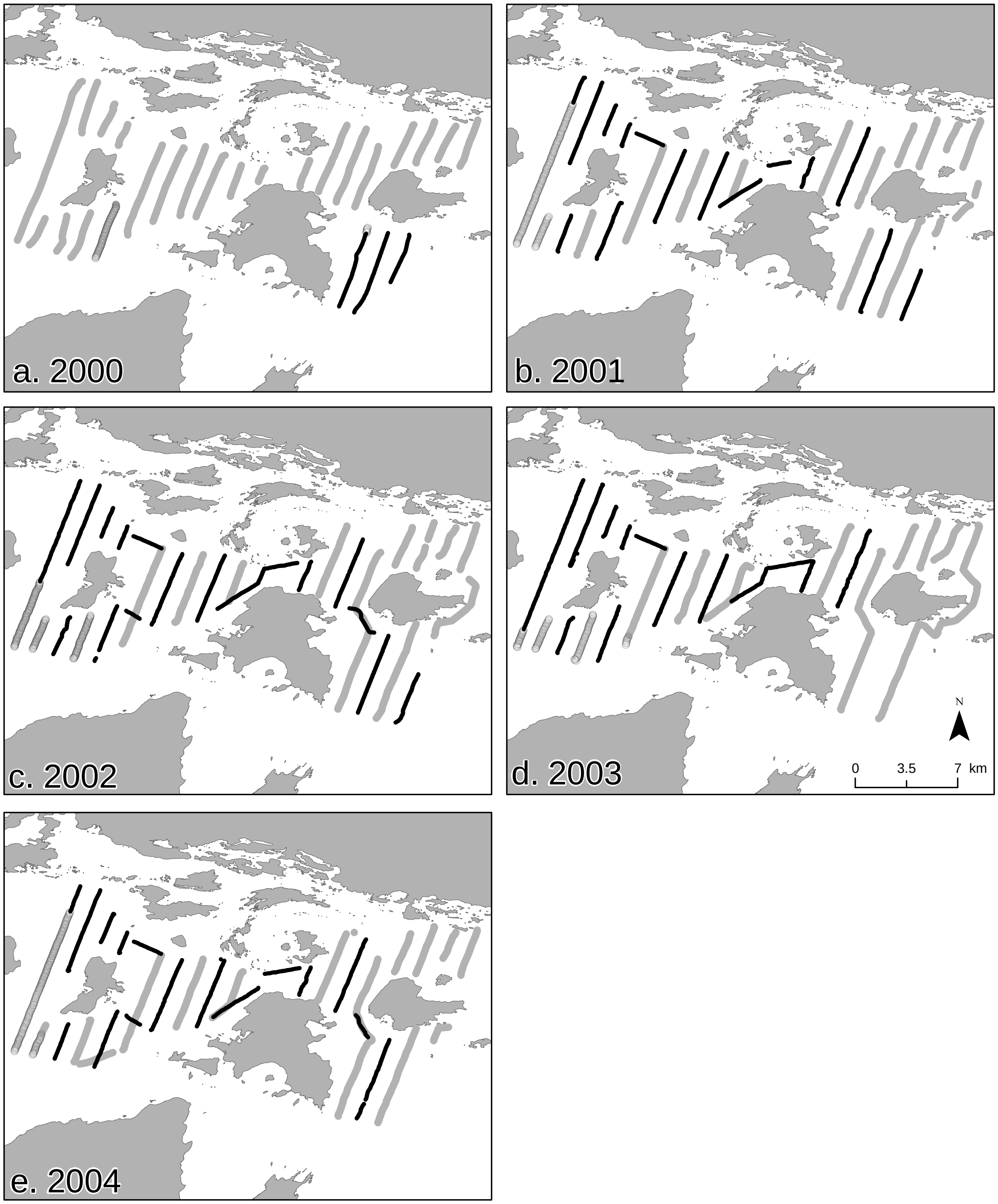
Appendix 8 - Figure 2: Frame 2 (Pointe Au Baril & Limestone Islands) survey transects of the Hydroacoustic Survey Program for a. 2000, b. 2001, c. 2002 & d. 2003 & e. 2004. Light shaded lines indicate those transects completed within day light hours, dark grey open circles are evening crepuscular transects, and the black lines indicate those transects completed during the night-time.



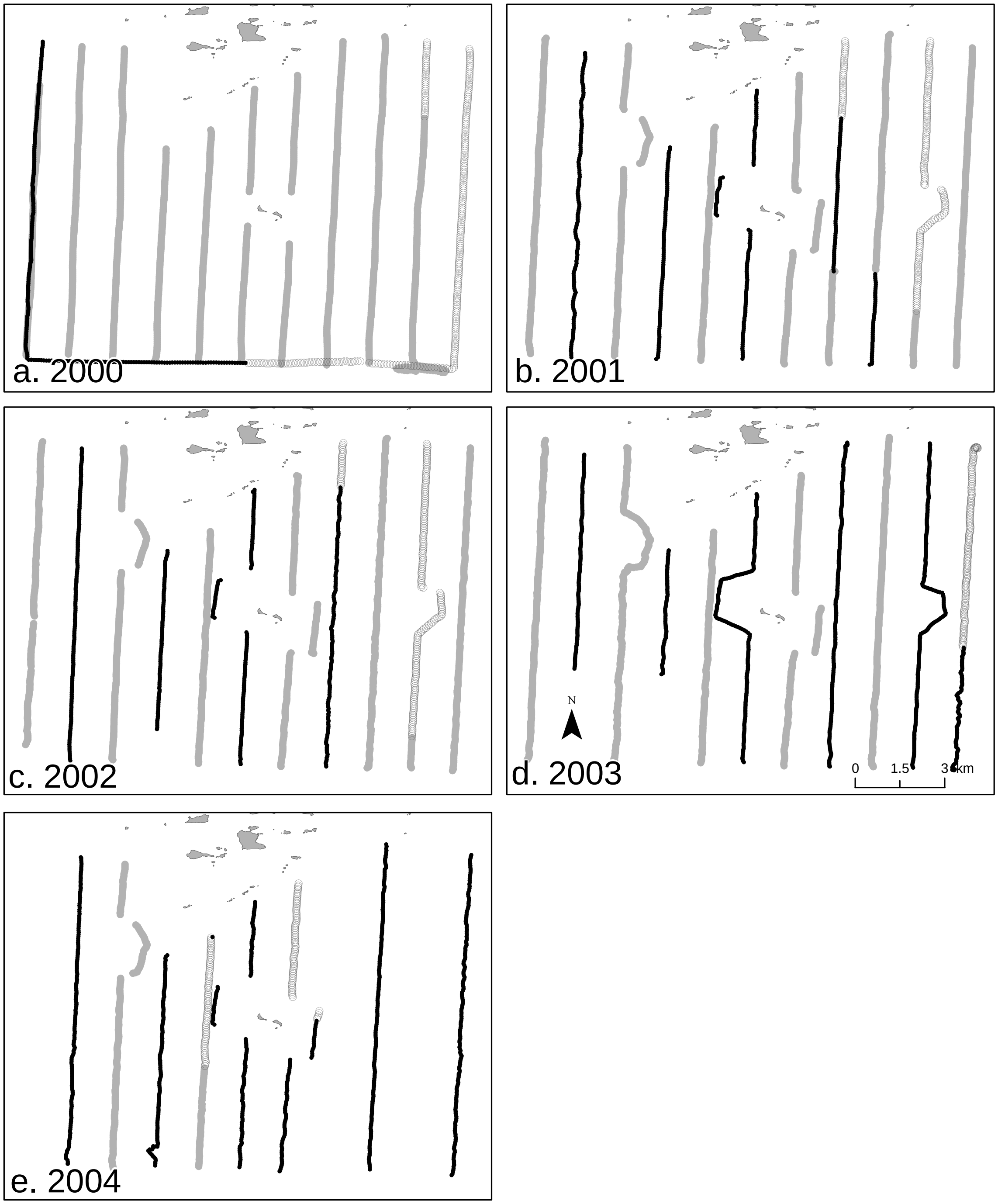
Appendix 8 – Figure 3: Frame 3 (Britt & the Magnetawan River delta) survey transects of the Hydroacoustic Survey Program for a. 2000, b. 2001, c. 2002 & d. 2003 & e. 2004. Light shaded lines indicate those transects completed within day light hours, dark grey open circles are evening crepuscular transects, and the black lines indicate those transects completed during the night-time.



