Development of a Shellfish Monitoring Network in Atlantic Canada 1996-1997

R. Sonier, K. LeBlanc, M. Hardy, M. Ouellette, L.A. Comeau and T. Landry.

Oceans and Sciences Branch
Fisheries and Oceans Canada
Gulf Region
P. O. Box 5030
Moncton, N.B.
Canada E1C 9B6

2011

Canadian Technical Report of
Fisheries and Aquatic Sciences 2944

Canadian Technical Report of Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of Fisheries and Oceans Canada, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in the data base *Aquatic Sciences and Fisheries Abstracts*.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page.

Numbers 1-456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457-714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. Numbers 715-924 were issued as Department of Fisheries and Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Rapport technique canadien des sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. II n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques de Pêches et Océans Canada, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications à part entière. Le titre exact figure au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la base de données *Résumés des sciences aquatiques et halieutiques.*

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre.

Les numéros 1 à 456 de cette série ont été publiés à titre de Rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de Rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de Rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Canadian Technical Report of
Fisheries and Aquatic Sciences

2011

Development of a Shellfish Monitoring Network in Atlantic Canada 1996-1997

by

R. Sonier, K. LeBlanc[1], M. Hardy, M. Ouellette, L.A. Comeau and T. Landry.

Oceans and Sciences Branch
Fisheries and Oceans Canada
Gulf Region
P. O. Box 5030
Moncton, N.B.
Canada E1C 9B6

---

[1] Environmental Affairs, Transport Canada. P.O. Box 42, 95 Foundry Street, Moncton, N.B. Canada E1C 8K6

Cat. No. Fs 97-6/2944E ISSN 0706-6457

Correct citation for this publication is:

R. Sonier, K. LeBlanc, M. Hardy, M. Ouellette, L.A. Comeau and T. Landry. 2011. Development of a Shellfish Monitoring Network in Atlantic Canada 1996-1997. Can. Tech. Rep. Fish. Aquat. Sci. 2944 : viii + 28pp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

R. Sonier, K. LeBlanc, M. Hardy, M. Ouellette, L.A. Comeau and T. Landry. 2011. Development of a Shellfish Monitoring Network in Atlantic Canada 1996-1997. Can. Tech. Rep. Fish. Aquat. Sci. 2944 : viii + 28pp.

The Shellfish Monitoring Network (SMN) is a standardized data collection tool for monitoring growth, meat yield and survival of molluscs in Atlantic Canada. The SMN is also useful for documenting water temperature at the sites. Using the American oyster (*Crassostrea virginica*) as an indicator species, the SMN was evaluated in the southern Gulf of St. Lawrence during the ice-free period (May-November) from 1996 to 1997. Six stations were monitored: Caraquet (NB), Richibouctou (NB), Ellerslie (PEI), Shemogue (NB), Tatamagouche (NS) and Cap Vert (Madelan Islands, QC). Significant differences were found between sites and between years. The survival rate was high at each study site; it ranged between 91 and 100%. Annual growth ranged between 5 and 10 mm at the sites. Mean water temperature ranged between 0 and 26ºC with peak values normally occurring in August. The minimum spawning temperature of 20ºC was recorded in July at the majority of the monitoring stations. Meat yield was site specific: condition index values ranged from 1.7 to 1.9 in May and from 1.6 to 6.8 in November. We conclude that the SMN is a simple, long-term, low-cost, and effective tool for monitoring shellfish growing conditions in relation to aquaculture productivity.

RÉSUMÉ

R. Sonier, K. LeBlanc, M. Hardy, M. Ouellette, L.A. Comeau et T. Landry. 2011. Development of a Shellfish Monitoring Network in Atlantic Canada 1996-1997. Rapp. tech. can. sci. halieut. et aquat.. 2944 : viii + 28pp.

Le Réseau de Surveillance des Mollusques (RSM) est un système de collecte de données standardisé qui évalue la croissance, les rendements de chair et la survie chez les mollusques au Canada Atlantique. Le RSM documente aussi les températures d’eau aux sites. L’huître américaine (*Crassostrea virginica*) fut utilisée comme espèce indicatrice en 1996 et 1997 pendant la période sans glace du sud du Golfe du St. Laurent. Six stations ont été choisies: Caraquet (NB), Richibouctou (NB), Ellerslie (ÎPE), Shemogue (NB), Tatamagouche (NÉ), et Cap Vert (Îles de la Madeleine, QC). Les taux de survie étaient élevés aux sites d’études; ils se chiffraient de 91 à 100%. L'accroissement annuel (mai à novembre) net était entre 5-10 mm au cours des deux années. La température moyenne variait entre 0 et 26ºC de mai à novembre; les valeurs maximales furent généralement atteintes en août. La température minimale pour initier la ponte des huîtres (20ºC) fut généralement atteinte en juillet. Les valeurs d'index de condition furent 1,7 à 1,9 en mai et entre 1,6 à 6,8 en novembre. Le protocole RSM est simple et peu coûteux de sorte à maintenir un programme d'échantillonnage à long terme vis-à-vis la production aquacole.

1.0 INTRODUCTION

Shellfish such as oysters, clams, mussels and scallops not only play an important ecological role as filter feeders, but are also an integral part of Atlantic Canada's economy. Landing values for 1999 were estimated at $163 million (sum for oysters, clams, mussels and scallops). Aquaculture production was valued at $31 million (sum for oysters, clams, mussels and scallops), which is equivalent to 80% of the total Canadian bivalve culture (Statistics Canada 2000). The American oyster is an important species for shellfish aquaculture. In 1999, oyster culture in Atlantic Canada represented $7.6 million (Statistics Canada 2000). Its economic importance has only been recently challenged by the blue mussel (*Mytilus edulis*) (Statistics Canada 2000).

Shellfish growth is influenced by environmental conditions such as water temperature, salinity, food quantity and quality, disease, predation and population density. These conditions can change over short geographical distances and must be taken into account when evaluating the feasibility of new shellfish farms. Monitoring programs are important because they can document geographical and temporal changes in growing conditions. For example, an oyster monitoring pilot study was conducted from 1988 to 1993 by *Le Centre de Recherches en Sciences de L'Environnement* (or the Environmental Sciences Research Centre) de *l'Université de Moncton* (New Brunswick, Canada) in partnership with oyster growers in the Gulf of St. Lawrence (Boghen *et al.* 1990). This was a collaborative initiative between the University and oyster growers of the Northumberland Strait. The objective was to acquire a better understanding of environmental effects on the growth and development of oysters in the Baie des Chaleurs and the Northumberland Strait. Data was collected and maintained in a database to be used as a reference tool for improving the development of commercial culture strategies and to monitor potential effects on the environment (Boghen *et al.* 1990). Industry involvement was necessary for the progression of the project and the program served as a model for other monitoring programs within the Gulf of St. Lawrence.

The "Gulfwatch" monitoring program in turn uses the blue mussel (*Mytilus edulis*) for keeping track of trace metal and toxic organic contaminants in the Bay of Fundy and Gulf of Maine (Sowles *et al.* 1997). Results are made available through a database that provides information on the status of water and sediment quality (Sowles *et al.* 1997). Gulfwatch has existed since 1991 and successfully operates through a plethora of government and non-government partnerships.

In France, researchers recognized that data collection methods for molluscs vary significantly between investigators, making comparisons problematic or impossible (Littaye-Mariette 1994). In 1993, a standardized and long-term monitoring method known as REMORA (*Réseau Mollusques des Rendements Aquacoles*) was developed by the French Research Institute for Exploitation of the Sea (IFREMER). REMORA was developed a as management tool, and essentially consists of taking oysters (*Crassostrea gigas*) from a single source, deploying them at fixed stations along the French coast, and monitoring their growth and health. The single source ensures that genetic traits are similar throughout the study population. The protocol requires 250 oysters per monitoring station: 200 are kept in a vexar bag for physiological analyses, whereas the remaining 50 are fixed to a plastic sheet [typically PVC (polyvinyl chloride) material] for growth analyses. This standard approach enables straightforward comparisons between sites and years.

In 1995, the Department of Fisheries and Oceans Canada (DFO) in partnership with the oyster industry began developing the Shellfish Monitoring Network (SMN) in the southern Gulf of St. Lawrence (Figure 1). The objective was similar to one identified in REMORA (*i.e.* to develop a standardized and long-term monitoring system that allows site-to-site and year-to-year comparisons). Initial trials used the blue mussel as an indicator of bay growing conditions. However, this protocol was challenging due to mussel spat availability at the time and low survival rates associated with the plastic sheet substrate.

In 1996, the use of the American oyster as an indicator proved successful. American oysters can be found in shallow waters at depths ranging from mid-intertidal to 30 m (Lavoie 1995). Oysters have a greater tolerance to temperature, salinity and air exposure compared to mussels. In addition, the oyster is an ideal bio-indicator for environmental monitoring because there is vast scientific knowledge readily available on the species, it has a worldwide distribution and it is a popular aquaculture species.

This report describes the methodology associated with the SMN, and presents results obtained during the developmental phase (1996 to 1997) through a simple, time and cost effective method of investigation that can be used in order to assess the health and performance of oysters in Atlantic coastal waters. The SMN involves distributing juvenile oysters from a single source to various sites throughout Atlantic coastal waters. The oysters are then measured during four key sample periods from May to November. Growth, condition index, survival and temperature monitoring at each station provide a good picture of oyster health. The documentation and distribution of the data obtained from this project represent a long-term and standardized method of data collection. It is hoped that continued industry, government and non-government partnerships of the Shellfish Monitoring Network will continue to develop shellfish aquaculture. Sample stations will be maintained so that they may represent shellfish health for the whole of Atlantic coastal waters.

