



Fisheries and Oceans  
Canada

Pêches et Océans  
Canada

GENERAL

# REPORT

Oceans, Habitat and Species at Risk Publication Series, Newfoundland and Labrador Region

## Gilbert Bay Marine Protected Area Monitoring Report



Photo Credit: CCDA and Bruce Lane

Canada

Oceans, Habitat and Species at Risk Publication Series,  
Newfoundland and Labrador Region  
No. 0001

2009

**GILBERT BAY MARINE PROTECTED AREA MONITORING REPORT**

by

J. M. Janes<sup>1</sup>, C. J. Morris<sup>1</sup>, E. J. Bennett<sup>1</sup>, and J. M. Green (MUN)<sup>2</sup>

<sup>1</sup>Fisheries and Oceans Canada, Newfoundland and Labrador Region  
P.O. Box 5667  
St. John's, NL A1C 5X1

<sup>2</sup>Department of Biology, Memorial University of Newfoundland  
St. John's, NL A1B 3X9.

© Her Majesty the Queen in Right of Canada, 2009.  
Cat. No. Fs22-6/1-2009E  
ISBN 1919-2193  
ISSN 1919-2193  
DFO No. 2009-1542

Correct citation for this publication:

Janes, J.M., Morris, C.M., Bennett, E.J., and J.M. Green 2009. Gilbert Bay Marine Protected Area Monitoring Plan. Oceans, Habitat and Species at Risk Publication Series, Newfoundland and Labrador Region. 0001: v + 12 p.

# Table of Contents

ABSTRACT.....	iv
1.0 INTRODUCTION .....	1
1.1. GILBERT BAY .....	1
1.2 GILBERT BAY MARINE PROTECTED AREA (MPA) .....	1
2.0 MONITORING TO MEET CONSERVATION OBJECTIVES.....	2
3.0 GILBERT BAY COD MONITORING PROGRAM .....	2
3.1 COD MONITORING METHODS .....	3
3.1.1 Plankton sampling - Cod egg and pelagic juvenile abundances .....	3
3.1.2 Adult cod sampling - population dynamics.....	3
3.1.3 Acoustic and Sonic tags - movements of Gilbert Bay cod .....	3
3.1.4 Oceanographic sampling – cod ecosystem .....	4
3.2 GENERAL TRENDS AND RESULTS .....	4
4.0 HABITAT MAPPING .....	5
5.0 WATER QUALITY MONITORING PROGRAM .....	6
6.0 ENFORCEMENT AND MONITORING.....	7
7.0 FUTURE PLANS .....	7
8.0 REFERENCES .....	8
APPENDIX 1: Map of Gilbert Bay Marine Protected Area.....	10
APPENDIX 2: Benthic Habitats of the Gilbert Bay Marine Protected Area .....	12

## ABSTRACT

The Gilbert Bay Marine Protected Area (MPA) was established under the *Oceans Act* in October, 2005 to conserve and protect a genetically distinct sub-species of Northern cod along the southeast coast of Labrador. MPA Management plans released in 2007 outline conservation objectives, associated management actions and goals for scientific monitoring. This monitoring plan outlines the methodology, general trends and results of the Gilbert Bay cod monitoring program, as well as results from the habitat mapping and water quality monitoring programs.

General trends and results from the cod monitoring program indicate an increase in the proportion of large cod. However, poor juvenile recruitment in recent years translates into no increase in biomass. Another contributing factor is that the large cod (> 50 cm) are migrating out of the MPA and possibly getting caught. The habitat mapping program identified The Shinney's, River Out (coralline-algal-encrusted gravel habitat) and Mogashu Tickle (gravel habitat) as areas of high biodiversity. These results are consistent with other research that identified The Shinney's as an important cod spawning and juvenile habitat site. As part of monitoring the cod habitat within the MPA, the water quality inside the MPA was measured for several years. No negative impacts were detected and it was decided that annual monitoring was no longer necessary.