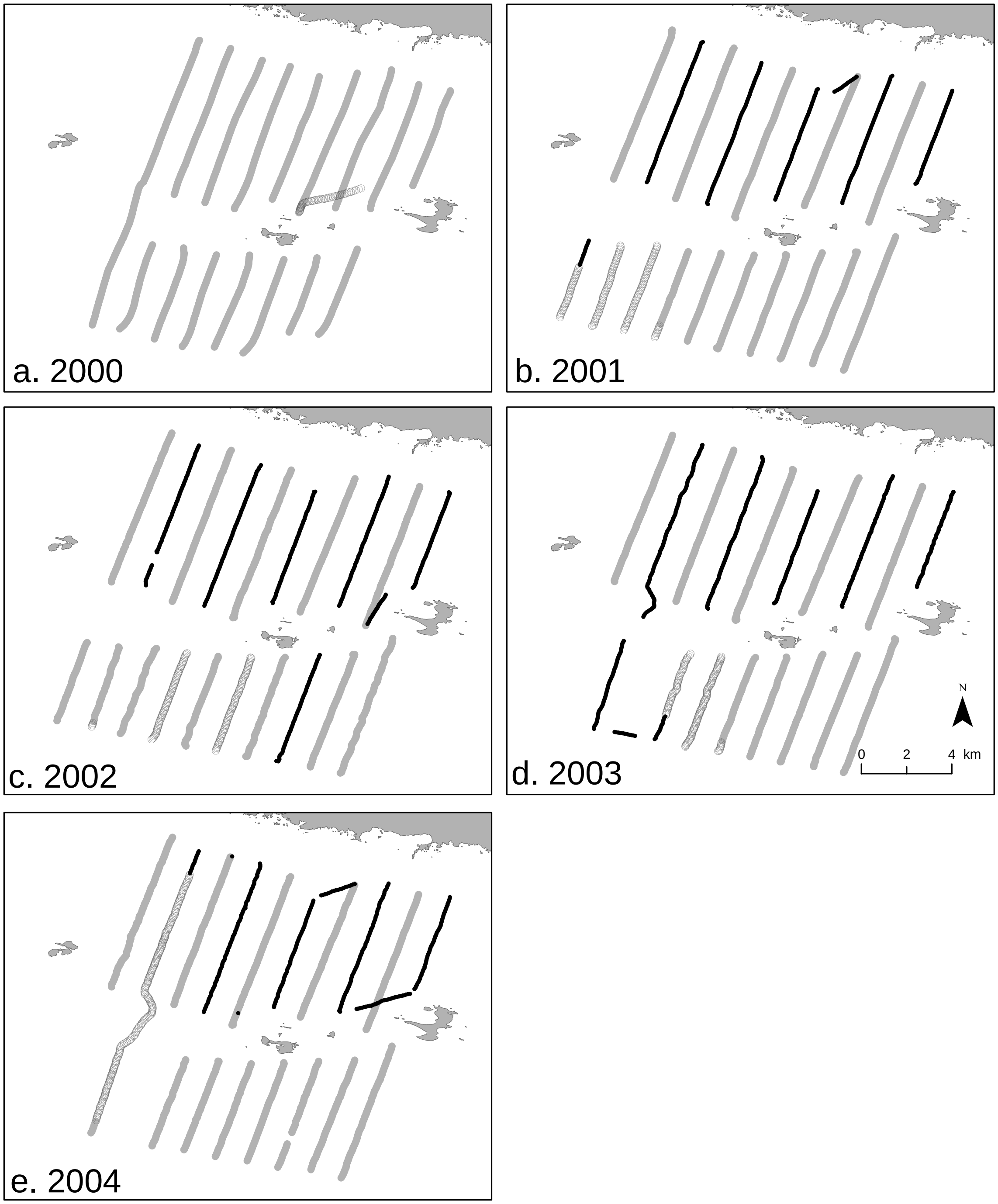
Appendix 8 – Figure 4: Frame 4 (E. Little Current at Heywood Island, Manitowaning and Frazer Bays) survey transects of the Hydroacoustic Survey Program for a. 2000, b. 2001, c. 2002 & d.2003 & e. 2004. Light shaded lines indicate those transects completed within day light hours, dark grey open circles are evening crepuscular transects, and the black lines indicate those transects completed during the night-time. Note that data are not available for this frame in 2000 and 2002.



Appendix 8 – Figure 5: Frame 5 (W. Little Current at Innes, Clapperton, and Amedroz Islands) survey transects of the Hydroacoustic Survey Program for a. 2000, b. 2001, c. 2003 & d. 2003 & e. 2004. Light shaded lines indicate those transects completed within day light hours, dark grey open circles are evening crepuscular transects, and the black lines indicate those transects completed during the night-time.



Appendix 8 – Figure 6: Frame 6 (Algoma Mills and the Cousin Islands) survey transects of the Hydroacoustic Survey Program for a. 2000, b. 2001, c. 2002 & d. 2003 & e. 2004. Light shaded lines indicate those transects completed within day light hours, dark grey open circles are evening crepuscular transects, and the black lines indicate those transects completed during the night-time.



Appendix 8 – Figure 7: Frame 7 (Thessalon & Grant Islands) survey transects of the Hydroacoustic Survey Program for a. 2000, b. 2001, c. 2002 & d. 2003 & e. 2004. Light shaded lines indicate those transects completed within day light hours, dark grey open circles are evening crepuscular transects, and the black lines indicate those transects completed during the night-time.

Appendix 9.

Simrad EY500 and BioSonics DT-6000 & DT-X Parameter Settings

Appendix 9 Table 1. EY500 parameter settings for Frame 5 2001 data. Settings were the same for Frame 1 2001 with the exception of the Disk Menu Range set to 140m.

EY500 Frame5 2001 Parameter Settings Output

Menu	Parameter
BOTTOM DETECTION MENU	Minimum Depth=0.0 m
	Maximum Depth=2500 m
	Min. Depth Alarm=0.0 m
	Max. Depth Alarm=0 m
	Bottom Lost Al.=Off
	Minimum Level=-50 dB
DISK MENU	Range=100 m
	Range Start=0 m
	Bottom Range=15 m
	Bot. Range Start=10 m
	No. of Main Val.=250
	No. of Bot. Val.=75
	TVG=20 log R
DISPLAY MENU	Range=100 m
	Transd. Number=1
	Range=100 m
	Range Start=0 m
	Auto Range=Off
	Bottom Range=10 m
	Bot. Range Start=5 m
	Bot. Range Pres.=Off
	Sub. Bottom Gain=0.0 dB
	Presentation=Normal
	TVG=20 log R
	Scale Lines=10
	Bot. Det. Line=On
	Layer Lines=O
	Integration Line=Off
	TS Colour Min.=-50 dB
	Sv Colour Min.=-70 dB

Menu	Parameter
NAVIGATION MENU	Navig. Input=Serial
	Start Sequence=$GPGLL
	Separation
	Stop Character=000D
	First Field No.=2
	No. of Fields=4
	Speed Input=Manual
	Manual Speed=10.0 knt
	Baudrate=4800
	Bits Per Char.=8
	Stop Bits=1
	Parity=None
TRANSCEIVER MENU	Mode=Active
	Transducer Type=ES120-7
	Transd. Sequence=Off
	Transducer Depth=0.00 m
	Absorption Coef.=38 dBkm
	Pulse Length=Medium
	Bandwidth=Auto
	Max. Power=63 W
	2-Way Beam Angle=-20.8 dB
	Sv Transd. Gain=26.10 dB
	TS Transd. Gain=26.10 dB
	Angle Sens.Along=21.0
	Angle Sens.Athw.=21.0
	3 dB Beamw.Along.=7.1 dg
	3 dB Beamw.Athw.=7.1 dg
	Alongship Offset=0.00 dg
	Athw.ship Offset=0.00 dg
TS DETECTION MENU	Min. Value=-50 dB
	Min. Echo Length=0.8
	Max. Echo Length=1.5
	Max. Gain Comp.=4.0 dB
	Max. Phase Dev.=4.0
UTILITY MENU	COM1

Appendix 9 Table 2. BioSonics DT-6000 Visual Acquisition parameter settings for all frames in 2003. The following was extracted from the BioSonics “VISACQ.cfg” parameter file. If required, the text shown in the table can be copied directly back into the BioSonics parameter file.

```
;-----------------------------------------------------------------------
; The SYSTEM section controls overall operation of the VISACQ program
[System]

; --Which drive to log data to (DO NOT USE A COLON! C for C:, D for D:,
E for E:, etc.)
FileDrive=C

; --Begin running as soon as the program is started
AutoRun=N

; --Do we want to automatically save files
AutoLog=Y

; --How are we limiting auto-named files: P for ping count, T for time
(minutes),
; --or S for size (kB)
LimitType=S

; --What value for the limit: pings, minutes, or kB
LimitValue=20000

; --Do we save the screen bitmaps (Y=save all bitmaps, 800 pings in
each)
SaveBitmaps=N

; --Which COM port has the GPS connected
; --(program will search if not supplied or 0, will NOT use GPS inputs
if set to -1)
GpsPort=1

; --Main window placement - DO NOT CHANGE
WindowPlacement=fffcfffc040402e8

; --Default TVG for all views: 20 or 40 (default is 40)
DefaultDisplayTVG=40

; --Salinity of the water
Salinity=0.0

; --Temperature of the water
Temperature=10.0

; --Real Time Processing Configuration - how do we send the data?
RTPUseTcpip=No
RTPTcpipPort=2048
RTPUsePrinter=Yes
RTPPrinterPort=2049
RTPPrinterChannel=1
RTPUseSerial=No
RTPSerialMode=BINARY
RTPSerialPort=
```

```
RTPSerialBaudRate=19200
RTPTcpipTarget=90.0.0.1
RTPUseFile=No
RTPOutputFile=C:\DT4000.DTE

;-----------------------------------------------------------------------
---
; The CHANNEL sections control the configuration of each transducer
channel

[Channel 1]

; --Where does this window appear - DO NOT CHANGE
WindowPlacement=00010049031d022a

; --Do we autorun this channel
Run=Y

; --Starting depth, in meters
Start=0.5

; --Stopping depth, in meters
Stop=120.0

; --Data threshold, in dB
Threshold=-65.0

; --Mode to threshold (0=FLAT, 1 = LINEAR, 2 = SQUARED)
ThresholdMode=2

; --Ping rate, in pings per second
PingRate=3.0

; --Pulse width, in mSec
PulseWidth=0.3

; --Type of pulse (A=AMBIENT/NONE, C = CHIRP, M = MONOTONE)
PulseType=M

; --Do we want to use the timer functions for this channel (Y/N)
UseTimer=N

; --How long do we run for each burst
MinutesOn=20

; --How long to stay off between bursts
MinutesOff=10

; --How long to "hold off" on start - initial delay time
StartAfter=1

; --Real Time processing configuration for this channel
RTPOutput=No
RTPBottomPeakThreshold=-35.0
RTPBottomPeakWidth=0.10
RTPBottomBlankingThreshold=-60.0
RTPBottomBlankingZone=0.25
```

```
RTPBottomBottomWindow=1.50
RTPBottomUsePreset=YES
RTPBottomPresetDepth=60.0
RTPTrackingCorrelation=0.90
RTPMinTrackingEchoStrength=-70.0
RTPMaxTrackingEchoStrength=-30.0
RTPMinTrackingRange=1.00
RTPMaxTrackingRange=60.00
RTPMinTrackingEchoWidth=0.80
RTPMaxTrackingEchoWidth=1.20
RTPMinTrackingAlongshipAngle=-6.0
RTPMaxTrackingAlongshipAngle=6.0
RTPMinTrackingAthwartshipAngle=-6.0
RTPMaxTrackingAthwartshipAngle=6.0
RTPMinDualBeamTrackingEchoDifference=0.0
RTPMaxDualBeamTrackingEchoDifference=6.0
RTPMaxTrackingEchoes=25

[Channel 0]
Run=N
Start=1.0
Stop=100.0
Threshold=-70.0
ThresholdMode=2
PingRate=1.0
PulseWidth=0.4
PulseType=M
```