2.0 MATERIALS AND METHODS

2.1 Spat and juvenile collection

The SMN protocol consists of retrieving juvenile oysters from a single site in the spring, deploying them at fixed stations, and monitoring their growth and health until winter. This protocol was repeated in 1996 and 1997.

The first step of the SMN in spring each year consisted of collecting juvenile oysters. Although the southern Gulf of St. Lawrence represents the northernmost geographical limit in the distribution of the American oyster (Figure 4), large oyster populations are found in the coastal waters of New Brunswick (NB), Prince Edward Island (PEI) and Nova Scotia (NS). Smaller populations are located in the Bras D'Or Lake, the Mira River, Cape Breton, and Ragged Head in Chedabucto Bay (Lavoie 1995). In this study, juvenile oysters originated from wild populations in Bouctouche Bay, NB, which was identified as a reliable and consistant source for yearly collections of seed. They were collected as spat (1 – 10 mm) by a local grower. The spat were transferred to a nearby 'nursery' lease where they grew into 2-year old juveniles. Juveniles were procured shortly after the ice had left, typically in May. At the beginning of the study, it was decided that the animals would be selected within a given size range, namely between 60 and 65 mm.

2.2 Shell growth and mortality

Shortly after their collection in spring, the juvenile oysters were transported to 10 monitoring stations: Caraquet NB; Richibouctou NB; Ellerslie PEI; Shemogue NB; Tatamagouche NS and Cap Vert, Québec (QC) (Figure 1). At each site, oysters were transferred into a condo cage (Figure 2), itself placed in an oyster cage (Figure 3) for protection. The condo cage was developed to monitor the individual performance of 32 oysters. In 1995, cages were suspended in the water column; however, this approach was fraught with difficulties because of the vulnerability of the cages to storms and/or vandalism. Cages were placed in the subtidal zone below spring low tides to avoid such problems.

At the deployment in May, the shell length (maximum distance between the umbo and the shell margin; Figure 2) of each condo animal was recorded to the nearest 0.1 mm using an electronic calliper. Thereafter, shell length was recorded every two months until November. Average daily shell growth for oysters in a condo was calculated for each site using the following formula:

$$G_R = \frac{\sum_{oyster=1}^{n} \frac{(L_A - L_S)}{D}}{n}$$

Where *n* represents the number of live oysters inside the condo cage, L_A and L_S are the shell lengths in autumn (November) and spring (May), respectively, and *D* is the number of days between L_A and L_S measurements. The mortality rate is reported as the percentage of animals that were dead in November.

2.3 Condition index

Condition indices are widely used in mollusc and shellfish aquaculture as measurements of the physiological condition of the species (Lucas and Beninger 1985). They are often used to evaluate the condition of the soft tissues (meat) in relation to its size (shell weight). Low tissue mass, relative to shell weight, may be an indication that animals are in a state of post-reproduction, are exhibiting signs of stress and/or an indication of the quantity and the quality of the food consumed by the animal.

Condition index analyses require that animals be sacrificed over the course of the year. Therefore, each cage in the SMN contained a Vexar® (plastic-meshed material) bag holding 100 juvenile oysters to provide for samples throughout the research period. Samples of 30 oysters are retrieved from each Vexar® bag in July, September and November and compared to a sample of 30 oysters which were obtained from the source sample at the nursery lease in May. All samples were kept on ice and stored at -18°C until analyzed. In the laboratory, the thawed oysters were shucked and their tissues were dried at 65°C for 18-24 h. Dry tissues were weighed and then ashed at 450°C. Shells were cleaned, air-dried, and weighed. The formula removes any biases due to water and inorganic content in soft tissue. The condition index is calculated as in Wayne and Millican (1975):

$$Condition\ Index = \frac{\left(Dry\ meat\ weight\,(g) - Ash\ weight\,(g)\right) \times 100}{Dry\ shell\ weight\,(g)}$$

2.4 Water temperature

Water temperatures were monitored between 1996 and 1997 by securing temperature recorders to condo cages. From May to November, the recorders (Minilogs®, Vemco Ltd. Canada) logged water temperature every hour with a resolution of 0.2°C and a nominal accuracy of ±0.5°C.

2.5 Statistics

In this report, 1996 and 1997 data were submitted to statistical procedures. To determine whether differences existed between the multiple sites or months, sample means were compared using the one-way ANOVA procedure or the Kruskal-Wallis test when ANOVA conditions weren't met. The Fisher's Least Significant Difference statistic was used to identify which pair of means differed. Where only two sample means were compared, the Student T-test or the two-sample Kruskal-Wallis test was used. A significance threshold of p-value 0.05 was adopted for all statistical tests. All analyses were corrected for missing values and results were presented as means ± 1 standard error (SE). Statistical analyses were performed with Systat Version 10 © SPSS Inc. 2000.

3.0 RESULTS AND DISCUSSION

3.1 Comparisons between sites

3.1.1 Survival

The survival rate of the caged oysters was high at all study sites, with the 1996-1997 averages ranging between 91 and 100% (Table 1). Overall, the survival rates are in agreement with industry standards for bottom culture operations (M. Daigle, Aquaculture Acadienne, pers. comm.). Most sites may therefore be excellent areas for cultivating oysters or for the enhancement and restoration of public shellfish areas.

3.1.2 Shell growth

Mean growth rates for all sites in 1996 and 1997 are presented in Tables 3 and 4. Estimates for net annual growth for the Gulf of St. Lawrence shellfish growing areas were in the range of 4.68–9.84 mm (season typically between May to November) for 1996 and 1997 (Table 5). Only Ellerslie showed inconsistent growth between 1996 and 1997, whereas Richibouctou was the most consistent (Table 5). Shemogue and Richibouctou had the highest growth rates for both years (Tables 3 and 4); however, these measures were very similar to some of the other study sites. Growth rates were significantly lower at the Tatamagouche and Ellerslie sites in 1997 compared to 1996 (Table 2). The cause(s) for this reduction in growth are not clear. In terms of geographical comparisons, site-to-site differences were detected in both 1996 and 1997. Shemogue presented the fastest growth in both years, whereas Caraquet showed the slowest growth (Table 5). The shell growth in Caraquet was between 5.33-6.32 mm in 1996 and 1997, whereas Allard and Doiron (1993) estimated the mean annual shell growth to be 11.3 mm for oysters grown on rearing tables in Caraquet Bay. Some observed decreases of shell length are the result of breakage due to a weak shell margin usually caused by environmental factors (i.e. storm event, high winds) but may also be attributed to poor husbandry practices. Energy could be re-allocated from soft tissue growth to shell growth for strengthening the shell margin during the growing season for protection against continued breakage.

3.1.3 Temperature

The variation of temperatures from site-to-site and from year-to-year in the study areas are shown in Figures 7 to 12. Interesting trends were observed between temperature and oyster growth (Tables 5 and 6). For example, Shemogue had the highest mean annual growth but did not have the highest temperature. Richibouctou had the highest mean temperature as compared to all other sites (Table 7). In this case, differences in net annual growth did not seem to be directly related to temperature. Fluctuations in food availability may be responsible for the observed differences. Monitoring temperature is important for establishing whether or not a shellfish growing area can provide optimal temperature conditions for mollusc shellfish. Average daily temperatures for the Gulf of St. Lawrence from 1996-1997 were between 0-26°C from May to December, which is lower than the optimal range of 20 to 30°C described in much of the literature (Sellers and Stanley 1984). Temperature requirements for oyster growth and spawning in Atlantic Canada may be at the lower thresholds following acclimatisation to the region. For all sampling stations, the temperature regime appears to be adequate for survival as well as growth, albeit slower in some areas. The traditional description of the geographical range for *C. virginica* (Figure 4) appears to be much larger than previously thought. Therefore, the oyster could prove to be a potential key specie for the development of aquaculture in regions outside the Gulf region as well. Further evidence to support this hypothesis is the presence of *C. virginica* in Oak Bay, St. Stephen, NB (S. Robinson, DFO- St. Andrews, pers. comm. 2003). Oysters were introduced to the area in the 1970`s and are still present today, although the actual dynamics of this population are still unknown (S. Robinson, DFO- St. Andrews, pers. comm. 2003).

3.1.4 Condition index

As early as July, two months following deployment, the caged oysters presented significant differences in physiological condition. This result, observed in both 1996 (Figure 5) and 1997 (Figure 6), indicates that the major physiological processes for this species are linked to local environmental factors (energy utilization for reproduction and spawning, post-reproduction energy reallocation in tissues before water temperature reaches below 4°C). It also appears that peak condition values occur at different sites from year to year. In 1996, for instance, peak values within the network were recorded at the Ellerslie site in November (Figure 5); in 1997, however, peak values shifted to the Shemogue and Tamatagouche sites (Figure 6). Condition index is a valuable measure for mollusc shellfish aquaculture as it helps identify changes in the soft tissue mass of the oyster in relation to its shell size. If tissue mass does not increase, it may be an indication that animals were exhibiting signs of stress and that the quantity and quality of the food taken in by the animal is only maintaining the survival of the animal and is not sufficient to promote growth.

3.2 Site specific data

3.2.1 Caraquet (NB)

This oyster cage was located at the southern end of Caraquet Bay. Water temperature at this site ranged between 0 and 26˚C during the monitoring effort (Figure 7). In terms of seasonal changes, the mean temperature increased until early August; it began declining steadily in September. Overall, the Caraquet site is favorable for oyster survival (Table 1). The shell length of caged oysters increased from May to September. Although growth effectively ceased in

September, growth rates were calculated for the May to November period in order to compare one site with another. At the Caraquet site, growth rates averaged 0.034 mm/d from May to November for 1996 and 1997 respectively which represented net growth of approximately 5 to 6 mm per year (Table 2 and Table 5). The condition index generally followed an increasing trend from May to November in both years, ranging from up to 2.84 in November 1996 from it's baseline of 1.87 in May (Figures 5). This result indicates that the oysters were accumulating energy reserves over the summer months, and that the commercial quality was best in autumn.