## RÉSUMÉ

La zone de protection marine (ZPM) de la baie Gilbert a été établie en vertu de la *Loi sur les océans* en octobre 2005 afin de conserver et de protéger une sous-espèce de morue du Nord distincte sur le plan génétique qui se trouve le long de la côte sud-est du Labrador. Les plans de gestion de la ZPM rendus publics en 2007 définissent les objectifs de la conservation et décrivent les mesures de gestion qui y sont rattachées ainsi que les buts visés par la surveillance scientifique. Le présent plan de surveillance expose les méthodes suivies, les tendances générales observées et les résultats obtenus dans le cadre du programme de surveillance de la morue de la baie Gilbert, ainsi que les résultats obtenus dans le cadre des programmes de cartographie de l'habitat et de surveillance de la qualité de l'eau.

Il ressort des tendances générales et des résultats provenant du programme de surveillance de la morue que la proportion de grandes morues est en hausse. Toutefois, en raison du piètre recrutement des juvéniles ces dernières années, il n'y a pas d'augmentation de la biomasse. Le fait que les grandes morues (> 50 cm) émigrent de la ZPM et sont donc peut-être capturées contribue aussi à cette absence de hausse de la biomasse. Le programme de cartographie de l'habitat a établi que The Shinney's, River Out (habitat de gravier incrusté de coralline officinale) et le passage Mogashu (habitat de gravier) étaient des zones de haute diversité. Cela correspond aux résultats des autres travaux de recherche selon lesquels The Shinney's joue un rôle important comme frayère

et alevinière de la morue. Dans le cadre du programme de surveillance de l'habitat de la morue dans la ZPM, la qualité de l'eau au sein de la ZMP a été mesurée pendant plusieurs années. Aucun impact néfaste n'ayant été décelé, on a jugé qu'une surveillance annuelle n'était plus nécessaire.

Voici l'information au sujet du rapport :

**Collection de publications de la Direction des océans, de l'habitat et des espèces en péril, Région de Terre-Neuve et du Labrador**

**Rapport de surveillance de la zone de protection marine de la baie Gilbert**

J. M. Janes, C. J. Morris, E. J. Bennett et J. M. Green

Pêches et Océans Canada, Région de Terre-Neuve et du Labrador  
C.P. 5667  
St. John's (T.-N.-L.) A1C 5X1

## **1.0 INTRODUCTION**

### **1.1. GILBERT BAY**

Gilbert Bay is a narrow inlet located on the southeast coast of Labrador approximately 300 km from Happy Valley-Goose Bay. A relatively remote region of the province of Newfoundland and Labrador, it is an area rich in culture with strong links to the land and sea. The population of the southeast region of Labrador is approximately 3,000 with a significant portion of this population being aboriginal, Inuit and people of European descent known as Métis (Murphy et al. 2002). The key communities near Gilbert Bay are Port Hope Simpson and William's Harbour where the majority of stakeholders reside. Located approximately 20 km from Gilbert Bay, Port Hope Simpson has a resident population of approximately 575 (1996). Originally established as a logging town in 1934, fishing became and remains the mainstay of the community (Murphy et al. 2002). William's Harbour is located at the mouth of Gilbert Bay approximately 35 km east of Port Hope Simpson and has a population of approximately 45 (1996). Originally a summer fishing station, summer residents eventually settled in the area on a year round basis in the late 1970s (DFO 2007).

### **1.2 GILBERT BAY MARINE PROTECTED AREA (MPA)**

Scientists from Memorial University of Newfoundland (MUN) have been studying Atlantic cod in Gilbert Bay since 1996. The study of Atlantic cod involved Fisheries and Oceans Canada (DFO) since 1997. MUN scientists working together with fish harvesters identified Gilbert Bay cod as a resident population, genetically distinct from other Atlantic cod populations (Ruzzante et al. 2000; Wroblewski 2000). In light of this information local residents became very concerned when the commercial northern cod fishery re-opened in 1998. Fishing effort in the region targeted Gilbert Bay cod because of its relative abundance compared to that found on traditional fishing grounds.

In order to protect the Gilbert Bay population of cod, the communities of Port Hope Simpson and Williams Harbour, with support from local fish harvesters, approached DFO to implement conservation measures. In 1998, DFO began the first of several consultations to determine the suitability of Gilbert Bay as a candidate Marine Protected Area under Canada's *Oceans Act*. Gilbert Bay was announced as an official Area of Interest (AOI) by the Minister of Fisheries and Oceans Canada in October of 2000, which provided interim protection measures for the site. To facilitate the feasibility of the site, the Gilbert Bay Steering Committee (GBSC) was established in 2001. The committee consists of representatives from municipal governments, Labrador Métis Nation, aquaculture, tourism and fishing industries, academia (MUN), Fisheries and Oceans Canada, and the provincial Department of Fisheries and Aquaculture.