Appendix 9 Table 3. BioSonics DT-X Visual Acquisition parameter settings for all frames in 2004. The following was extracted from the BioSonics "VISACQ.cfg" parameter file. If required the text shown in the table can be copied directly back into the BioSonics parameter file.

```
% DTX Configuration File
% BioSonics, Inc., Advanced Digital Hydroacoustics
% Copyright (C)2002-2003 BioSonics, Inc.  All Rights Reserved.
% Generated by DTX Controller v1.6.40.2
% --------------------------------------------------------
version=1
% Cycle Definition
1       %Transducer Configurations (1,2,...,16)
1       %Transducer Channel (1,2,...,16)

% Hardware Parameters
P     %Operating mode (S,D,P) (Ex: a split-beam echosounder system can
operate in S,D,or P
       %modes, but a single-beam can operate only in S mode.)
0     %Transmit power reduction (dB) (0-Hi, nonz-Lo)
300   %Pulse duration (microseconds)
1           %Pulse Type (0-passive (listen only-CURRENTLY UNAVAILABLE)
%                  1-active, monotone pulse)
%Environment and Acoustic Parameters
1           %Beginning range (m)
100         %Ending range (m)
15          %Ambient water temperate (deg C)
0           %Water salinity (ppt) (0-fresh, ~30-salt)
1     %Depth (m) for sound velocity and absorption calculations
7     %pH, for absorption calculation
-80.0    %Collection threshold (dB)
2           %Threshold type (0-flat; 1-linear (20logR); 2-square
(40logR))
0.0    %Calibration Correction (dB)
% Data Handling Parameters
% (N#-number of CYCLES, N0-proceed till user terminates BioScript)
N
0
% (T#-file size by time in minutes (max 30), T30-generate 30 minute
files)
T
5
% Performance Parameters
6.0    %Pulse Rate [Concept: CYCLE rate (SYSTEM-WIDE) (cycles per second
- Hz)]

% Network Parameters
2048     %EPC to broadcast acoustic data packets to port #

% Relay Handling
0      %Relay method - 0 => old way ('V' cmd, relays switched between
pings),
       % 1 => new way ('v' cmd, relays switched right after data
collected)
```

Appendix 10

Coastal Gill Netting Survey Effort Summary Tables

SAM	Gear Description	2003 Est. Fish Density of Site Location	Site Location from Rnd. Site Map (SILOC)	Latitude (NAD83)	Longitude (NAD83)	Set Date	Set Time	Lift Date	Lift Time	Effort Duration (Hrs)
Frame 1										
65	GLSM - Bottom	High	14-9	45.21250	-80.28817	08/09/04	18:44:00	08/10/04	07:30:00	12.8
62	GL10 - Canned	High	14-9	45.21417	-80.29266	08/09/04	18:09:00	08/10/04	08:35:00	14.4
63	GLSM - Canned	High	14-9	45.21417	-80.28833	08/09/04	18:15:00	08/10/04	08:25:00	14.2
64	GL10 - Bottom	High	14-9	45.21183	-80.29300	08/09/04	18:30:00	08/10/04	07:58:00	13.5
Frame 2										
56	GLSM - Canned	High	6-11	45.44417	-80.51683	08/07/04	10:38:00	08/08/04	09:03:00	22.4
58	GLSM - Bottom	High	6-11	45.44117	-80.51850	08/07/04	11:03:00	08/08/04	08:53:00	21.8
57	GL10 - Bottom	High	6-11	45.44150	-80.52467	08/07/04	10:55:00	08/08/04	08:17:00	21.4
55	GL10 - Canned	High	6-11	45.44367	-80.52400	08/07/04	10:27:00	08/08/04	09:19:00	22.9
61	GLSM - Canned	High	8-10	45.47100	-80.52750	08/08/04	12:16:00	08/09/04	07:48:00	19.5
60	GLSM - Bottom	High	8-10	45.46983	-80.53000	08/08/04	11:59:00	08/09/04	07:33:00	19.6
59	GL10 - Bottom	High	8-10	45.46950	-80.53000	08/08/04	11:48:00	08/09/04	07:06:00	19.3
Frame 3										
49	GL10 - Bottom	High	9-10	45.73417	-80.75517	08/04/04	09:00:00	08/05/04	06:37:00	21.6
50	GLSM - Canned	High	9-10	45.73233	-80.76017	08/04/04	08:30:00	08/05/04	06:20:00	21.8
51	GLSM - Bottom	High	9-10	45.73217	-80.75900	08/04/04	09:30:00	08/05/04	05:45:00	20.3
48	GL10 - Canned	High	9-10	45.73533	-80.75650	08/04/04	08:00:00	08/05/04	07:41:22	23.7
54	GLSM - Canned	High	5-13	45.69733	-80.72117	08/05/04	09:00:21	08/06/04	08:02:00	23.0
53	GLSM - Bottom	High	5-13	45.69417	-80.72317	08/05/04	08:38:00	08/06/04	08:40:00	24.0
52	GL10 - Bottom	High	5-13	45.69900	-80.72417	08/05/04	08:18:00	08/06/04	08:22:00	24.1
Frame 4										
42	GL10 - Bottom	High	8-8	45.91600	-81.79550	07/26/04	20:40:00	07/27/04	09:15:38	12.6
41	GLSM - Canned	High	8-8	45.91200	-81.79767	07/26/04	20:29:38	07/27/04	10:06:26	13.6
40	GL10 - Canned	High	8-8	45.91600	-81.79884	07/26/04	20:05:55	07/27/04	11:00:20	14.9
43	GLSM - Bottom	High	8-8	45.91250	-81.79333	07/26/04	21:00:00	07/27/04	09:03:40	12.1
45	GLSM - Canned	High	9-8	45.91850	-81.79333	07/27/04	13:00:00	07/28/04	07:09:43	18.2
44	GL10 - Canned	High	9-8	45.92267	-81.79350	07/27/04	12:40:00	07/28/04	07:20:07	18.7
47	GLSM - Bottom	High	9-8	45.91850	-81.79083	07/27/04	13:30:00	07/28/04	06:33:30	17.1
46	GL10 - Bottom	High	9-8	45.92233	-81.79066	07/27/04	13:18:00	07/28/04	06:40:00	17.4
Frame 5										
33	GLSM - Canned	High	9-8	46.07250	-82.31567	07/24/04	20:45:00	07/25/04	09:42:33	13.0
34	GL10 - Bottom	High	9-8	46.07450	-82.31783	07/24/04	21:00:00	07/25/04	09:08:00	12.1
35	GLSM - Bottom	High	9-8	46.07000	-82.31783	07/24/04	21:12:00	07/25/04	08:57:06	11.8
32	GL10 - Canned	High	9-8	46.07800	-82.31750	07/24/04	20:32:00	07/25/04	09:54:15	13.4
37	GLSM - Canned	High	4-9	46.03283	-82.29617	07/25/04	13:32:35	07/26/04	08:25:12	18.9
39	GLSM - Bottom	High	4-9	46.03083	-82.29350	07/25/04	14:15:00	07/26/04	08:00:00	17.8
38	GL10 - Bottom	High	4-9	46.02934	-82.29967	07/25/04	14:04:27	07/26/04	08:10:00	18.1
36	GL10 - Canned	High	4-9	46.03083	-82.30350	07/25/04	13:17:23	07/26/04	08:35:51	19.3

2004 DCCO Coastal Gill Net Survey Netting Site Summary

SAM	Gear Description	2003 Est. Fish Density of Site Location	Site Location from Rnd. Site Map (SILOC)	Latitude (NAD83)	Longitude (NAD83)	Set Date	Set Time	Lift Date	Lift Time	Effort Duration (Hrs)
Frame 6										
14	GLSM - Bottom	Moderate	9-4	46.11234	-82.86900	07/12/04	15:01:42	07/13/04	09:06:16	18.1
13	GL10 - Bottom	Moderate	9-4	46.11533	-82.86600	07/12/04	14:47:17	07/13/04	08:33:52	17.8
15	GLSM - Canned	Moderate	9-4	46.11117	-82.86550	07/12/04	15:16:09	07/13/04	09:24:28	18.1
24	GL10 - Canned	High	6-8	46.07467	-82.81850	07/22/04	09:17:54	07/23/04	08:32:56	23.3
27	GLSM - Bottom	High	6-8	46.07917	-82.81633	07/22/04	10:42:25	07/23/04	08:15:00	21.5
25	GLSM - Canned	High	6-8	46.07900	-82.81966	07/22/04	09:31:13	07/23/04	08:55:21	23.4
26	GL10 - Bottom	High	6-8	46.07533	-82.81633	07/22/04	10:32:15	07/23/04	07:49:12	21.3
29	GLSM - Canned	Moderate	6-12	46.08567	-82.77433	07/23/04	11:28:18	07/24/04	08:32:22	21.1
28	GL10 - Canned	Moderate	6-12	46.08683	-82.76884	07/23/04	11:14:46	07/24/04	08:52:49	21.6
31	GLSM - Bottom	Moderate	6-12	46.08167	-82.77383	07/23/04	12:24:00	07/24/04	07:46:41	19.4
30	GL10 - Bottom	Moderate	6-12	46.08250	-82.76850	07/23/04	11:51:35	07/24/04	07:59:30	20.1
Frame 7										
3	GL10 - Bottom	Moderate	9-11	46.17567	-83.32867	07/09/04	19:10:00	07/10/04	09:31:30	14.4
4	GLSM - Bottom	Moderate	9-11	46.17533	-83.32250	07/09/04	19:40:00	07/10/04	09:01:27	13.4
2	GLSM - Canned	Moderate	9-11	46.17783	-83.32333	07/09/04	18:25:00	07/10/04	09:56:00	15.5
1	GL10 - Canned	Moderate	9-11	46.17916	-83.31767	07/09/04	18:00:00	07/10/04	10:30:00	16.5
8	GLSM - Bottom	Low	6-9	46.13900	-83.35550	07/10/04	14:36:17	07/11/04	09:01:41	18.4
5	GL10 - Canned	Low	6-9	46.13417	-83.36083	07/10/04	12:47:23	07/11/04	10:29:34	21.7
6	GLSM - Canned	Low	6-9	46.13683	-83.35650	07/10/04	12:57:23	07/11/04	09:45:41	20.8
7	GL10 - Bottom	Low	6-9	46.13600	-83.36200	07/10/04	14:10:34	07/11/04	09:08:47	19.0
12	GLSM - Bottom	Moderate	12-14	46.19600	-83.29183	07/11/04	13:08:13	07/12/04	09:38:37	20.5
9	GL10 - Canned	Moderate	12-14	46.19100	-83.28683	07/11/04	12:10:23	07/12/04	10:00:14	21.8
10	GLSM - Canned	Moderate	12-14	46.19316	-83.29200	07/11/04	12:42:30	07/12/04	10:02:28	21.3
11	GL10 - Bottom	Moderate	12-14	46.19500	-83.28633	07/11/04	12:51:53	07/12/04	09:38:58	20.8
16	GL10 - Canned	Moderate	10-12	46.18217	-83.31617	07/19/04	17:04:00	07/20/04	08:25:26	15.4
18	GL10 - Bottom	Moderate	10-12	46.18417	-83.31917	07/19/04	17:40:00	07/20/04	07:41:39	14.0
19	GLSM - Bottom	Moderate	10-12	46.18717	-83.31567	07/19/04	17:48:00	07/20/04	07:28:00	13.7
17	GLSM - Canned	Moderate	10-12	46.18583	-83.31167	07/19/04	17:14:00	07/20/04	08:07:33	14.9
22	GL10 - Bottom	Moderate	9-13	46.16983	-83.29667	07/20/04	10:43:00	07/21/04	07:35:00	20.9
20	GL10 - Canned	Moderate	9-13	46.17100	-83.30033	07/20/04	09:48:07	07/21/04	08:32:05	22.7
21	GLSM - Canned	Moderate	9-13	46.17367	-83.29583	07/20/04	10:11:45	07/21/04	08:28:14	22.3
23	GLSM - Bottom	Moderate	9-13	46.17233	-83.29166	07/20/04	10:50:00	07/21/04	07:27:26	20.6
69	GLSM - Bottom	Moderate	10-12	46.18733	-83.31517	08/17/04	10:41:00	08/18/04	06:06:00	19.4
67	GLSM - Canned	Moderate	10-12	46.18583	-83.31167	08/17/04	10:20:00	08/18/04	07:45:00	21.4
66	GL10 - Canned	Moderate	10-12	46.18217	-83.31617	08/17/04	10:00:00	08/18/04	07:01:00	21.0
68	GL10 - Bottom	Moderate	10-12	46.18417	-83.31917	08/17/04	10:36:00	08/18/04	06:15:00	19.6