3.2.2 Richibouctou (NB)

The oyster monitoring cage was located in the Saint Charles River, Petite-Aldouane, Richibouctou (NB) which flows into the Richibouctou Harbour. Oyster culture is well developed within this estuary. Mean daily temperatures ranged from 5 to 25ºC between May and November (Figures 8). Annual shell growth averaged approximately 0.049 mm/day (Table 2). Oyster condition reached up to 3.08 in July 1997 followed by a significant drop to 1.74 in November (Figure 6). These differences were likely due to spawning activities by the caged oysters. In Richibouctou, spawning temperatures (20ºC) were reached in mid-June. In 1997 the year end condition index (November) of the oysters was interestingly similar to the May baseline (Figure 6) compared to 1996 data (Figure 5) where condition index was higher at year end then in May. Overall conditions in Richibouctou are favorable for oyster survival (Table 1) and growth (Table 2).

3.2.3 Shemogue (NB)

The oyster monitoring cage was located in Little Shemogue Harbour, downstream from Blacklock Brook. One oyster culture lease is present in Little Shemogue Harbour, and the area was once a site for commercial oyster harvest. Temperature range was 4 to 24˚C from May to November, with a mean peak temperature in mid-July for both years (Figure 9). Annual shell growth averaged approximately 0.0556 mm/d (Table 2). In 1996 oyster condition index increased throughout the year and reached a maximum of 3.31 in November (Figure 5), while in 1997 the maximum of 3.78 occurred in September (Figures 6). Soft tissue growth was favorable throughout the monitoring effort. Little Shemogue Harbor provided excellent conditions for oyster survival (Table 1) and growth.

3.2.4 Ellerslie (PEI)

The monitoring cage was located near the shellfish hatchery in Ellerslie PEI. The mean daily temperature range was 5 to 26˚C from May to November, with a mean peak temperature in August for both years (Figures 10). Annual shell growth averaged between 5 to 8 mm per year (Table 5). Oyster condition varied significantly from year to year. In 1996 the condition index increased consistently to a maximum of 6.87 in November (Figure 5), while in 1997 the index peaked at 2.92 in July and decreased thereafter (Figure 6). The decrease in growth from June to July as seen 1997 may be due to a spawning event by the caged oysters. Ellerslie offers excellent growing conditions for oyster growth and represents the highest condition index levels observed in the monitoring stations. Large numbers of starfish on the oyster monitoring cage were observed for the study years. However, their presence did not seem to have contributed significantly to higher mortality rates (Table 1).

3.2.5 Tatamagouche (NS)

The oyster monitoring cage was located in Tatamagouche Bay, downstream from Dobson Creek in Malagash NS. The mean temperature range was 5 to 24˚C during the recorded period, with peak temperatures in August (Figures 11). However, those peak temperatures (27 and 33˚C) may have been the result of the temperature probe being air-exposed at very low tides. Annual shell growth averaged between 7-8 mm (Table 5). Oyster condition increased throughout the season for both years, reaching their maximum of 3.69 and 3.61 in 1996 and 1997 respectively (Figures 5 and 6). Soft tissue growth was favorable throughout the study period. The oyster sampling cage and oysters were typically covered by oyster spat (oysters with a shell length of ≤10 mm). Spat was found on cages during September, but a large portion of oyster spat had died between September and November. These observations suggest that this site may prove to be a useful spat collection area. However, spat collected in this area for aquaculture purposes should still be investigated for survival. Furthermore, the labour associated with maintaining the quality of the oyster (removing the oyster spat collected on the oysters) may be high and is worth consideration before establishing a commercial oyster lease on this particular site.

3.2.6 Cap Vert (QC)

An oyster monitoring cage was in Cap Vert, located on the south-eastern coastal waters of the Magdelan Islands (QC). Temperature range in 1997 was 5 to 21˚C from May to November, with a mean peak temperature in August (Figure 17). Only a few days had temperatures which exceeded 20ºC. This may have implications for spawning at the site. Shell growth averaged 5.22 mm in 1997 (Table 5). Oyster condition in 1997 varied only slightly from the initial condition, increasing from 1.66 to 1.87 from May to July and thereafter decreasing 1.58 for the remainder of the year (Figure 6). Environmental conditions did not appear to have significant effects on survival or growth for oysters caged in Cap Vert (Table 1).

4.0 CONCLUSIONS

In 1996 and 1997, the SMN demonstrated variability between sites and between years in many of the observed parameters. This standardized system allows for comparisons of growth, condition, survival and temperatures, where none would normally be possible. For shellfish growers, the SMN provides a baseline and shows trends with which to the growers can evaluate their production. Direct comparisons of SMN results and aquaculture production should be avoided because of the important impact of different husbandry methods. For example, growth measurements in the SMN provide local shellfish growers with estimates of grow-out time to market or a given site. Based on 1996-1997 growth results, oysters at the SMN sites are expected to attain the cocktail size (64 mm) within four to five years, while reaching commercial size (76 mm) requires additional time. Shemogue, Richibouctou and Tatamagouche could attain the latter market-size within five to seven years, whereas all other sites may require as long as eight years. Since the SMN reflects bottom-culture, time-to-market may have been overestimated because much of the industry has replaced the bottom culture approach with the generally faster growing floating bag technique. Although growth may be different due to husbandry, the results observed in the SMN will likely be very representative of the relative trends and provide important answers to growers.

The SMN has been kept simple and affordable in order to promote its use as a long-term sustainable data collection program that can be used by groups in partnership with DFO. The documentation and distribution of the data collected is becoming an integral element of this program. The SMN provides a framework with which to conduct additional scientific studies and environmental monitoring. It is hoped that industry-government partnerships, and continued support from Provincial Agencies, will ensure the continuation and expansion of this shellfish monitoring network.

5.0 ACKNOWLEDGMENTS

Fisheries and Oceans Canada would like to thank all participants that provided past and continued support of the SMN including the aquaculture industry throughout the Gulf of St. Lawrence, Provincial Fisheries and Aquaculture Departments in New Brunswick, Nova Scotia, Prince-Edward-Island and Québec. Special thanks to the following companies, agencies and individuals for their various technical contributions in 1996 and 1997 (in alphabetical order):

Gerald Cormier	Caraquet (NB)
Maurice Daigle	Aquaculture Acadienne, Richibouctou (NB)
Ellen and Andrew Ferguson	Tatamagouche (NS)
Neil MacNair	Department of Fisheries, Aquaculture and Environment, Charlottetown (PEI)
Bruno Myrand	Agriculture, Pêcheries et Alimentation, Station Technologique Maricole des Îles de la Madeleine, Iles-de-la-Madeleine (QC)
Steven and Brian Pauley	Little Shemogue Oyster Farm, Shemogue (NB)

7.0 LITERATURE CITED

Allard, J. and Doiron, S. 1993. Growth of American Oyster (*Crassostrea virginica*) on 3-level Tables. Bull. Aquacul. Assoc. Canada 93-4.

Boghen, A., Allard, J., Beninger, P. and Bataller, E. 1990. A monitoring program for the oyster industry of New Brunswick: Current status. Bull. Aqua. Assoc. Can. 1:75-78.

Lavoie, R. E. 1995. Culture of the American Oyster, *Crassostrea virginica*. Pages from 191-224 from Cold-Water Aquaculture in Atlantic Canada, Second Edition, edited by Andrew D. Boghen © 2000 The Canadian Institute for Research and Regional Development (ISBN: 0-88659-033-7)

Littaye-Mariette, A. 1994. Monitoring the growth of *Crassostrea gigas* in French oyster farming areas: protocol and results of 1993. ICES C.M. 1994/F: 15

Lucas, A. and Beninger, P. G. 1985. The use of physiological condition indices in marine bivalve aquaculture. Aquaculture 44, 187-200.

Rosenthal, H., Scarratt, D.J. and McInerney-Northcott, M. 2000. Aquaculture and the Environment. Pages from 451-500 from Cold-Water Aquaculture in Atlantic Canada, Second Edition, edited by Andrew D. Boghen © 2000 The Canadian Institute for Research and Regional Development (ISBN: 0-88659-033-7)

Scarrat, D.J., Cook, R. H.; Drinnan, R. E. and Sanders, F. 1987. Impact of Climate on Aquaculture in Atlantic Canada. In Proceedings of the Nova Scotia Climate Advisory Committee on the Impact of Climate on Fisheries, May 11, 1987, Halifax, Nova Scotia, and edited by W. G. Richards.

Sowles, J., Crawford, R., Hennigar, P., Harding, G., Jones, S., Chases, M., Robinson, W., Perderson, J., Coombs, K., Taylor, D. and Greeman, K. 1997. Gulfwatch project standard procedures: field and laboratory: Gulfwatch implementation period 1993-2001.p.115

Sellers, M.A. and Stanley, J.G. 1984. Species Profiles: Life Histories and Enveronmental Requirements of Coastal Fishes and Invertabrates (North Atlantic). American Oyster. U.S. Fish Wildl. Serv. FWS/0BS-82/11.23. U.S. Army Corps of Engineers, TR EL-82-4. 15pp.

Statistics Canada 2000. www.statisticscanada.ca. Statistics Canada - Cat. No. 23-603-UPE. Prepared in September 2000.

Wayne, P. R. and Millican, P. F. 1975. Growth and biochemical composition in *Ostrea edulis* and *Crassostrea gigas*. In. H. Barnes (Editor), Proc. 9th Eur. Mar. Biol. Symp., Oban. Aberdeen University Press, Aberdeen, pp. 587-607.