Through consultations with the Steering Committee and other stakeholders, regulations specifically for the Gilbert Bay MPA were developed. Public consultations were

conducted to ensure all stakeholders were comfortable with the regulatory intent of the proposed MPA. Once this review process was complete, Gilbert Bay was designated as a Marine Protected Area under the *Oceans Act* on October 11, 2005 (DFO 2007).

On July 18, 2007, the Gilbert Bay Marine Protected Area Management Plan was released. This management plan is intended to guide and inform management decisions for the Gilbert Bay MPA over the next several years. A product of the collaborative efforts of MUN, DFO and numerous other stakeholders, the management plan outlines conservation objectives and management actions for the MPA with respect to scientific monitoring, compliance and enforcement, as well as public awareness. This Management Plan is scheduled for review and renewal in 2010.

The Gilbert Bay MPA monitoring program involves three programs; a cod monitoring program, a habitat mapping program and a water quality program. Data on the cod population has been collected consecutively from 1998 to 2009 and the database is maintained at Fisheries and Oceans Canada. This report includes cod data from 1998 - 2008 only. The habitat mapping program started in 2002 and continued annually from 2005 to 2007. The water quality monitoring started in 2005 and ran consecutively until 2007, at which time it was decided that the program would continue bi-annually.

## **2.0 MONITORING TO MEET CONSERVATION OBJECTIVES**

Regulatory conservation objectives refer to those for which the MPA was created and subsequently supported through the development of site specific regulations. The primary regulatory based conservation objective for the Gilbert Bay MPA is:

- the conservation and protection of the Gilbert Bay cod and its habitats.

The development of related management actions further supports conservation objectives by identifying the activities which will be undertaken by DFO to reach conservation goals and ascertain the effectiveness of the MPA. The monitoring programs outlined in the following sections are implemented to meet this regulatory conservation objective.

## **3.0 GILBERT BAY COD MONITORING PROGRAM**

The Gilbert Bay cod monitoring program is used to assess whether the MPA meets the conservation objectives set out in the management plan. Since 1996, demographic and spatial data has been collected on this cod population by MUN researchers and in collaboration with DFO researchers (since 1998). Over the years this research subsequently developed into a cod monitoring program in Gilbert Bay. Methods used to collect data on Gilbert Bay cod and their habitats include plankton sampling, adult cod



sampling, acoustic tagging and oceanographic sampling. These sampling methods are described below.

### **3.1 COD MONITORING METHODS**

#### ***3.1.1 Plankton sampling - Cod egg and pelagic juvenile abundances***

Plankton sampling is conducted during spring (May-June) and summer (August), to collect cod eggs and juveniles respectively. Samples are collected at depths between 0 and 7 meters, using a 1-m diameter ring net with 333 micrometer mesh (Morris and Green 2002). During spring, cod egg density and stage of egg development indicates the location and timing of spawning. During August, the abundance and size distribution of pelagic juvenile cod indicates year class strength and variation in growth.

The examination of spawning Atlantic cod (approximately 600 individuals) during spring compliments plankton sampling data. Upon capture, fish are examined for maturity status; the number and size of cod releasing milt or eggs is recorded.

#### ***3.1.2 Adult cod sampling - population dynamics***

Approximately 600 fish are tagged (with external t-bar tags), measured and released each spring and summer using hook and line procedure. This is the primary method for sampling fish that are greater than 15 cm. This work is used to monitor population changes in size composition, abundance and catch per unit effort (CPUE) (Morris and Green 2002). Genetic samples (fin clips) are periodically taken from a portion of these fish. A small number of re-captured fish having a tag from a previous year are sacrificed and retained for aging (using otoliths) and examination of diets and general health (Green 2007).