Appendix 11

UGLMU Project Description: Lake Huron Research and Monitoring Program – Coastal Gillnetting Survey & Ground-Truthing.

UPPER GREAT LAKES MANANAGEMENT UNIT, LAKE HURON PROJECT DESCRIPTION

Project Name: Lake Huron DCCO Research and Monitoring Program – Coastal Gillnetting Survey and Ground-truthing.
Fishnet Project Code: LHA_IA04_C03
Start Date: July 5, 2004 **End Date:** September 4, 2004

Project Description:

Results of the 2003 hydroacoustic surveys have highlighted the need to further understand the composition of the Lake Huron coastal fish community within the study frames. Large fish schools (>50m x 3m or estimated approx 1500kg/hectare of fish biomass) were commonly observed during the daytime surveys in all sample sites. Sites with an increased abundance of these schools observed during the daytime most often translated into proportionately high densities of single targets (individual fish) and increased total integrated backscattered energy values observed on surveys at night within the same study site. It is from the night survey, when fish are somewhat scattered through the water column, that biomass estimates are generated.

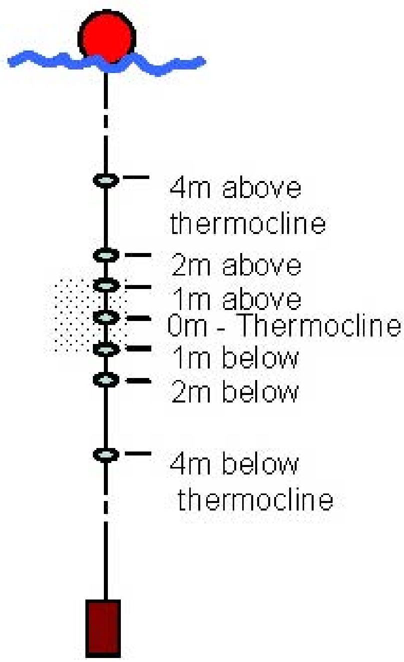
Species composition and the estimated size distribution of the population is required to convert the integrated back scattered energy observed from acoustics to fish density and biomass estimates. Models used to estimate the fish biomass observed in 2003 were based on the work of Warner et al and Fleischer and Argyle and Curtis for alewife and Love for those targets with a length greater than would be expected for alewife. The conversion value, ó (spherical backscatter coefficient), is calculated from the mean target strength for a given size distribution of fish and varies with fish size, body shape, swimbladder morphology, and swimming behaviour (see John Horne's work).

Results of the gillnetting survey for 2003 suggests that the application of the models (for alewife) discussed above may not be appropriate for use with the acoustic data collected for the project. Six UGLMU index nets were set in three study frames (1, 3, and 6) in 2003 to collect information on the size distribution and species composition of the fish community in each area of the lake. Large catches of Lake chub (*Couesius plumbeus*) were observed in all net sets in Georgian Bay and were the most abundant catch across all sites in frame 3 (Britt). Also of note is the relative abundance of trout perch (*Percopsis omiscomaycus*) observed in the catches in frame 3. Only one alewife was observed throughout all sites, the only other species observed in the nets that are typically known to school during the day, and are of similar size to the targets observed acoustically.

As a result of the 2003 acoustics and gillnetting observations, the technical committee has recommended an increase in gillnetting effort across all study frames to sample fish to;

1. provide an estimate of the fish length distribution of fish within and between frames
2. provide information on the species composition of the fish community within and between frames
3. provide mean round weight estimates and length vs weight relationships for converting estimated density numbers to density weight.

Temperature Loggers:

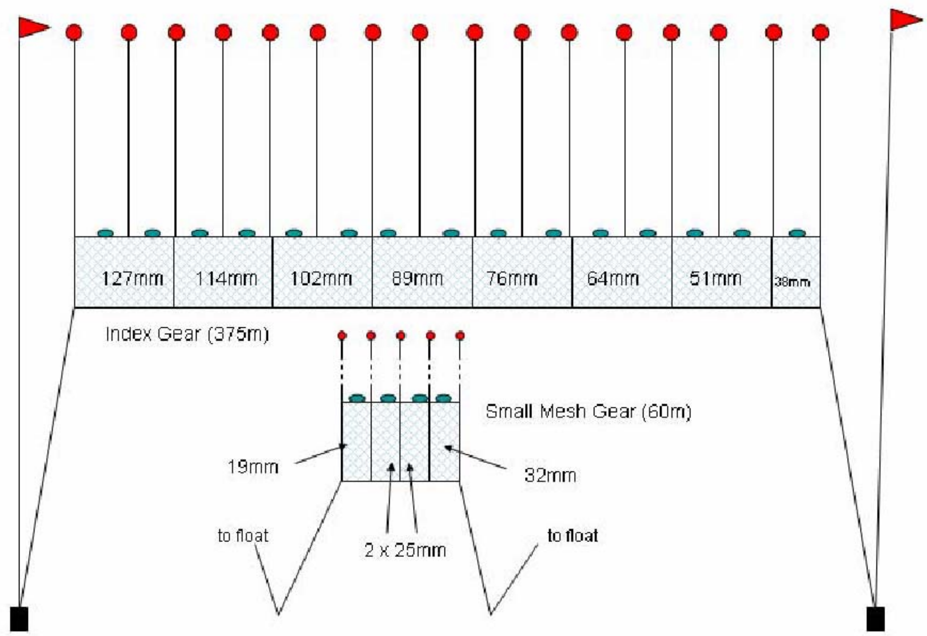


1. The netting crew will be provided with a string of temperature loggers. The string will have Stowaway TidBit Temperature records placed at, above and below the thermocline. The crew will use the temperature sonde to determine the depth of thermocline. The tidbits will be then adjusted on the string to collect temperature data at the depth of the thermocline as well as 1, 2 and 4 meters above thermocline and 1, 2 and 4 meters below thermocline (see figure to left).
2. Within each frame the Stowaway Tidbit temperature string will be set at a location provided by the project lead on the first set night of the frame. The string will be retrieved on the final net lift day in the frame. The gps coordinates, string set time and date, string lift time and date will be recorded on the data sheet provided.
3. Temperature loggers will be placed on the float line at the centre panel of each net set to record the temperature at fishing depth (1 per net).
4. Each tidbit should be inspected before and after each deployment to verify the units are still functioning (blinking green light).

Netting Methodology and Fish Sampling:

1. Data logger project should use similar template as offshore index template.
2. The number of nets set on each sampling day and in each study frame is outlined in table 2. This is to be taken as a guide only and is highly dependent on catches, weather conditions etc.
3. A stratified (observed fish densities within the water column from 2003 hydroacoustic survey) random design will be used to select netting sites. A list of randomized sampling grids (1000m x 1000m) and GPS coordinates will be provided for the netting crew prior to the project start (appended to the end of this document). It is important for the crew to avoid setting the canned nets in heavy boat traffic areas etc.
4. At each site the temperature will be recorded using the temperature sonde to determine the depth and depth range of thermocline. Temperature measurements, recorded by 1m increments, will be completed for depths 5m above and 5m below the observed thermocline

5. At each site, one gang of index net and one gang of small mesh will be set on the bottom in a line using the same protocol as outlined in the UGLMU Offshore Index Program methods. One index gang and one small mesh gang will then be set in a “canned” or suspended configuration (see figure below). The canned set will be set parallel (within 200-300m) to the bottom nets. Adjust the float lines to have the float line of the net hang 1m below the observed thermocline depth. It will be easiest to set the canned nets down wind of the bottom sets.



6. Rules For Setting Nets
   i. The bottom depth of all netting sites **should not exceed 20-25m.**
   ii. The top of the canned nets will not be set **<5m below surface**. If thermocline is observed to be shallower than 5m, the top of the canned nets should be set at 5m.
   iii. Canned nets will not be set where the bottom of the net is **<3m above bottom.**
   iv. All nets are to be set along the depth contours (parallel). The start and end depth of the bottom net should **not differ by >5m.**
   v. On those days when netting is to be done in coordination with the hydroacoustic survey crew (July 19-August 13), the crew should only select random netting sites (SILOC) from the “HIGH” density category. Note that Frame 7 no “HIGH” density sites are available, therefore the selection should be made from the “MED” density list.

vi. Those days when gill netting is to be completed outside of the hydroacoustic surveys (July 9-14 and Aug 16-Sept 3), the crew is to select one random site (SILOC) from either a "HIGH", "MED", or "LOW" density site per day. The crew should attempt to complete at least one site from each of the 3 density categories while in a Frame. Note that Frame 7 has no "HIGH" density sites available. In this case the crew should select two "MED" sites and one "LOW" density site.