Table 1: Percent survival of 32 oysters placed in condo cages during a six month exposure (May to November) at all sample stations for 1996 and1997.

Site (Province)	1996	1997	Mean survival (%)
Caraquet (NB)	100	94	97
Richibouctou (NB)	97	91	94
Ellerslie (PEI)	97	91	94
Shemogue (NB)	100	94	97
Tatamagouche (NS)	97	97	97
Cap Vert (QC)	n/a*	100	100

* Cap Vert (Qc) was only monitored in 1997.

Table 2: Site comparisons for growth rate (mm/day) between 1996 and 1997. Asterisks (*) indicate significant differences (p-value < 0.05) between 1996 and 1997.

Site	Mean ± SE (mm/day) 1996	Mean ± SE (mm/day) 1997	p
Caraquet (NB)	0.0340 ± 0.0031	0.0341 ± 0.0021	0.967
Richibouctou (NB)	0.0542 ± 0.0035	0.0443 ± 0.0035	0.0529
Shemogue (NB)	0.0550 ± 0.0039	0.0562 ± 0.0033	0.810
Tatamagouche (NS)	0.0499 ± 0.0037	0.0402 ± 0.0031	0.05*
Ellerslie (PEI)	0.0518 ± 0.0048	0.0266 ± 0.0026	0.0005*
Cap Vert (QC)	n/a*	0.0363 ± 0.0030	

* Cap Vert (Qc) was only monitored in 1997.

Table 3: Site comparisons for growth rates (mm/day) during 1996 exposures. The asterisk (*) indicates a significant difference (p-value < 0.05) in growth rates between sites. Different growth rates are represented by a different letter.

Site	Sampling Date (1996)	Mean ± SE (mm/day)	p-value
Shemogue (NB)	3 Jun - 4 Nov	0.0550 ± 0.0039 *ab*	0.001*
Richibouctou (NB)	3 Jun - 6 Nov	0.0542 ± 0.0035 *ab*	
Ellerslie (PEI)	3 Jun -5 Nov	0.0518 ± 0.0048 *ab*	
Tatamagouche (NS)	3 Jun - 8 Nov	0.0499 ± 0.0037 *bc*	
Caraquet (NB)	3 Jun -7 Nov	0.0340 ± 0.0031 *c*	

Table 4: Site comparisons for growth rate (mm/day) during 1997 exposures. The asterisk (*) indicates a significant difference (p-value < 0.05) in growth rates between sites. Different growth rates are represented by a different letter.

Site	Sampling Date (1997)	Mean ± SE (mm/day)	p-value
Shemogue (NB)	14 May - 4 Nov	0.05620 ± 0.0033 *a*	0.0005*
Richibouctou (NB)	14 May - 7 Nov	0.0443 ± 0.0035 *ab*	
Tatamagouche (NS)	14 May - 4 Nov	0.0402 ± 0.0031 *b*	
Cap Vert (QC)*	13 June - 4 Nov	0.0360 ± 0.0031 *b*	
Caraquet (NB)	14 May - 14 Nov	0.0341 ± 0.0021 *b*	
Ellerslie (PEI)	14 May - 6 Nov	0.0266 ± 0.0026 *c*	

* Cap Vert (Qc) was only monitored in 1997.

Table 5: Net annual growth and estimate of number of years to reach Cocktail and Commercial oysters length for those grown throughout sample sites in the southern Gulf of St. Lawrence.

Site	Net annual growth (mm) 1996	1997	Cocktail market (65 mm or 2.5 inches)	Commercial market (76 mm or 3 inches)
Caraquet (NB)	5.33	6.32	5-6	7-8
Richibouctou (NB)	8.51	7.89	5	6
Shemogue (NB)	8.52	9.84	4-5	5-6
Tatamagouche (NS)	7.94	7.03	4-5	6-7
Ellerslie (PEI)	8.08	4.68	5-6	6-8
Cap Vert (QC)	n/a*	5.22	6	8

Estimates are for oysters grown from year 0.
* Cap Vert (Qc) was only monitored in 1997.

Table 6: Comparisons of mean temperature (°C) during ice-free period at the study sites.

Site	Sampling Date	Mean ± SE (°C) 1996	Mean ± SE (°C) 1997
Caraquet (NB)	20 Jun-20 Sept	19.1 ± 0.248	19.1 ± 0.175
Richibouctou (NB)	6 June-10 Sept	19.8 ± 0.163	20.4 ± 0.194
Shemogue (NB)	24 Jun-2 Nov	16.4 ± 0.451	16.7 ± 0.455
Tatamagouche (NS)	17 Jun-3 Nov	17.4 ± 0.415	17.2 ± 0.173
Ellerslie (PEI)	27 May-5 Nov	17.2 ± 0.409	16.4 ± 0.369
Cap Vert (QC)	12 Jun-4 Nov	n/a*	14.8 ± 0.346

* Cap Vert (Qc) was only monitored in 1997.

Table 7: Comparisons of mean temperature (°C) during ice-free period at the study sites in 1996 and 1997. Asterisks (*) indicate significant differences (p-values < 0.05) in annual comparisons among the six sites. Different letters assigned to the temperature represent data that are different from one another.

Site	Sampling Date	Mean ± SD (°C)	p-value
Ellerslie (PEI)	14 Jul-10 Sept 1996	21.6 ± 0.197 *a*	0.0001*
Shemogue (NB)		20.5 ± 0.164 *b*	
Caraquet (NB)		20.2 ± 0.250 *b*	
Richibouctou (NB)	14 Jul-10 Sept 1997	22.2 ± 0.177 *a*	0.0005*
Ellerslie(PEI)		20.6 ± 0.118 *b*	
Tatamagouche (NS)		21.0 ± 0.252 *b*	
Shemogue (NB)		20.4 ± 0.185 *bc*	
Caraquet (NB)		19.6 ± 0.180 *c*	
Cap Vert (QC)		18.3 ± 0.141 *d*	

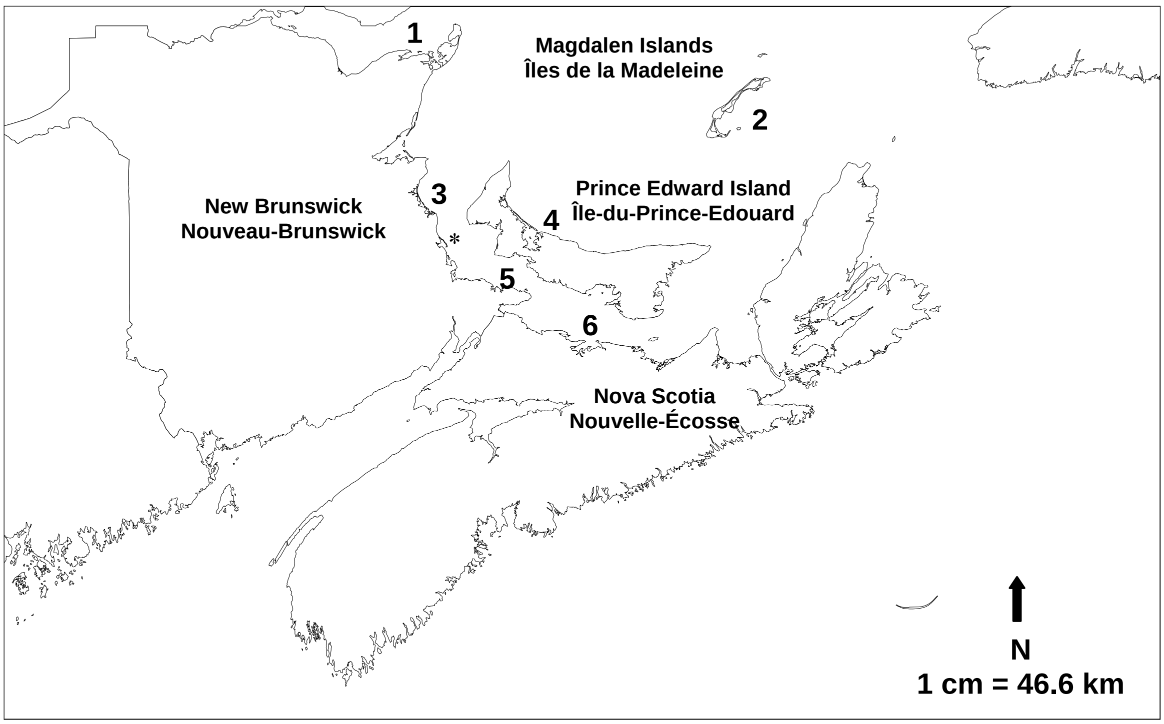


Figure 1: Oyster monitoring sites in Atlantic Canada during the study period of 1996 and 1997. The asterisk (*) represents the location of broodstock collection, Bouctouche (NB). The number (1) Caraquet NB, (2) Cap Vert, Îles de la Madeleine QC, (3) Richibouctou NB, (4) Ellerslie PEI, (5) Shemogue NB, (6) Tatamagouche NS.