#### ***3.1.3 Acoustic and Sonic tags - movements of Gilbert Bay cod***

Acoustic tagging consists of surgically implanting a tag in the body cavity of the fish. The tags can be tracked from approximately 1 km away using both manual and remote tracking equipment. Several acoustic tagging and tracking studies have been conducted since 1998 to investigate the movement patterns of cod in Gilbert Bay. During the past three years, MUN and DFO researchers have implemented a remote network of receivers distributed throughout Gilbert Bay to collect information year round. Sonic tracking is also used to determine the movements of Gilbert Bay cod, including different movement patterns between small and large fish, as well as movements to areas outside the MPA, i.e. spillover. In the last two years, the use of moored VR2 receivers (hydrophones) has replaced the active tracking of acoustically tagged fish. Strategic placement of VR2 receivers in The Shinneys, the Main Arm of Gilbert Bay, and areas outside the MPA will provide a cost effective picture determining specific habitat use, movement patterns, and oceanographic conditions (J.M. Green Memorial University of Newfoundland St. John's A1B 3X9 "pers. comm.").

### ***3.1.4 Oceanographic sampling – cod ecosystem***

Temperature loggers have been deployed annually in Gilbert Bay since 1998, recording water temperature year round at 2 m and 8 m depths (Morris and Green 2002). The Fisheries Oceanography group at MUN has also maintained a VEMCO temperature data logger off Williams Harbour in Gilbert Bay since 2003. The data logger measures hourly temperatures at 4 m depth (Wroblewski 2008a).

During spring and summer, a calibrated Seabird 19 or 25 CTD (conductivity, temperature, density) instrument has been used to obtain vertical profiles of the water column in the Shinneys and Main Arm of Gilbert Bay. These instruments are provided and maintained by DFO's biological and physical oceanography group. CTD data is used to determine the depth of cod eggs in the water column during the spawning season. Water column characteristics also explain retention mechanisms responsible for maintaining cod eggs within Gilbert Bay.

## **3.2 GENERAL TRENDS AND RESULTS**

These cod are genetically and geographically distinct from other northern cod populations (Wroblewski 2000; Morris and Green 2002). The Gilbert Bay or “Golden” cod range from reddish brown to gold colouration, attributed primarily to a carotenoid rich diet of invertebrates (Gosse and Wroblewski 2004). Gilbert Bay cod spawn in specific areas confined within the bay between the end of May and early June. In contrast, other stocks spawn offshore, usually between January and March. This characteristic provides little or no opportunity for mixing during reproduction that would allow a transfer of genes between the stocks (Ruzzante et al. 2000). Gilbert Bay cod experience slower growth rates than other northern cod populations due, in part, to the limitations in food availability (Morris and Green 2002). It has also been suggested that the slower growth rate is a result of extended periods of low water temperatures (Wroblewski et al. 2007).

The estimated biomass of the Gilbert Bay cod population was around 70 tonnes in 2003 (Morris et al. 2003). Standardized fishing effort data collected since then has indicated a decrease in the number of Gilbert Bay cod, possibly as a result of poor juvenile recruitment in recent years (C. J. Morris, Fisheries and Oceans Canada Box 5667 St. John's A1C 5X1 and J. M. Green, Memorial University of Newfoundland, St. John's A1B 3X9 “unpublished data”). However, there has been an increase in the amount of large commercial-sized cod in the population since the MPA was established.

It is likely that the 1996 year class has been the strongest cohort observed since monitoring began. Since then, recruitment has been highly variable and often poor. Potentially strong cohorts were observed in 2001, 2002 and 2004, but they were not as strong as that produced in 1996 (C. J. Morris, Fisheries and Oceans Canada Box 5667 St. John's A1C 5X1 and J. M. Green, Memorial University of Newfoundland St. John's A1B 3X9 “unpublished data”). It is too early to tell if the 2004 cohort produced a large number of offspring, although early indications suggest it might have. In recent years,

however, recruitment has been low suggesting that although the proportion of large fish may have increased, the total number of individuals in the population may not have increased substantially. It is not uncommon to experience several years of poor recruitment due to environmental conditions. However, it helps to have large number of spawners in the population when good environmental conditions occur in order to produce strong year classes (J. M. Green, Memorial University of Newfoundland, St. John's A1B 3X9 "pers. comm.").