7. The entire catch should be separated by mesh size (EFF), identified and counted.
8. Refer to the attached document "2004 Gill netting Project Biological Sampling" for a description of the biological sampling requirements.
9. If catches are high enough that the crew anticipates biological sampling of the catch will require more time than will be available in the remainder of the current work day and will require > 4 hours into the next work day, the crew **should not** set back that day. The next day will be set aside for sampling the remaining catch and setting back the nets in the afternoon if required. Where possible, personnel from the hydroacoustics survey crew will be available to help the netting crew sample the catch if required.

Fish Identification and Unknown Species: All species need to be identified correctly. If the crew is uncertain about the identity of any species, one or more specimens should be kept as voucher species and labeled with a unique "Unknown" species number (i.e. UK01 etc).

1. The voucher sample should be placed in a Whirl-pak and fixed with an adequate amount of 10% formalin solution. Refer to MSDS sheets for working with formalin solution. Be sure to use latex gloves.
2. Complete a "voucher specimen label" in pencil and place the label in the Whirl-pak with the specimen
3. Label the outside of the Whirl-pak with the SAM, FRAME, DATE, GR, XSETTYPE, EFFand UK#
4. The following day the rinsed specimen and label should be transferred to a sample bottle containing 70% ethanol. The remaining 10% formalin in Whirl-pak should be collected in a waste bottle and returned to the office for proper disposal.
5. All unknown fish encountered in the catch that appear to be the same species as the voucher specimen, should be referred to **as 999 in SPC and the UK## should be entered into the COMMENT field on the datalogger** until a proper identification has been assigned.
6. Once the crew identifies the correct species of the unknown specimen, the species name (or genus) is to be recorded in the "Unknown Voucher Specimen Log" **and the UK## should not be reused.**

2004: Proposed netting effort

Option 1 (preferred): 7 day netting schedule

Frame	GL01 Index Gear 2 Straps a day (1 canned, 1 bottom)	Small Mesh Straps (60m) 2 straps a day (1 panel 3/4" (15m) & 2 panels 1" (30m) & 1 panels 1 1/4" (15m)) (1 canned, 1 bottom)	Fishing Days on Site
1	10	10	5
2	10	10	5
3	10	10	5
4	10	10	5
5	10	10	5
6	10	10	5
7	10	10	5
Total	70	70	

Option 2: 10 day schedule with 1 strap of index and 2 small mesh straps

Frame	GL01 Index Gear 1 Straps a day (1 canned, 1 bottom)	Small Mesh Straps (60m) 2 straps a day (1 panel 3/4" (15m) & 2 panels 1" (30m) & 1 panels 1 1/4" (15m)) (1 canned, 1 bottom)	Fishing Days on Site
1	5	10	5
2	5	10	5
3	5	10	5
4	5	10	5
5	5	10	5
6	5	10	5
7	5	10	5
Total	35	70	

The following table contains a summary of the species specific sampling procedures for the 2004 gill netting program. These numbers should be considered a minimum, if time permits, more samples are always preferred.
NOTE: Although this table was adapted from the 2003 Offshore index protocol, sampling instructions codes and the corresponding footnotes have been revised for this project.

Species	Number Per Mesh	Sampling Instructions
Pink Salmon	10	2
Coho Salmon	10	2
Chinook Salmon	10	**4**
Rainbow Trout	10	2*****
Brown Trout	10	2
Lake Trout	ALL	**1***
Lake Whitefish	30	2
Lake Herring	30	**3***
Chub (C. hoyi)	30	2
Round Whitefish	10	2
Burbot	10	2
White Perch	10	2
White Bass	10	2
Yellow Perch	30	2
Walleye	10	2
Smelt	30	3
Alewife	30	3
Lake Chub (C. Plumbeus)	30 + 30 Bag*	3
Trout Perch	30 + 30 Bag*	3
Suckers	20	**3****
Lake Sturgeon	ALL	5
Deepwater Sculpin	ALL	6
All other species	30 + 30 FL Only	3

1. Total and fork length, round weight, scales, sex and maturity, lamprey marks (GLFC), fin clips, stomach contents, tags, and heads from AD clips (* - collect scales and fin rays from all unclipped lake trout). **Note that the Sport Fish Contaminant Monitoring Program has request samples from 15 LT from Frames 1-3 and 15 LT from Frames 4-5.**
2. Total and fork length, weight, lamprey marks (GLFC), and tags. No Sex or Maturity required. No age structure required (*****for Rainbows, identify if cage culture fish)
3. Total and fork length, weight, **scales**, lamprey marks (GLFC), and tags. No Sex or Maturity required (*****Lake Herring-**scales, otoliths and fin rays**, ****** Common White Sucker - take **operculum**)
4. Chinook salmon will be sampled the same as #1, with the additional considerations. The head from all chinook salmon with an adipose clip, either alone or in combination with other clips, must be collected. For unclipped salmon, several caudal vertebrae are to be collected and wrapped in foil for tetracycline analysis. All remaining salmon (paired fin clips) are to be sampled as #1.
5. Fork length, total length, dressed length, round weight, girth, lamprey wounds, tags and left pectoral fin ray. **Apply appropriate tag** and released unharmed if possible, otherwise collect dressed and filleted weights, stomach contents, and sex and maturity data as well.
6. All deepwater sculpin caught are to be measured (TLEN), weighed and retained. Specimens should be placed in a bag and labeled with the SAM, SPC, EFF, EFFDT01, and FRAME**. If the crew is uncertain of identifying the species correctly, all sculpin specimens should be kept.**

***30+30 Bag**: After biologically sampling the first 30 randomly sampled fish in each mesh size, up to an additional 30 more randomly sampled fish are to be separated into plastic bags by species and mesh size. The SAM, SPC, EFF, EFFDT01, and FRAME should be clearly marked on each bag. Each bag should then be grouped into larger bags and clearly marked with SAM, FRAME, and DATE. All bagged samples should be frozen as soon as possible. Check availability of freezer space in the Blind River, Espanola, and Parry Sound District offices.

Once the minimum sample number has been obtained for a species from a panel, the remaining fish of that species will be counted. Finally, for 'sportfish' - smallmouth bass, largemouth bass, sturgeon, musky and gar, sample following #5 and release alive and unharmed if possible.

2004 Coastal Gillnetting Survey & Ground-Truthing (LHA_IA04_CO3)
Random Site Selection List

Random Order	FRM	SILOC	DENSITY	XEasting UTMNAD83	YNorthing UTMNAD83	LAT DM_NAD83	LONG DM_NAD83
1	1	4--11	HIGH	558156.99	4997245.74	45 07.5773923	80 15.6290374
2	1	15--8	HIGH	555156.99	5008245.74	45 13.5324716	80 17.8447235
3	1	3--11	HIGH	558156.99	4996245.74	45 07.0373333	80 15.6360141
4	1	14--9	HIGH	556156.99	5007245.74	45 12.9876751	80 17.0872766
5	1	16--7	HIGH	554156.99	5009245.74	45 14.0771849	80 18.6024117
6	1	7--13	HIGH	560156.99	5000245.74	45 09.1875048	80 14.0815986
7	1	7--14	HIGH	561156.99	5000245.74	45 09.1823476	80 13.3183591
8	1	10--12	HIGH	559156.99	5003245.74	45 10.8127363	80 14.8235015
9	1	3--12	HIGH	559156.99	4996245.74	45 07.0323524	80 14.8732479
10	1	17--7	HIGH	554156.99	5010245.74	45 14.6172386	80 18.5958748
1	1	15--7	MED	554156.99	5008245.74	45 13.5371304	80 18.6089455
2	1	9--12	MED	559156.99	5002245.74	45 10.2726840	80 14.8306182
3	1	10--10	MED	557156.99	5003245.74	45 10.8226348	80 16.3507185
4	1	10--11	MED	558156.99	5003245.74	45 10.8177281	80 15.5871083
5	1	8--13	MED	560156.99	5001245.74	45 09.7275572	80 14.0743684
6	1	16--6	MED	553156.99	5009245.74	45 14.0817599	80 19.3667573
7	1	14--8	MED	555156.99	5007245.74	45 12.9924176	80 17.8513748
8	1	9--8	MED	555156.99	5002245.74	45 10.2921348	80 17.8845841
9	1	9--13	MED	560156.99	5002245.74	45 10.2676087	80 14.0671349
10	1	11--11	MED	558156.99	5004245.74	45 11.3577810	80 15.5801086
1	1	6--10	LOW	557156.99	4999245.74	45 08.6624083	80 16.3782037
2	1	7--10	LOW	557156.99	5000245.74	45 09.2024663	80 16.3713372
3	1	8--10	LOW	557156.99	5001245.74	45 09.7425233	80 16.3644676
4	1	7--9	LOW	556156.99	5000245.74	45 09.2072834	80 17.1345900
5	1	7--11	LOW	558156.99	5000245.74	45 09.1975641	80 15.6080877
6	1	6--9	LOW	556156.99	4999245.74	45 08.6672240	80 17.1413363
7	1	7--12	LOW	559156.99	5000245.74	45 09.1925769	80 14.8448414
8	1	9--11	LOW	558156.99	5002245.74	45 10.2776743	80 15.5941048