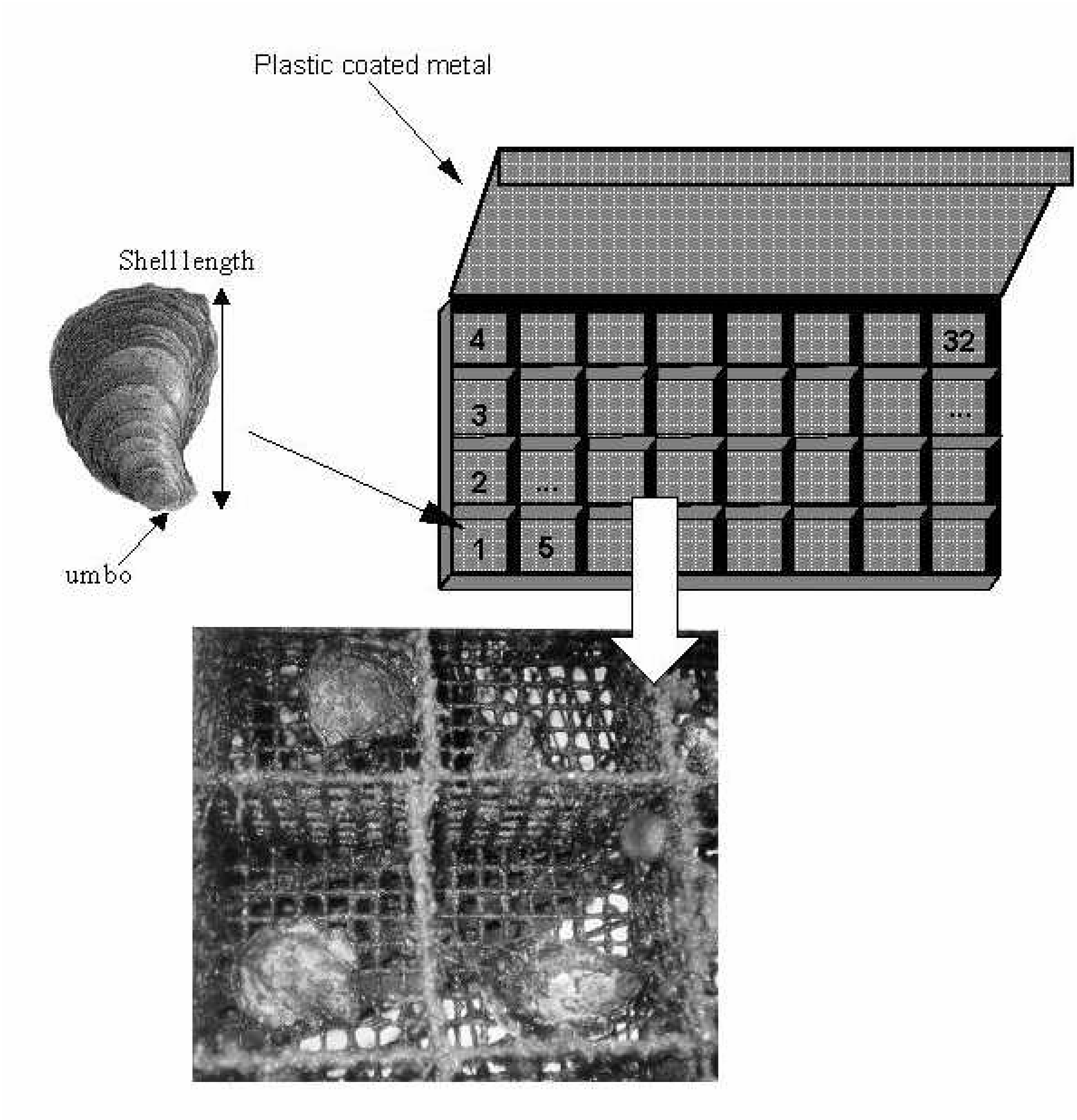


Figure 2: Picture of a condo cage used for measuring individual oyster growth. The condo is placed within the oyster monitoring cage.

Figure 3: Photograph of oyster monitoring cage used for the Shellfish Monitoring Network. This study method is representative of oyster bottom-culture.

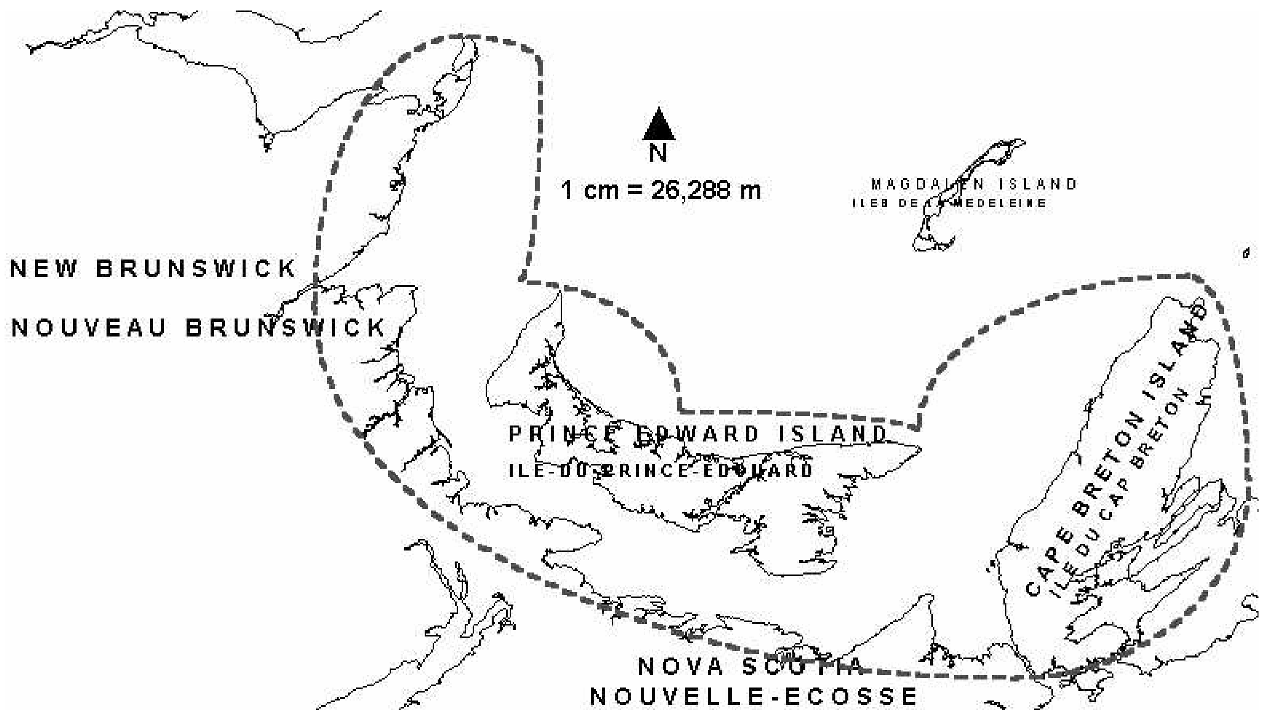


Figure 4: Geographical limits of oyster harvest and potential development of oyster culture in the Gulf of St. Lawrence as described by Rosenthal *et al.* (2000) and as adapted from Scarratt *et al.* (1987).

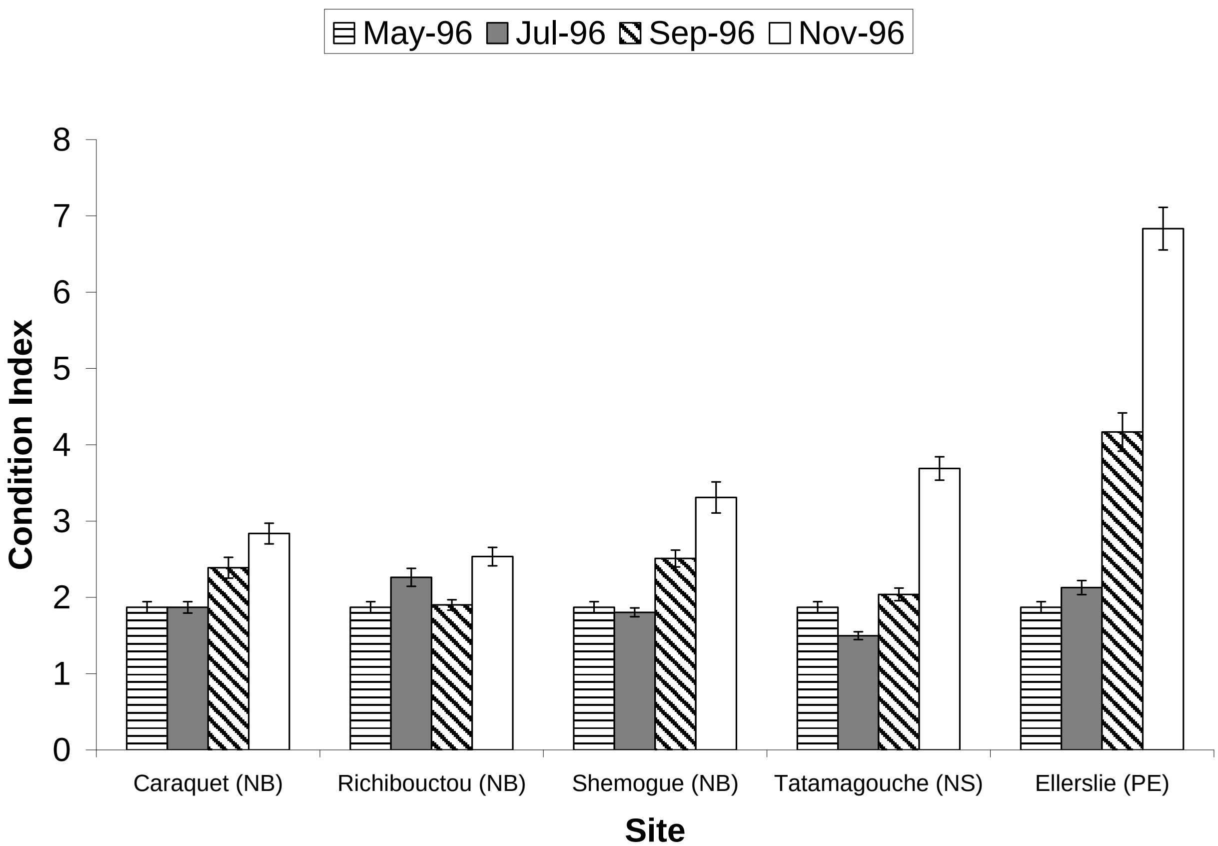


Figure 5: Condition index of oysters during 1996 (n=30).