Tagging experiments indicate that cod remain in Gilbert Bay throughout the year (Green and Wroblewski 2000). This "bay residency" and a "homing-to-spawn" behavior will increase the likelihood of reproductive isolation from other cod populations (Green and Wroblewski 2000; Morris and Green 2002). However, during the summer, some Gilbert Bay cod migrate to the headlands, mixing with offshore cod along the Labrador coast but return to Gilbert Bay to spawn (Green and Wroblewski 2000; Morris and Green 2002). These migratory fish consist mainly of larger cod (> 50 cm) (C. J. Morris, Fisheries and Oceans Canada Box 5667 St. John's A1C 5X1 and J. M. Green, Memorial University of Newfoundland, St. John's A1B 3X9 "unpublished data"; Green 2007). Although data is currently limited, acoustic tracking suggests that spillover is more extensive than previously thought, likely in concert with increases in the proportion of large fish in the population (J. M. Green, Memorial University of Newfoundland St. John's A1B 3X9 "pers. comm."). This information is of particular relevance to questions concerning the influence of recreational and/or commercial fishing upon the resident cod population. This data may be valuable to assess the effectiveness of existing and future regulations.

#### **4.0 HABITAT MAPPING**

Identifying critical habitats for Gilbert Bay cod was highlighted as a management action (DFO 2007) to meet the conservation objective of the MPA. The Canadian Hydrographic Service (CHS), in collaboration with DFO's Science Branch and Oceans Programs Division, conducted a multibeam sonar survey of Gilbert Bay in the fall of 2002 (Morris and Power 2004). This survey was initiated by staff at Science Branch to monitor cod habitat use in Gilbert Bay and it covered approximately 32 km<sup>2</sup>. During Phase I of this program, MUN researchers analyzed the bathymetry, slope and multibeam backscatter data from the survey. This analysis generated potential substrate maps for the bay as a whole, and for individual portions of the bay, using backscatter classification rules generated from bottom substrate and biotic data in Newman Sound, Newfoundland (Copeland et al. 2006).

In Phase II, MUN researchers ground-truthed the bathymetry, slope, and backscatter data from the multibeam survey. The methods used to conduct this mapping were underwater video imagery, and grab sampling. Collectively this data allowed the production of substrate maps for all areas of the Gilbert Bay MPA covered by the CHS survey. The substrate and habitat mapping program identified River Out and The Shinneys (MPA

Zone 1B) as areas of high substrate and habitat heterogeneity, and high biodiversity (Copeland et al. 2007).

Field sampling in the River Out area found large sponges, high abundances of coralline-algal-encrusted gravel, and the only site with true rhodoliths. Mogashu Tickle, the only site of the tidal rapids between River Out and The Shinneys, was observed to have extremely high current strengths, and probable areas of exposed rock wall habitats.

The Gilbert Bay cod science monitoring program conducted by Morris and Green indicates that The Shinneys has been the most important spawning area for Gilbert Bay cod since monitoring began in 1998. This area also contains very important juvenile cod habitat. In 2006, habitat mapping in The Shinneys revealed linear ridges of coralline-algal-encrusted gravel atop bedrock, separating current-scoured shallow muddy basins. Mapping was limited by the extent of the multibeam sonar data which covers 38% of the 8 km<sup>2</sup> constituting The Shinneys.

Phase III of the habitat mapping project was conducted during the fall of 2007. This phase of the project was intended to further characterize the habitats and biota of River Out, Mogashu Tickle and The Shinneys, including shallow areas of Zone 1B. This phase also focused on sampling of rock wall habitats in Leg Island Basin, which often have very high biodiversity. Transect lines surveyed with GPS-interfaced single-beam depth sounder and video camera was used to classify substrates in these areas (Copeland et al. 2008). The areas with highest biodiversity observed in Gilbert Bay were the coralline algae encrusted gravel habitat and the Mogashu Tickle gravel habitat (see Appendix 2).

## **5.0 WATER QUALITY MONITORING PROGRAM**

A water quality monitoring program was initiated by the Oceans Programs Division in 2005 due to the presence of a sewage outfall in William's Harbour which serves 100% of the population, and undergoes primary treatment. Solid wastes are filtered and only liquids are discharged as per regulatory standards based on the *Water Resource Act*. Since the sewage outfall is within the boundary of the Gilbert Bay MPA, a preliminary monitoring program has been developed to determine its effect on the health of the local marine ecosystem. This monitoring program continued until 2007 and there were no indications that the outfall was having any negative impacts on ecosystem health. It was recommended that assessments would no longer be required on an annual basis. However, if questionable results are obtained during future inspections, mitigation options will have to be considered and a more stringent, long term monitoring program would have to be put in place.