Random Order	FRM	SILOC	DENSITY	XEasting UTMNAD83	YNorthing UTMNAD83	LAT DM_NAD83	LONG DM_NAD83
1	2	9--6	HIGH	532790.77	5035558.52	45 28.3670640	80 34.8293892
2	2	7--7	HIGH	533790.77	5033558.52	45 27.2840896	80 34.0700523
3	2	3--20	HIGH	546790.77	5029558.52	45 25.0789095	80 24.1175685
4	2	17--3	HIGH	529790.77	5043558.52	45 32.6955769	80 37.1029962
5	2	3--8	HIGH	534790.77	5029558.52	45 25.1209120	80 33.3196800
6	2	5--6	HIGH	532790.77	5031558.52	45 26.2068322	80 34.8454013
7	2	4--8	HIGH	534790.77	5030558.52	45 25.6609711	80 33.3154399
8	2	10--7	HIGH	533790.77	5036558.52	45 28.9042569	80 34.0576683
9	2	7--12	HIGH	538790.77	5033558.52	45 27.2684996	80 30.2333489
10	2	3--19	HIGH	545790.77	5029558.52	45 25.0828816	80 24.8843976
1	2	8--11	MED	537790.77	5034558.52	45 27.8118422	80 30.9960709
2	2	4--10	MED	536790.77	5030558.52	45 25.6548268	80 31.7814882
3	2	11--6	MED	532790.77	5037558.52	45 29.4471748	80 34.8213719
4	2	18--5	MED	531790.77	5044558.52	45 33.2303191	80 35.5619461
5	2	2--11	MED	537790.77	5028558.52	45 24.5715126	80 31.0237247
6	2	8--8	MED	534790.77	5034558.52	45 27.8211991	80 33.2984593
7	2	6--9	MED	535790.77	5032558.52	45 26.7380557	80 32.5397328
8	2	10--8	MED	534790.77	5036558.52	45 28.9013079	80 33.2899570
9	2	5--11	MED	537790.77	5031558.52	45 26.1916813	80 31.0099076
10	2	4--11	MED	537790.77	5030558.52	45 25.6516259	80 31.0145155
1	2	11--11	LOW	537790.77	5037558.52	45 29.4319954	80 30.9822146
2	2	16--8	LOW	534790.77	5042558.52	45 32.1416138	80 33.2644018
3	2	11--9	LOW	535790.77	5037558.52	45 29.4383252	80 32.5178713
4	2	0--13	LOW	539790.77	5026558.52	45 23.4847448	80 29.4999606
5	2	1--14	LOW	540790.77	5027558.52	45 24.0213464	80 28.7285174
6	2	12--9	LOW	535790.77	5038558.52	45 29.9783765	80 32.5134928
7	2	11--7	LOW	533790.77	5037558.52	45 29.4443109	80 34.0535364
8	2	11--8	LOW	534790.77	5037558.52	45 29.4413611	80 33.2857028
9	2	1--13	LOW	539790.77	5027558.52	45 24.0248016	80 29.4951180
10	2	11--10	LOW	536790.77	5037558.52	45 29.4352033	80 31.7500419

Random Order	FRM	SILOC	DENSITY	XEasting UTMNAD83	YNorthing UTMNAD83	LAT DM_NAD83	LONG DM_NAD83
1	3	8--10	HIGH	518720.14	5063782.91	45 43.6409110	80 45.5650548
2	3	9--5	HIGH	513720.14	5064782.91	45 44.1879888	80 49.4187921
3	3	4--10	HIGH	518720.14	5059782.91	45 41.4807370	80 45.5743193
4	3	9--9	HIGH	517720.14	5064782.91	45 44.1825332	80 46.3339452
5	3	8--9	HIGH	517720.14	5063782.91	45 43.6424913	80 46.3361402
6	3	10--9	HIGH	517720.14	5065782.91	45 44.7225742	80 46.3317491
7	3	7--7	HIGH	515720.14	5062782.91	45 43.1053482	80 47.8802604
8	3	8--8	HIGH	516720.14	5063782.91	45 43.6439849	80 47.1072267
9	3	2--12	HIGH	520720.14	5057782.91	45 40.3972305	80 44.0382614
10	3	12--8	HIGH	516720.14	5067782.91	45 45.8041491	80 47.0989362
1	3	10--12	MED	520720.14	5065782.91	45 44.7175699	80 44.0177529
2	3	11--7	MED	515720.14	5066782.91	45 45.2655175	80 47.8724695
3	3	10--7	MED	515720.14	5065782.91	45 44.7254764	80 47.8744186
4	3	1--10	MED	518720.14	5056782.91	45 39.8605976	80 45.5812562
5	3	1--8	MED	516720.14	5056782.91	45 39.8636647	80 47.1216972
6	3	5--9	MED	517720.14	5060782.91	45 42.0223607	80 46.3427190
7	3	6--13	MED	521720.14	5061782.91	45 42.5555677	80 43.2571825
8	3	1--9	MED	517720.14	5056782.91	45 39.8621744	80 46.3514762
9	3	11--13	MED	521720.14	5066782.91	45 45.2557663	80 43.2437301
10	3	12--7	MED	515720.14	5067782.91	45 45.8055577	80 47.8705194
1	3	11--12	LOW	520720.14	5066782.91	45 45.2576085	80 44.0151838
2	3	12--9	LOW	517720.14	5067782.91	45 45.8026536	80 46.3273539
3	3	14--12	LOW	520720.14	5069782.91	45 46.8777191	80 44.0074694
4	3	5--8	LOW	516720.14	5060782.91	45 42.0238528	80 47.1134342
5	3	12--11	LOW	519720.14	5067782.91	45 45.7994022	80 44.7841925
6	3	3--8	LOW	516720.14	5058782.91	45 40.9437605	80 47.1175676
7	3	14--11	LOW	519720.14	5069782.91	45 46.8794762	80 44.7792966
8	3	4--7	LOW	515720.14	5059782.91	45 41.4852122	80 47.8860940
9	3	11--11	LOW	519720.14	5066782.91	45 45.2593639	80 44.7866388
10	3	13--11	LOW	519720.14	5068782.91	45 46.3394396	80 44.7817452

Random Order	FRM	SILOC	DENSITY	XEasting UTMNAD83	YNorthing UTMNAD83	LAT DM_NAD83	LONG DM_NAD83
1	4	8--8	HIGH	438482.77	5084566.83	45 54.7150310	81 47.5924575
2	4	8--11	HIGH	441482.77	5084566.83	45 54.7307476	81 45.2717333
3	4	9--8	HIGH	438482.77	5085566.83	45 55.2550077	81 47.6001521
4	4	5--8	HIGH	438482.77	5081566.83	45 53.0950955	81 47.5693958
5	4	5--15	HIGH	445482.77	5081566.83	45 53.1305126	81 42.1569476
6	4	2--8	HIGH	438482.77	5078566.83	45 51.4751521	81 47.5463670
7	4	4--9	HIGH	439482.77	5080566.83	45 52.5604347	81 46.7886443
8	4	4--8	HIGH	438482.77	5080566.83	45 52.5551152	81 47.5617159
9	4	7--9	HIGH	439482.77	5083566.83	45 54.1803778	81 46.8113204
10	4	15--5	HIGH	435482.77	5091566.83	45 58.4783119	81 49.9697170
1	4	14--7	MED	437482.77	5090566.83	45 57.9494549	81 48.4129983
2	4	10--7	MED	437482.77	5086566.83	45 55.7895668	81 48.3816679
3	4	12--7	MED	437482.77	5088566.83	45 56.8695126	81 48.3973257
4	4	0--8	MED	438482.77	5076566.83	45 50.3951855	81 47.5310326
5	4	7--6	MED	436482.77	5083566.83	45 54.1641427	81 49.1316480
6	4	4--12	MED	442482.77	5080566.83	45 52.5758702	81 44.4694081
7	4	9--7	MED	437482.77	5085566.83	45 55.2495926	81 48.3738446
8	4	7--10	MED	440482.77	5083566.83	45 54.1856150	81 46.0378707
9	4	11--7	MED	437482.77	5087566.83	45 56.3295402	81 48.3894949
10	4	12--18	MED	448482.77	5088566.83	45 56.9243287	81 39.8823858
1	4	6--12	LOW	442482.77	5082566.83	45 53.6558428	81 44.4837730
2	4	3--11	LOW	441482.77	5079566.83	45 52.0308262	81 45.2351883
3	4	17--18	LOW	448482.77	5093566.83	45 59.6242635	81 39.9146984
4	4	6--13	LOW	443482.77	5082566.83	45 53.6608168	81 43.7104377
5	4	17--19	LOW	449482.77	5093566.83	45 59.6287295	81 39.1399662
6	4	7--12	LOW	442482.77	5083566.83	45 54.1958278	81 44.4909605
7	4	4--10	LOW	440482.77	5080566.83	45 52.5656670	81 46.0155691
8	4	3--13	LOW	443482.77	5079566.83	45 52.0408519	81 43.6892699
9	4	5--10	LOW	440482.77	5081566.83	45 53.1056506	81 46.0229994
10	4	9--14	LOW	444482.77	5085566.83	45 55.2856651	81 42.9579220

Random Order	FRM	SILOC	DENSITY	XEasting UTMNAD83	YNorthing UTMNAD83	LAT DM_NAD83	LONG DM_NAD83
1	5	1--6	HIGH	396396.3	5095491.96	46 00.3099982	82 20.2871481
2	5	9--8	HIGH	398396.3	5103491.96	46 04.6469653	82 18.8400116
3	5	4--9	HIGH	399396.3	5098491.96	46 01.9564603	82 18.0008821
4	5	2--6	HIGH	396396.3	5096491.96	46 00.8498705	82 20.3001701
5	5	10--9	HIGH	399396.3	5104491.96	46 05.1957143	82 18.0769528
6	5	1--5	HIGH	395396.3	5095491.96	46 00.3008822	82 21.0618758
7	5	2--5	HIGH	395396.3	5096491.96	46 00.8407516	82 21.0750234
8	5	3--6	HIGH	396396.3	5097491.96	46 01.3897418	82 20.3131983
9	5	4--8	HIGH	398396.3	5098491.96	46 01.9475985	82 18.7760051
1	5	11--8	MED	398396.3	5105491.96	46 05.7267057	82 18.8656569
2	5	10--18	MED	408396.3	5104491.96	46 05.2716706	82 11.0937824
3	5	12--4	MED	394396.3	5106491.96	46 06.2301607	82 21.9829496
4	5	5--5	MED	395396.3	5099491.96	46 02.4603544	82 21.1145036
5	5	9--9	MED	399396.3	5103491.96	46 04.6558409	82 18.0642593
6	5	11--6	MED	396396.3	5105491.96	46 05.7086800	82 20.4176475
7	5	12--5	MED	395396.3	5106491.96	46 06.2393959	82 21.2068438
8	5	4--5	MED	395396.3	5098491.96	46 01.9204877	82 21.1013372
9	5	5--9	MED	399396.3	5099491.96	46 02.4963382	82 18.0135455
10	5	9--10	MED	400396.3	5103491.96	46 04.6646288	82 17.2885009
1	5	4--3	LOW	393396.3	5098491.96	46 01.9019759	82 22.6515274
2	5	2--4	LOW	394396.3	5096491.96	46 00.8315453	82 21.8498703
3	5	7--4	LOW	394396.3	5101491.96	46 03.5308643	82 21.9163308
4	5	10--4	LOW	394396.3	5104491.96	46 05.1504448	82 21.9562830
5	5	7--17	LOW	407396.3	5101491.96	46 03.6438956	82 11.8346748
6	5	9--4	LOW	394396.3	5103491.96	46 04.6105856	82 21.9429593
7	5	3--2	LOW	392396.3	5097491.96	46 01.3527297	82 23.4130759
8	5	6--15	LOW	405396.3	5100491.96	46 03.0875785	82 13.3738431
9	5	10--6	LOW	396396.3	5104491.96	46 05.1688159	82 20.4045696
10	5	6--16	LOW	406396.3	5100491.96	46 03.0958322	82 12.5984276
1	6	6--8	HIGH	359632.65	5104969	46 05.0325434	82 48.9318674
2	6	5--7	HIGH	358632.65	5103969	46 04.4804376	82 49.6896841