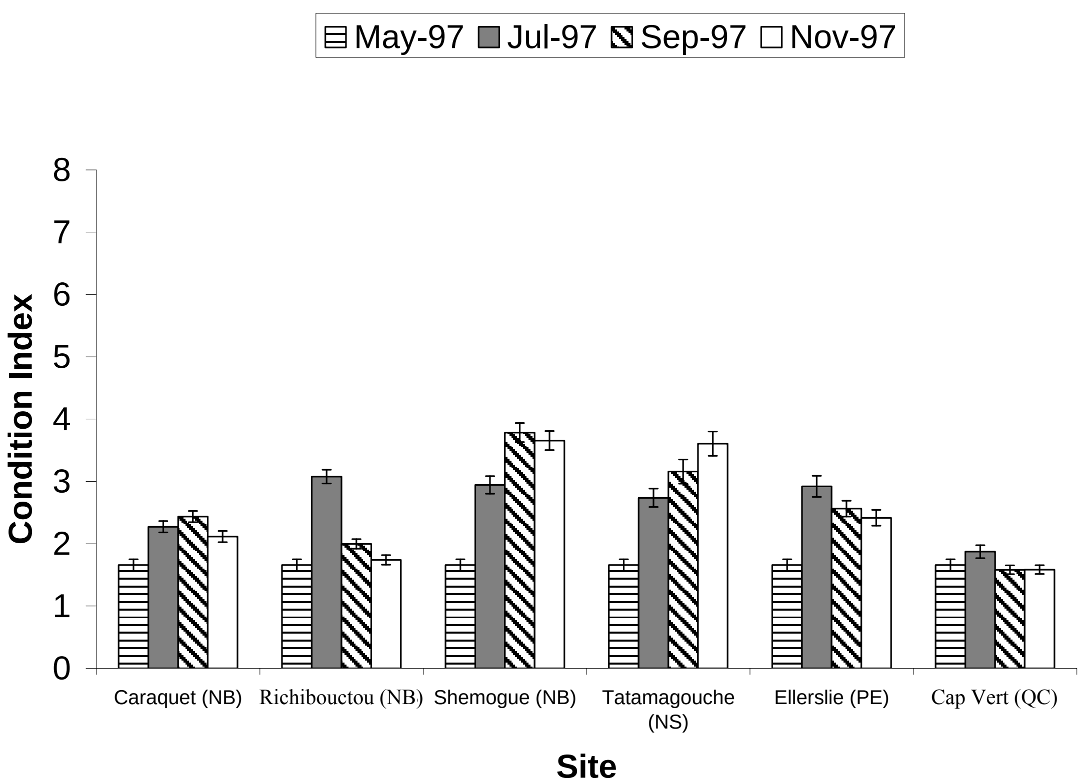
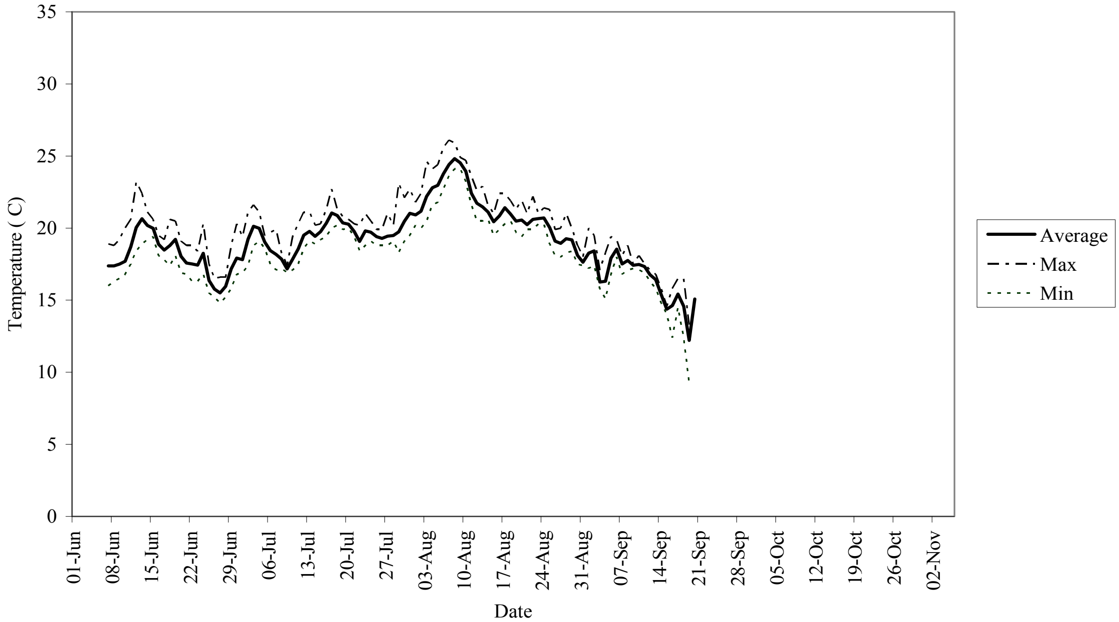
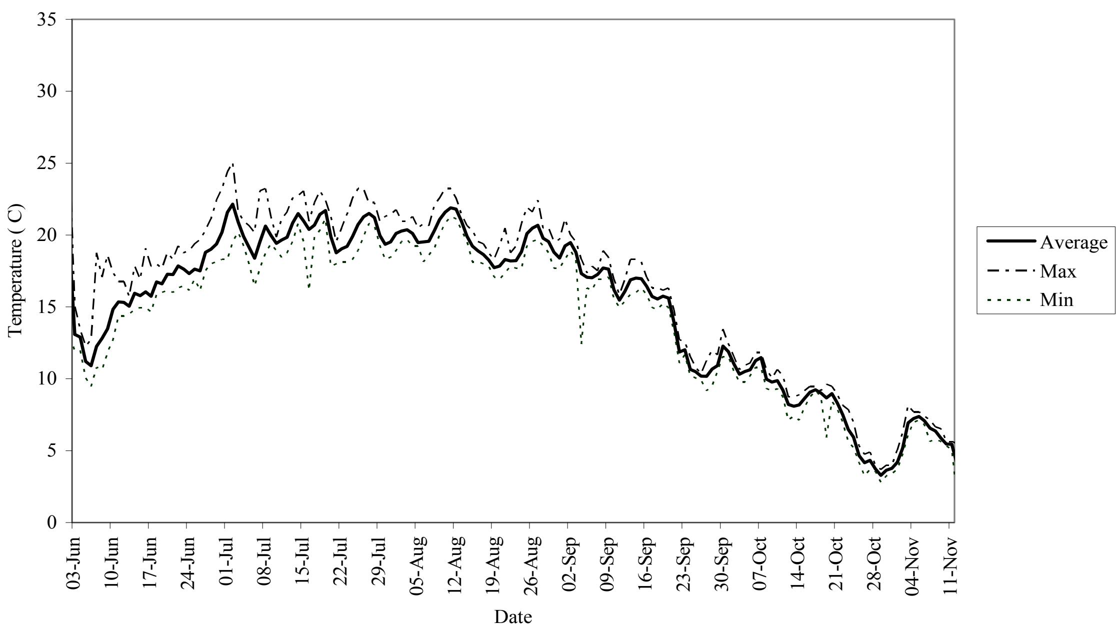


Figure 6: Condition index of oysters during 1997 (n=30).

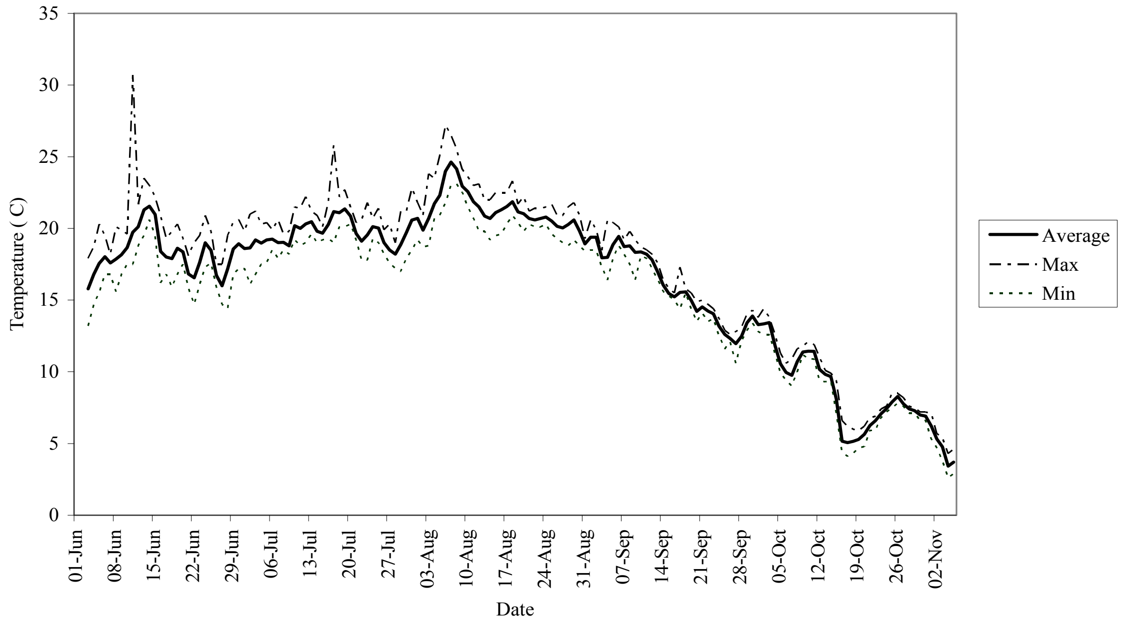


A)