## **6.0 ENFORCEMENT AND MONITORING**

In order to achieve management objectives for the Gilbert Bay MPA, ongoing enforcement and monitoring of the area is necessary. In an effort to increase the level of enforcement in the Gilbert Bay MPA, in the fall of 2006, the Oceans Division provided funding to the Labrador Métis Nation (LMN). The LMN employed Aboriginal Fisheries Guardians for a 10 week period to conduct regular patrols in the Gilbert Bay area. The Aboriginal Fishery Officers carried out a total of 28 patrols. By the end of the season, a total of one herring net and two seal nets were seized just outside the boundaries of the MPA. However, no charges were laid.

In December 2007, a Service Level Agreement (SLA) between Conservation and Protection Division, DFO and the Oceans Division, DFO was signed. This agreement provides for an increased level of enforcement in the Gilbert Bay MPA during the fall and winter months. The number of patrols increased from three patrols up to 17 multi-day patrols in the Gilbert Bay area. These months were identified by the Gilbert Bay MPA Steering Committee as the time of year when the MPA may be most susceptible to illegal fishing activities due to a decrease in the amount of licensed fishing activity. This Service Level Agreement will be reviewed annually and may vary based on requirements and available resources.

## **7.0 FUTURE PLANS**

The data series on cod movement patterns, population demographics and size, growth rates, spawning time and locations, larval abundance, and oceanographic data are important indicators that ensure the conservation of the Gilbert Bay cod population. Other complimentary monitoring efforts increase our knowledge of cod habitat and ensure continued protection of this MPA. The monitoring program will be reviewed annually and changes incorporated as necessary in consultation with the Steering Committee, DFO Science Branch and MUN, and will depend on available resources. In 2009, a Regional Advisory Process (RAP) is scheduled to review the 10 years of cod data collected in Gilbert Bay.

## 8.0 REFERENCES

- Copeland, A., Bell, T., Edinger, E., Hu, L., and Wroblewski, J. 2006. Habitat Mapping in Gilbert Bay, Labrador - Marine Protected Area Phase I Final Report. Marine Habitat Mapping Group, Memorial University of Newfoundland, St. John's, 68 p.
- Copeland, A., Edinger, E., Bell, T., Hu, L., Wroblewski, J., and Devillers, R. 2007. Habitat Mapping in Gilbert Bay, Labrador - Marine Protected Area Phase II Final Report. Marine Habitat Mapping Group, Memorial University of Newfoundland, St. John's, 108p.
- Copeland, A., Edinger, E., LeBlanc, P., Bell, T., Devillers, R., and Wroblewski, J. 2008. Marine Habitat Mapping in Gilbert Bay, Labrador – Marine Protected Area Phase III Final Report. Marine habitat mapping group report # 08-01, Memorial University of Newfoundland, St. John's, 79 p.
- Fisheries and Oceans Canada, 2007. Gilbert Bay Marine Protect Area Management Plan. Government of Canada.
- Gosse, K.R., and Wroblewski, J.S. 2004. Variant colourations of Atlantic cod (*Gadus morhua*) in Newfoundland and Labrador nearshore waters. ICES J. Mar. Sci. 61(5): 752-759.
- Green, J.M. 2007. Summary of 2007 May/June & July/August Field Work by J. M. Green in the Gilbert Bay, Labrador MPA. Submitted to MPA Program, Oceans Division, Oceans and Habitat Branch, DFO, St. John's August 28<sup>th</sup>, 2007.
- Green, J.M., and Wroblewski, J.S. 2000. Movement patterns of Atlantic cod in Gilbert Bay, Labrador: evidence for bay residency and spawning site fidelity. Journal of the Marine Biological Association of the United Kingdom 80: 1077-1085.
- Morris, C.J., and Power, A. 2004. Habitat mapping at three potential Marine protected Areas in the Newfoundland and Labrador Region. CSAS Res. Doc. 2004/006.
- Morris, C. J., and Green, J.M. 2002. Biological characteristics of a resident population of Atlantic cod (*Gadus morhua* L.) in southern Labrador. ICES J. Mar. Sci. 59: 666–678.
- Morris, C.J., Simms, J.M., and Anderson, T.C. 2002. Biophysical overview of Gilbert Bay: proposed marine protected area. Can. Manuscr. Rep. Fish Aquat. Sci. 2595: 25 p.
- Murphy, M., Morris, C.J., and Simms, J.M. 2002. Socioeconomic overview of Gilbert Bay Area of Interest (AOI) Labrador. Prepared for the Oceans Programs Division, Department of Fisheries and Oceans, St. John's, NL.