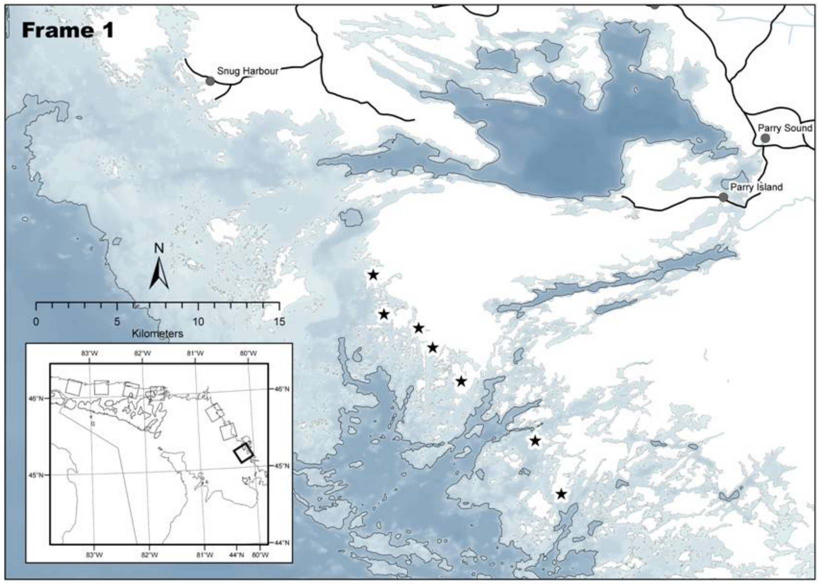
Random Order	FRM	SILOC	DENSITY	XEasting UTMNAD83	YNorthing UTMNAD83	LAT DM_NAD83	LONG DM_NAD83
1	6	9--4	MED	355632.65	5107969	46 06.6017176	82 52.0890967
2	6	3--6	MED	357632.65	5101969	46 03.3885150	82 50.4293076
3	6	6--12	MED	363632.65	5104969	46 05.0811389	82 45.8291863
4	6	12--4	MED	355632.65	5110969	46 08.2208816	82 52.1438580
5	6	7--8	MED	359632.65	5105969	46 05.5722842	82 48.9495826
6	6	5--6	MED	357632.65	5103969	46 04.4679857	82 50.4651990
7	6	8--10	MED	361632.65	5106969	46 06.1365124	82 47.4154783
8	6	7--13	MED	364632.65	5105969	46 05.6328281	82 45.0705807
9	6	7--6	MED	357632.65	5105969	46 05.5474526	82 50.5011247
10	6	6--7	MED	358632.65	5104969	46 05.0201754	82 49.7075168
1	6	12--11	LOW	362632.65	5110969	46 08.3076204	82 46.7090164
2	6	2--10	LOW	361632.65	5100969	46 02.8980136	82 47.3107737
3	6	2--7	LOW	358632.65	5100969	46 02.8612185	82 49.6362371
4	6	4--10	LOW	361632.65	5102969	46 03.9775170	82 47.3456420
5	6	1--8	LOW	359632.65	5099969	46 02.3338257	82 48.8434180
6	6	5--4	LOW	355632.65	5103969	46 04.4428190	82 52.0162032
7	6	10--8	LOW	359632.65	5108969	46 07.1915007	82 49.0027788
8	6	1--7	LOW	358632.65	5099969	46 02.3214769	82 49.6184383
9	6	11--11	LOW	362632.65	5109969	46 07.7678730	82 46.6916379
10	6	2--8	LOW	359632.65	5100969	46 02.8735711	82 48.8610910

Random Order	FRM	SILOC	DENSITY	XEasting UTMNAD83	YNorthing UTMNAD83	LAT DM_NAD83	LONG DM_NAD83
1	7	9--11	MED	320191.93	5115579.54	46 10.2033490	83 19.7582224
2	7	12--14	MED	323191.93	5118579.54	46 11.8691646	83 17.4956163
3	7	10--12	MED	321191.93	5116579.54	46 10.7587000	83 19.0042733
4	7	9--13	MED	322191.93	5115579.54	46 10.2348389	83 18.2049774
5	7	10--13	MED	322191.93	5116579.54	46 10.7744058	83 18.2275190
6	7	10--14	MED	323191.93	5116579.54	46 10.7900238	83 17.4507539
7	7	9--14	MED	323191.93	5115579.54	46 10.2504520	83 17.4283388
8	7	9--15	MED	324191.93	5115579.54	46 10.2659772	83 16.6516895
9	7	12--9	MED	318191.93	5118579.54	46 11.7901464	83 21.3805982
10	7	9--12	MED	321191.93	5115579.54	46 10.2191379	83 18.9816053
1	7	6--9	LOW	318191.93	5112579.54	46 08.5528601	83 21.2423486
2	7	8--10	LOW	319191.93	5114579.54	46 09.6479191	83 20.5119189
3	7	12--7	LOW	316191.93	5118579.54	46 11.7579236	83 22.9345143
4	7	12--15	LOW	324191.93	5118579.54	46 11.8847043	83 16.7185876
5	7	6--8	LOW	317191.93	5112579.54	46 08.5368227	83 22.0185542
6	7	6--10	LOW	319191.93	5112579.54	46 08.5688097	83 20.4661321
7	7	4--5	LOW	314191.93	5110579.54	46 07.4091208	83 24.3001005
8	7	6--5	LOW	314191.93	5112579.54	46 08.4881839	83 24.3471046
9	7	3--4	LOW	313191.93	5109579.54	46 06.8532146	83 25.0523982
10	7	6--6	LOW	315191.93	5112579.54	46 08.5044846	83 23.5709322

Appendix 12

Quantitative electrofishing site coordinates and maps of electrofishing site locations within each frame