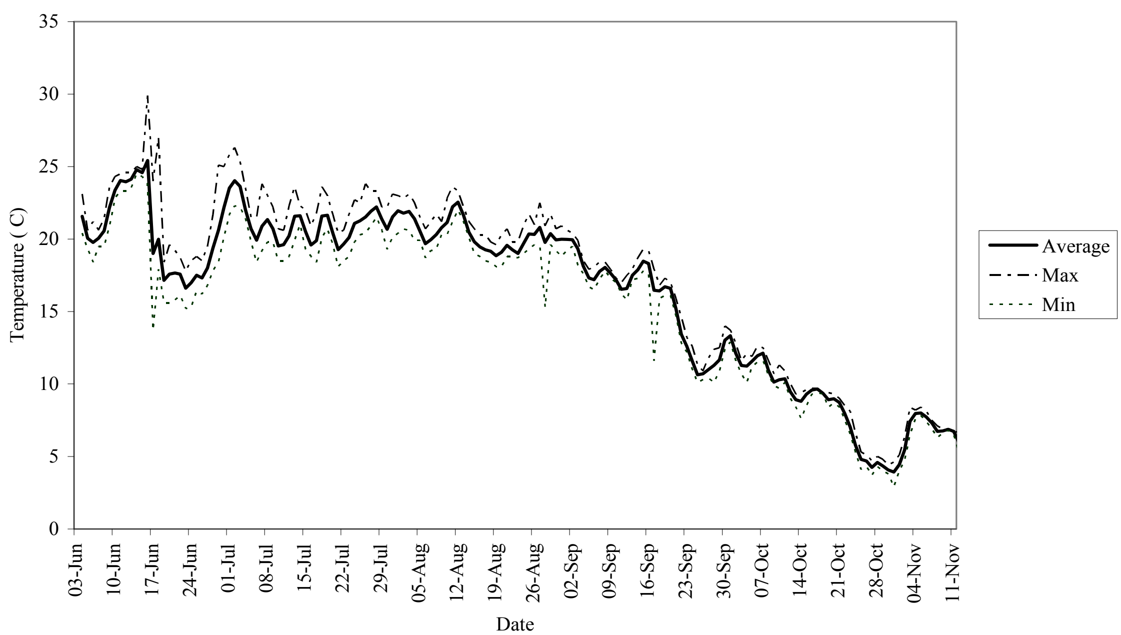


B)

Figure 7: Temperature profile of the Caraquet site in 1996 (A) and 1997 (B)

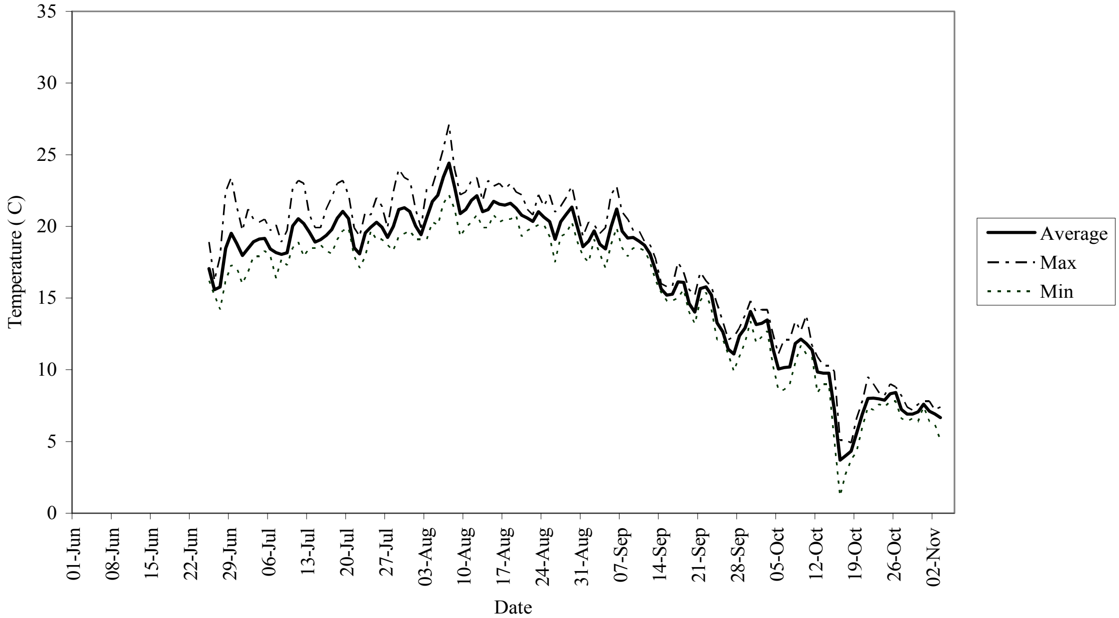


A)

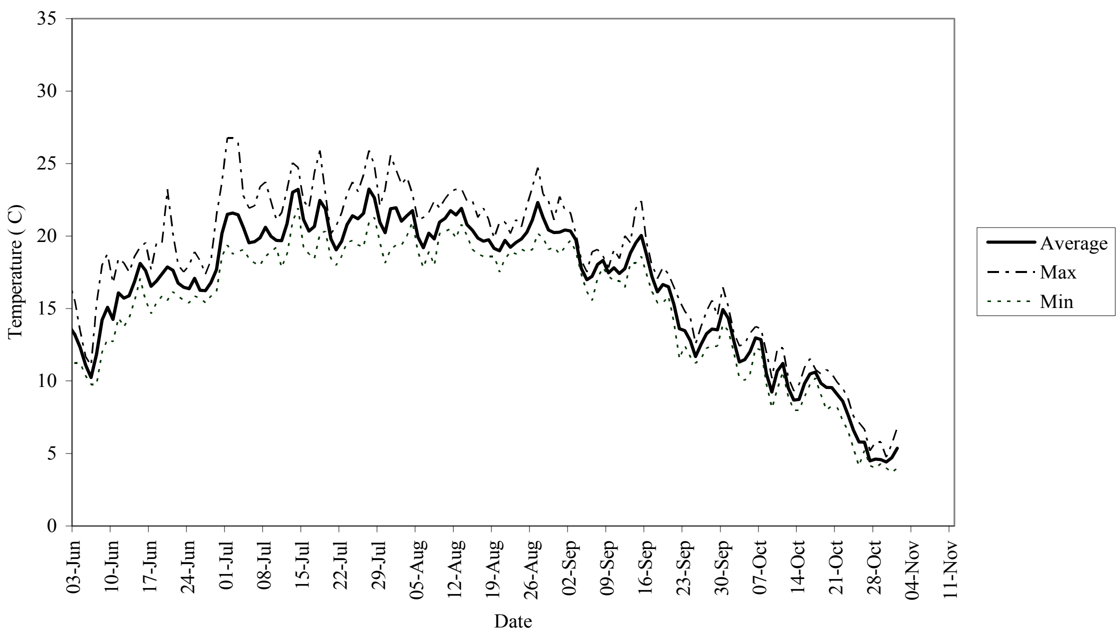


B)

Figure 8: Temperature profile of the Richibouctou site in 1996 (A) and 1997 (B)

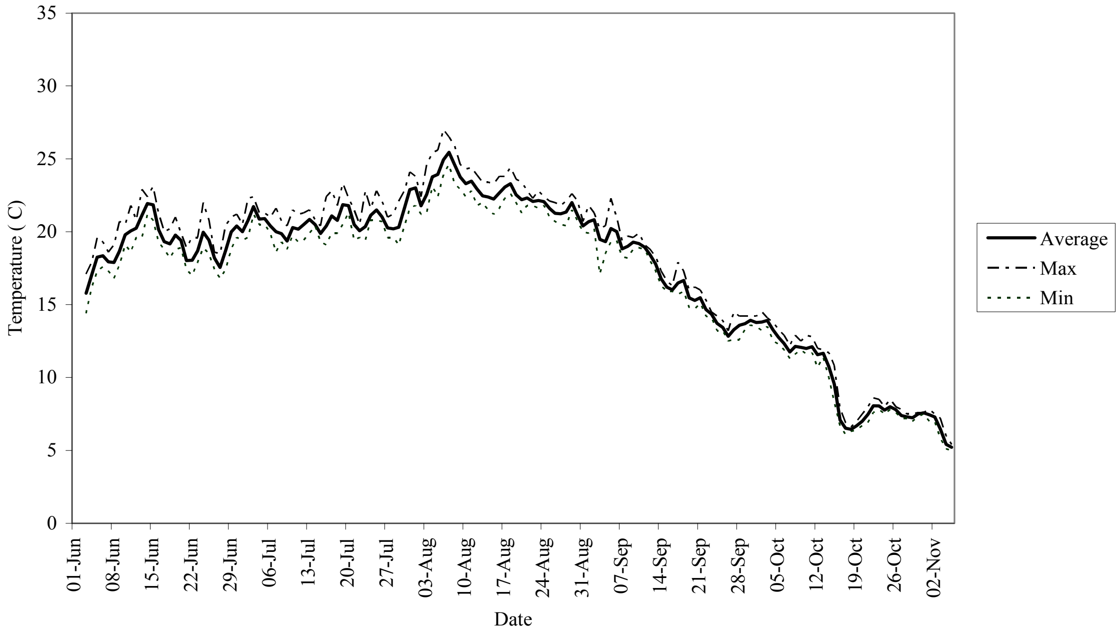


A)