Ruzzante, D.E., Wroblewski, J.S., Taggart, C.T., Smedbol, R.K., Cook, D., and Goddard, S.V. 2000. Bay-scale population structure in coastal Atlantic cod (*Gadus morhua*) in Labrador and Newfoundland, Canada. *J. Fish. Biol.* 56: 431-447.

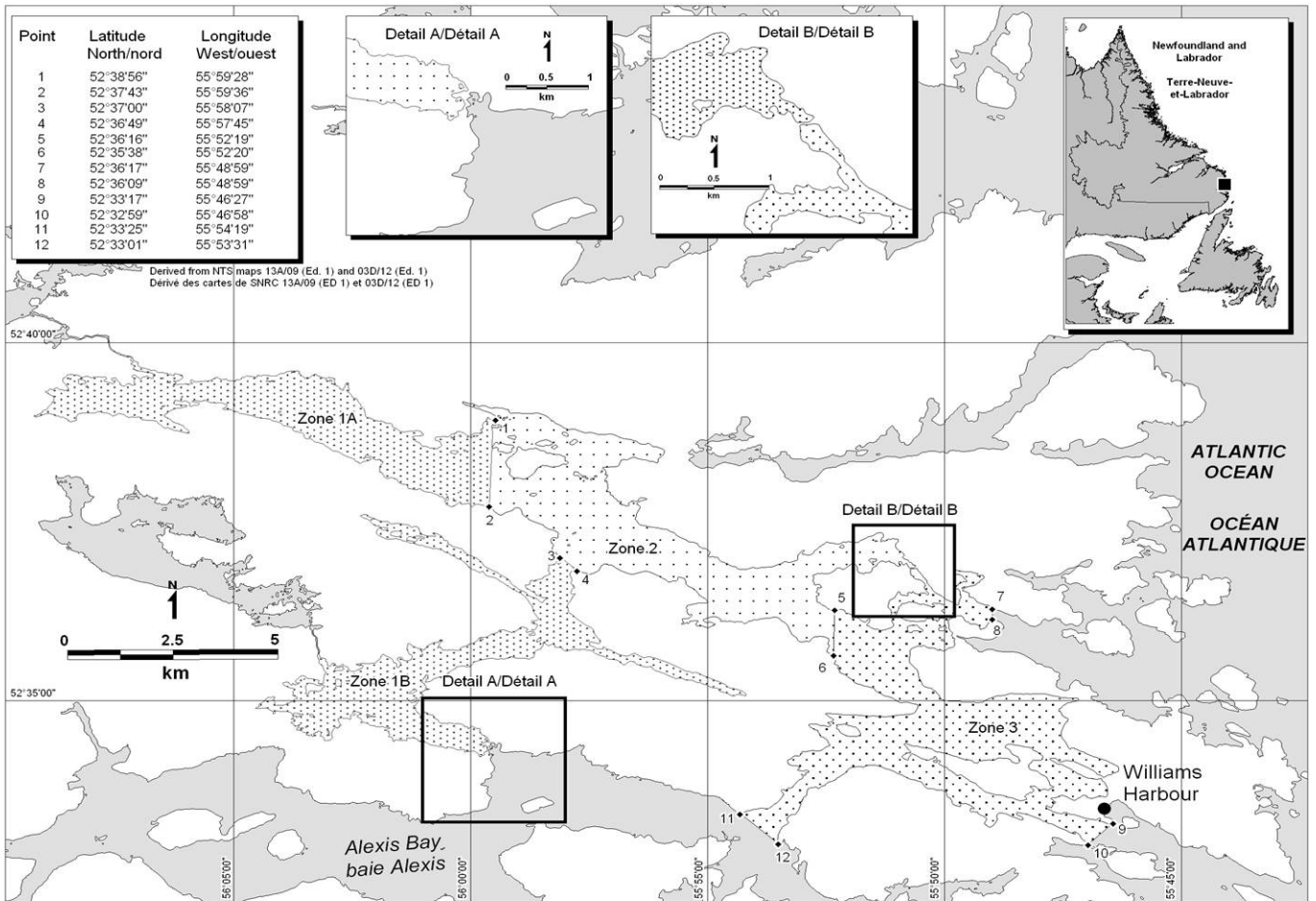
Wroblewski, J. S. 2008a. Ocean temperatures and salinities in Gilbert Bay, Labrador 1996-1997 and 2004-2007. MUN Fisheries Oceanography Group Data Report 2008-1. Memorial University, St. John's. 22p.