			Waypoint Latitude and Longitude					
Frame	Site	Length (m)	Start		100 metres		200 metres	
1	11	200	45.28117	-80.21983	45.28167	-80.22133	45.28200	-80.22167
1	12	200	45.26200	-80.21467	45.26250	-80.21567	45.26333	-80.21600
1	13	200	45.25533	-80.19783	45.25467	-80.19783	45.25450	-80.19783
1	14	200	45.24583	-80.19100	45.24550	-80.19117	45.24517	-80.19133
1	15	100	45.22950	-80.17717	45.22967	-80.17717		
1	16	200	45.20067	-80.14133	45.20000	-80.14083	45.20000	-80.14033
1	17	200	45.17483	-80.12867	45.17517	-80.12833	45.17633	-80.12767
2	21	200	45.50233	-80.39050	45.50333	-80.39050	45.50417	-80.39050
2	22	200	45.49050	-80.40583	45.49050	-80.40550	45.48967	-80.40400
2	23	200	45.46500	-80.39400	45.46617	-80.39483	45.46617	-80.39500
2	24	200	45.45567	-80.42933	45.45517	-80.43033	45.45517	-80.43133
2	25	100	45.42200	-80.38600	45.42250	-80.38683		
2	26	200	45.42400	-80.35917	45.42367	-80.35833	45.42333	-80.35700
2	27	200	45.41900	-80.33533	45.41817	-80.33533	45.41750	-80.33517
3	31	200	45.81550	-80.68783	45.81617	-80.68683	45.81683	-80.68767
3	32	200	45.80717	-80.67317	45.80733	-80.67333	45.80817	-80.67250
3	33	200	45.80350	-80.67583	45.80283	-80.67467	45.80200	-80.67400
3	34	100	45.77467	-80.64383	45.77417	-80.64350		
3	35	200	45.76667	-80.61617	45.76633	-80.61500	45.76633	-80.61383
3	36	200	45.74983	-80.64833	45.75033	-80.64767	45.75067	-80.64667
3	37	200	45.73533	-80.65433	45.73567	-80.65317	45.73617	-80.65200
4	41	200	45.94483	-81.87700	45.94567	-81.87633	45.94650	-81.87533
4	42	100	45.97833	-81.86233	45.97833	-81.86100		
4	43	200	45.97833	-81.79900	45.97733	-81.79700	45.97800	-81.79767
4	44	200	45.96650	-81.74833	45.96583	-81.74783	45.96483	-81.74733
4	45	200	45.98833	-81.73200	45.98750	-81.73167	45.98667	-81.73167
4	46	200	45.95017	-81.68550	45.95067	-81.68433	45.95100	-81.68317
4	47	200	45.96250	-81.64083	45.96300	-81.63967	45.96367	-81.63900
5	51	200	46.17383	-82.33550	46.17383	-82.33683	46.17400	-82.33817
5	52	200	46.14967	-82.33200	46.15033	-82.33283	46.15083	-82.33417
5	53	200	46.13867	-82.31000	46.13883	-82.31133	46.13917	-82.31267
5	54	200	46.13850	-82.27300	46.13833	-82.27183	46.13850	-82.27067
5	55	100	46.12983	-82.25317	46.12950	-82.25183		
5	56	200	46.10067	-82.12017	46.10067	-82.12150	46.10067	-82.12300
5	57	200	46.09267	-82.11517	46.09300	-82.11617	46.09333	-82.11717
6	61	100	46.17533	-82.88317	46.17500	-82.88450		
6	62	200	46.17550	-82.83217	46.17517	-82.83333	46.17517	-82.83467
6	63	200	46.18867	-82.79567	46.18883	-82.79700	46.18867	-82.79833
6	64	200	46.19050	-82.76283	46.19017	-82.76400	46.19017	-82.76550
6	65	200	46.19350	-82.72100	46.19300	-82.72200	46.19267	-82.72350
6	66	200	46.20000	-82.68317	46.19967	-82.68417	46.19883	-82.68517
6	67	200	46.19800	-82.65100	46.19750	-82.64967	46.19767	-82.64833
7	71	200	46.22817	-83.36967	46.22850	-83.37083	46.22883	-83.37150
7	72	200	46.22517	-83.36167	46.22450	-83.36250	46.22433	-83.36350
7	73	200	46.21800	-83.33017	46.21833	-83.33167	46.21800	-83.33283
7	74	200	46.21450	-83.30917	46.21500	-83.30817	46.21583	-83.30783
7	75	200	46.20717	-83.29100	46.20783	-83.29017	46.20867	-83.29033
7	76	200	46.19850	-83.22217	46.19867	-83.22350	46.19883	-83.22483
7	77	100	46.19667	-83.18667	46.19667	-83.18800		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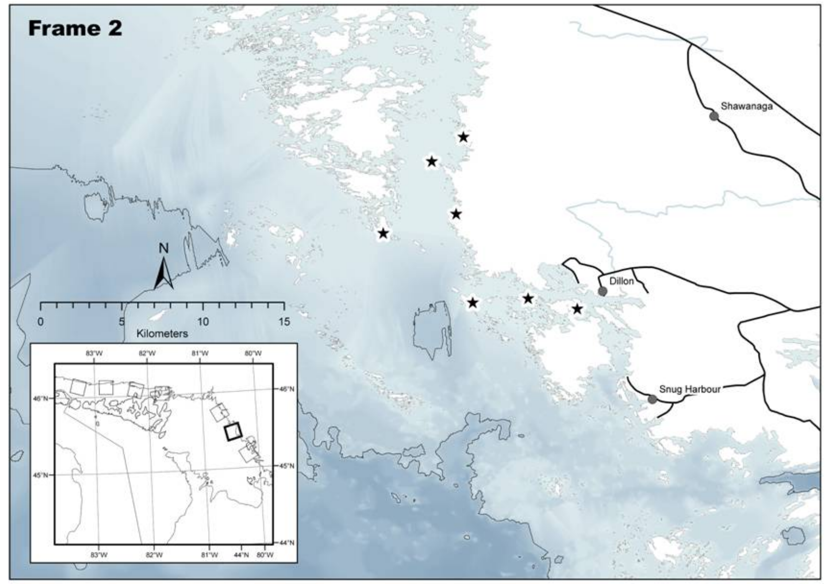
Snug Harbour
Parry Sound
Parry Island
N
0
5
10
15
Kilometers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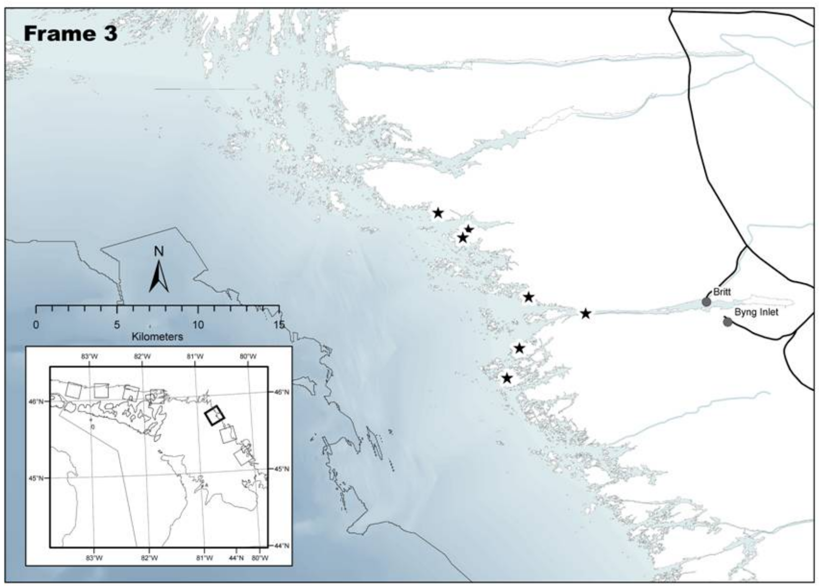
Shawanaga
Dillon
Snug Harbour
N
0
5
10
15
Kilometers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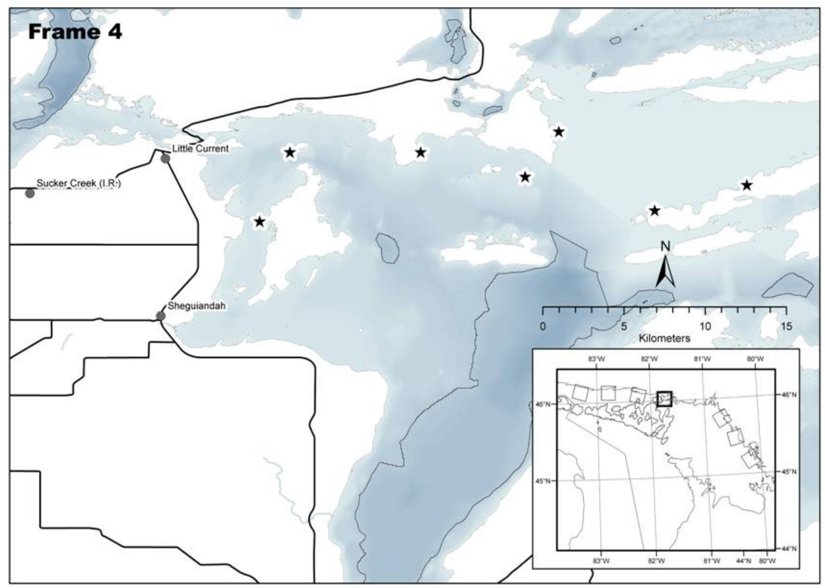
Britt
Byng Inlet
N
0
5
10
15
Kilometers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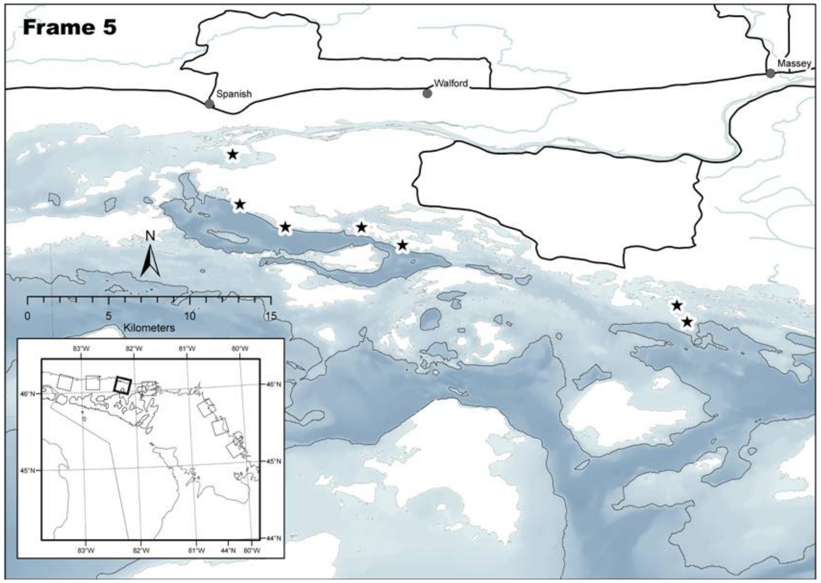
Little Current
Sucker Creek (I.R.)
Sheguiandah
N
0
5
10
15
Kilometers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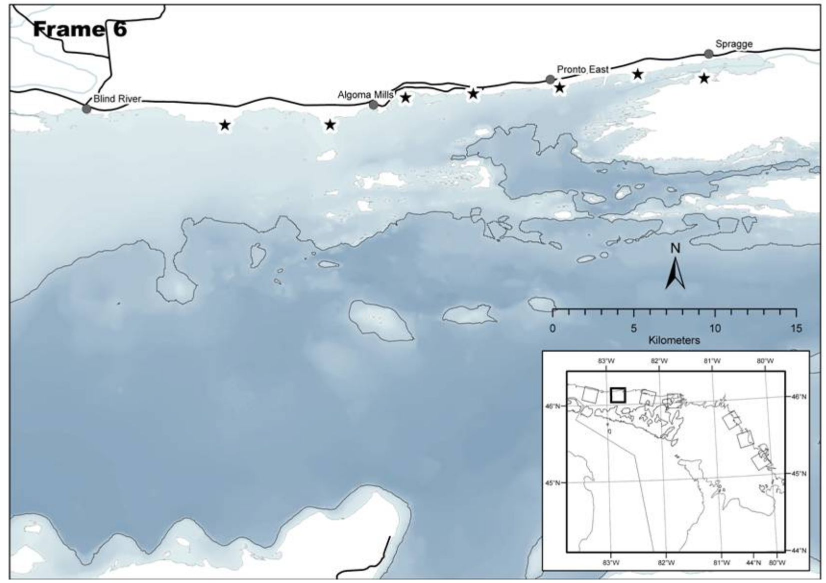
Spanish
Walford
Massey
N
0 5 10 15
Kilometers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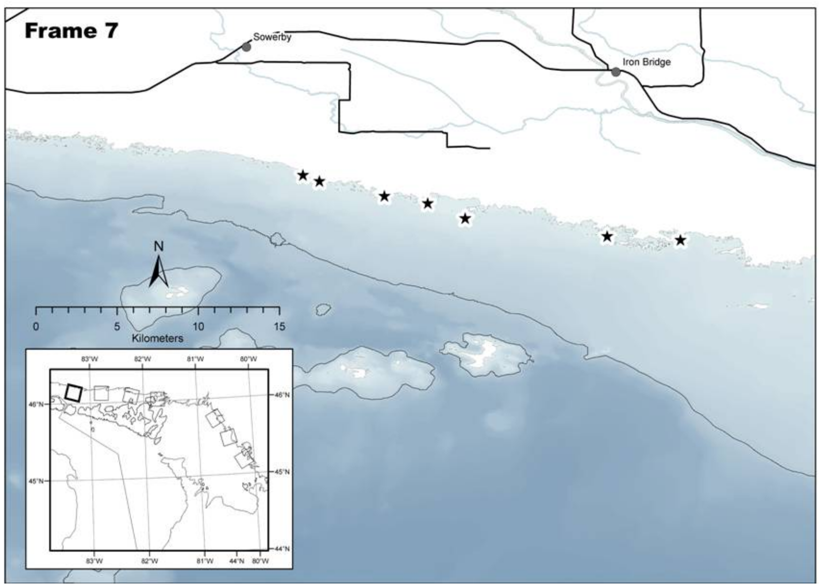
Blind River
Algoma Mills
Pronto East
Spragge
N
0 5 10 15
Kilometers


Frame 7
Sowerby
Iron Bridge
N
0 5 10 15
Kilometers