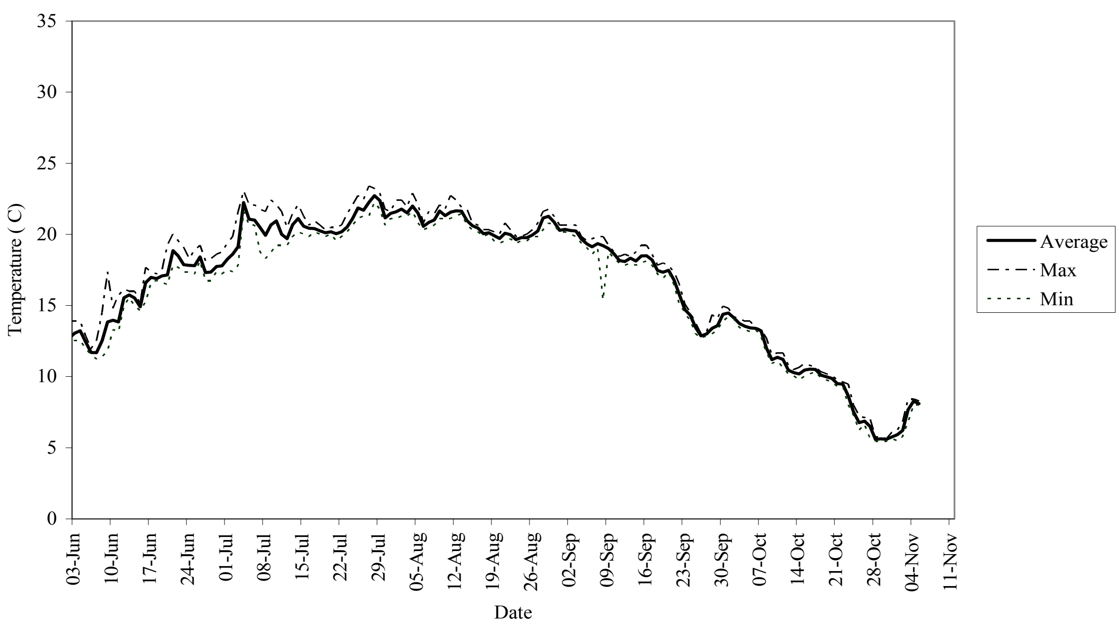


B)

Figure 9: Temperature profile of the Shemogue site in 1996 (A) and 1997 (B)

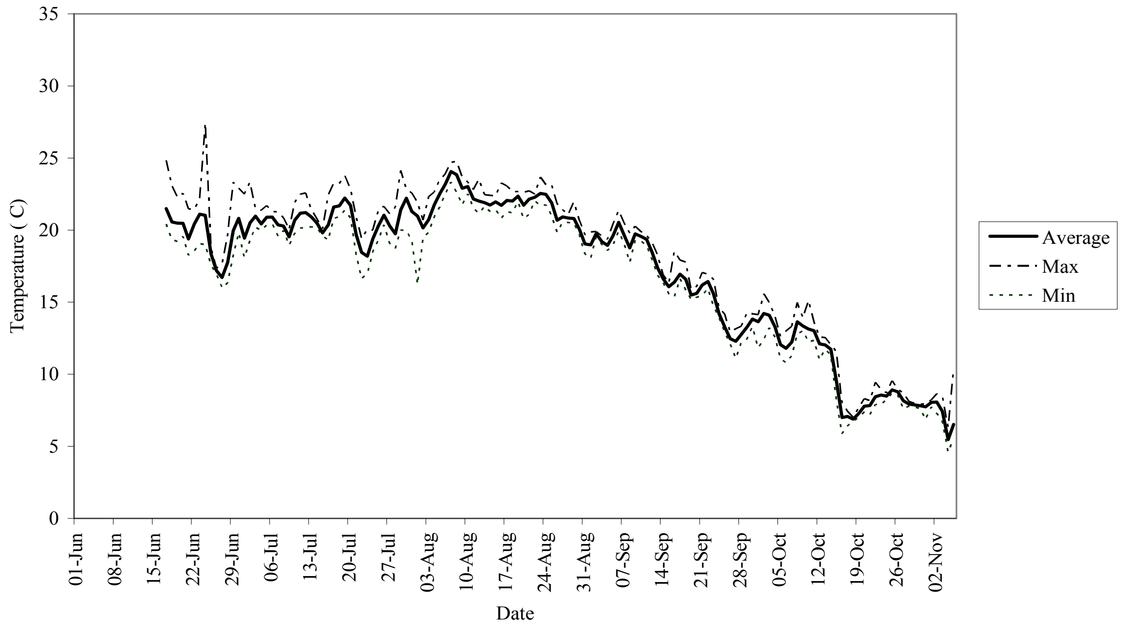


A)

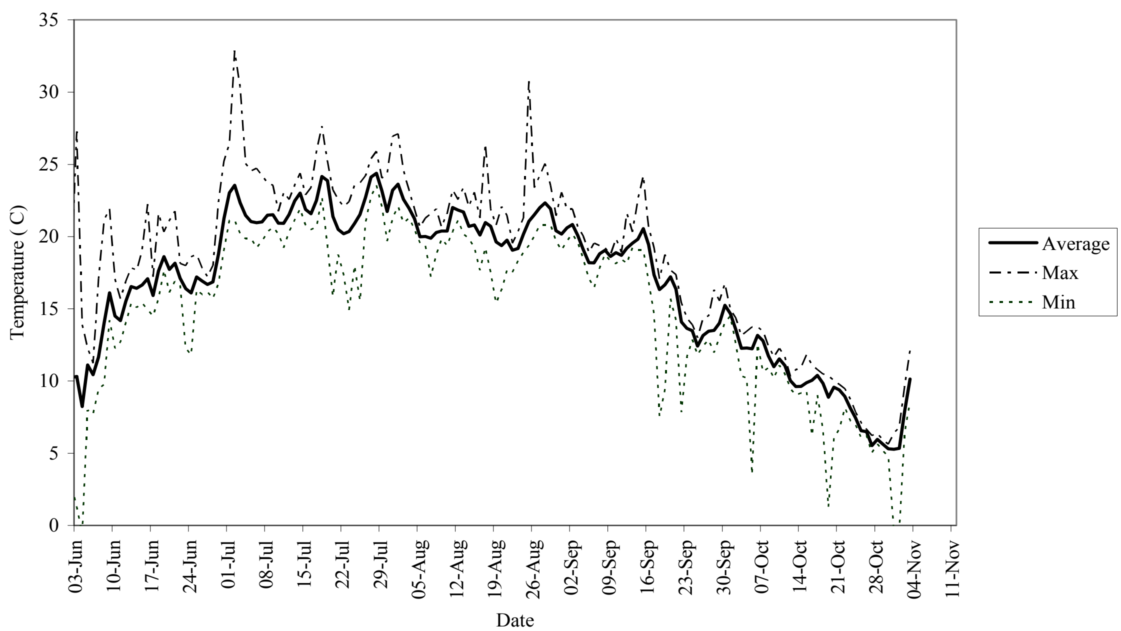


B)

Figure 10: Temperature profile of the Ellerslie site in 1996 (A) and 1997 (B)



A)



B)

Figure 11: Temperature profile of the Tatamagouche site in 1997

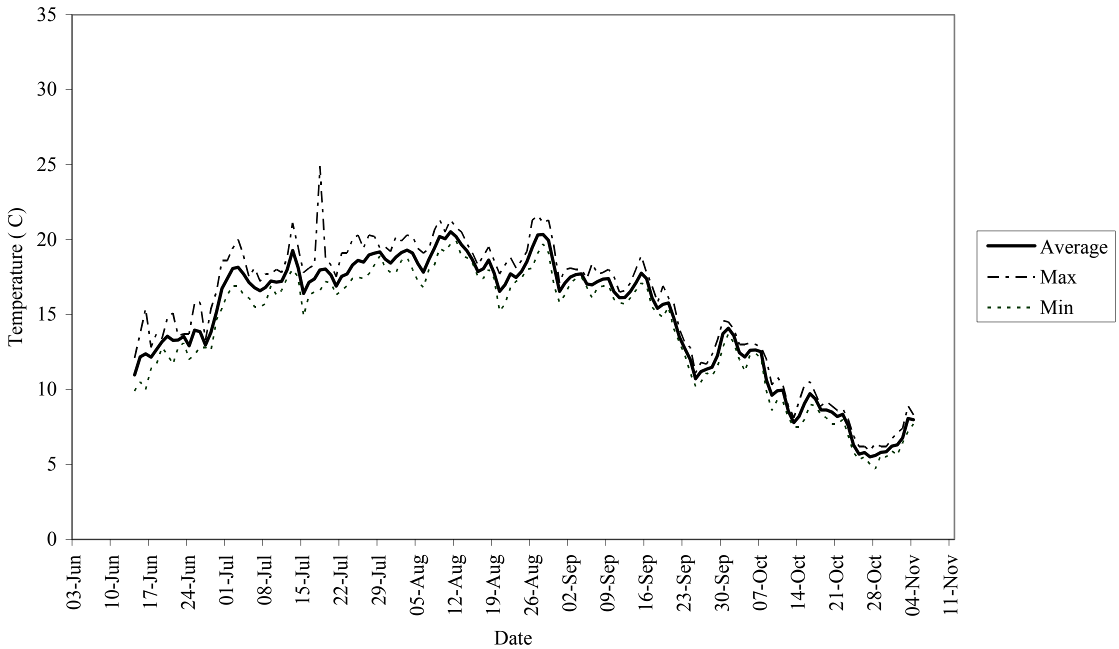


Figure 12: Temperature profile of the Cap Vert site in 1997