Wroblewski, J.S. 2000. The colour of cod: Fishers and scientists identify a local cod stock in Gilbert Bay, southern Labrador. *In* Finding Our Sea Legs: Linking Fishery People and Their Knowledge with Science and Management. Edited by B. Neis and L. Felt. ISER Books, Memorial University, St. John's. pp. 72-81.

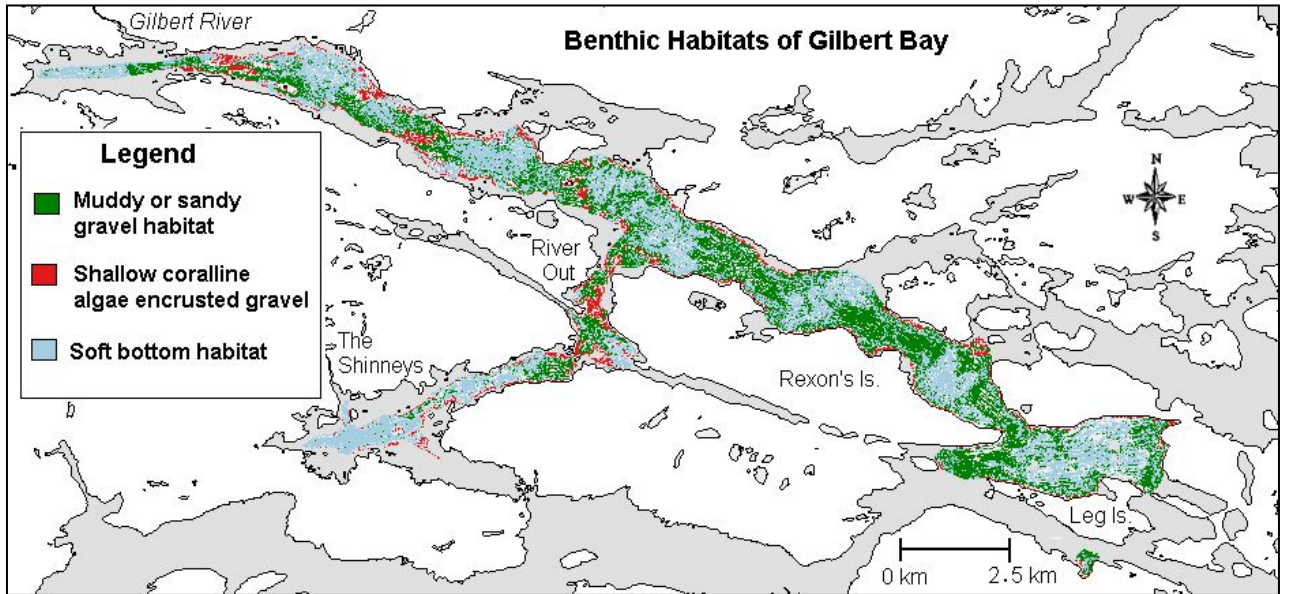
Wroblewski, J.S., Kryger-Hann, L.K., Methven, D.A., and Haedrich, R.L. 2007. The fish fauna of Gilbert Bay, Labrador: A marine protected area in the Canadian subarctic coastal zone. *J. Mar. Biol. Assoc. Unit. Kingd.* 87: 575-587.

**APPENDIX 1: Map of Gilbert Bay Marine Protected Area**





**APPENDIX 2: Benthic Habitats of the Gilbert Bay Marine Protected Area**



Copeland et al. 2008