Shellfish Habitat Restoration Project in

Cocagne Bay and Shediac Bay

Final Report

Prepared for:

The Department of Fisheries and Oceans – Small Craft Harbour

By:

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ACKNOWLEDGEMENTS

The Shediac Bay Watershed Association would like to thank its Directors and staff members for their great involvement and interest in this project, especially Lise Auffrey-Arsenault who developed the initial proposal. Special thanks are directed to Joe Caissie for providing us valuable information on the status of oysters in Shediac Bay and for his help in performing the work. We also wish to thank the following individuals for their valuable contribution to planning and facilitation in this project: Neil LeBlanc (underwater pictures and monitoring), Francis Caissie (fisherman), and Joe Caissie Seafood. We are also grateful for the help from DFO Aquaculture and Environmental Science Division's staff members, Marc Ouellette, Thomas Landry, Matthew Hardy and Daniel Bourque, for providing us with valuable information and for their help in producing an underwater video. We would also like to thank Peter Curley from Public Works and Government Services Canada and Guy Robichaud from DFO – Assessment Section of the Oceans and Habitat Division, for their valuable input in this project.

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EXECUTIVE SUMMARY

The shellfish restoration project was put together to enhance oyster (*Crassostrea virginica*) habitat in both Cocagne and Shediac bays as well as to establish quahaug (*Mercenaria mercenaria*) reproductive sanctuaries in Shediac Bay. As a result of Malpeque disease, native oyster beds are merely 10% of their original biomass. Quahaug populations in the southern Gulf of St. Lawrence have also declined over the past five decades, largely due to increasing harvesting pressures.

In Cocagne and Shediac bays, shell material was added to the sea floor (shelling) to create recruitment substrate for oyster spats. Shelling activities occurred on a 3,710 m^2 surface area in Cocagne Bay and on a 3,520 m^2 surface area in Shediac Bay. It is hoped that oysters will settle on this substrate and create new reefs. By creating reef structures, oysters increase biodiversity, provide a viable food source and habitat for many species.

Recruitment in Cocagne Bay was high and a large number of juvenile oysters are now growing on the restored site. In Shediac Bay, oyster recruitment was not very successful. Therefore, adult oysters were added on the restored bed.

Quahaug reproductive sanctuaries were also established in Shediac Bay by planting large quahaugs (>50 mm). By increasing the shellfish density up to 100 large quahaugs/m^2 in two 40 m^2 plots (total of 8,000 quahaugs), we were expecting to enhance the reproductive success, thus, allowing the natural population to grow.

Shellfish play an ecologically important role by filtering the water column. They contribute by reducing water turbidity and nutrient pollution effects (for example algae blooms). They also contribute to the recycling of nutrients and organic material. By restoring shellfish, the SBWA is therefore helping to improve water quality for residents and users of the bay.

1 INTRODUCTION

1.1 Background

The Federal Fisheries Act ensures the protection of both fish and fish habitat. Under Section 35(2) of the Act there is a clause allowing development projects to proceed in spite of Harmful Alteration Disruption or Destruction (HADD) of fish habitat. The Small Craft Harbour branch of the Department of Fisheries and Oceans was involved in harbour improvement projects in the NB southern Gulf area, which resulted in HADDs. A condition of the section 35(2) authorization was that compensation be required to offset the HADDs. Consequently, the Shellfish Restoration Project was implemented by the SBWA in Cocagne Bay and Shediac Bay to compensate for these HADD's.

The objectives of this project are 1) to restore oyster (*Crassostrea virginica*) habitat in both Shediac Bay and Cocagne Bay, and 2) to create two quahaug (*Mercenaria mercenaria*) reproductive sanctuaries in Shediac Bay.

A technique was used to restore oyster habitat and it consisted of spreading shell material (shelling) on the benthos to increase the surface of available substrate for oyster spats to settle. It was anticipated that increasing oyster densities in the bays could create oyster reefs, which would in turn increase biodiversity, and provide a viable food source and habitat for many species.

The creation of quahaug reproductive sanctuaries in Shediac Bay is expected to enhance the reproductive success of the shellfish. Consequently, an increase in the natural population should be observed in the long-term.

1.2 General Information

The restoration project took place in the southern Gulf of St. Lawrence in two distinctive estuarine systems, Cocagne Bay and Shediac Bay (Fig. 1).

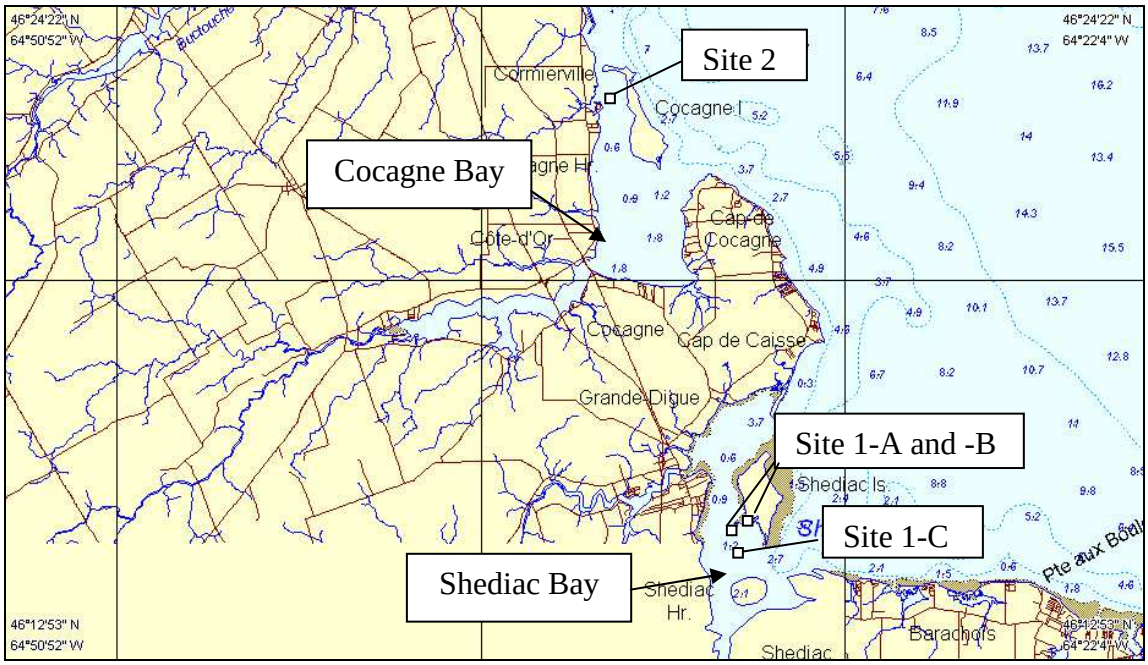

Figure 1. A portion of the Southern Gulf of St. Lawrence showing the location of the shellfish habitat restoration sites.

1.3 Permits and Authorization

- An Experimental Permit was obtained from the Department of Fisheries and Oceans.

- A Permit for the Introduction and Transfer of Live Fish could be necessary if shellfish were to be transferred from one system (bay) to another (DFO, Oceans and Habitat Division).

- A request for a License of Occupation on Submerged Crown Land from the Land Use Application Service Centre (DNR) is necessary to confirm that the experimental set up is unobtrusive to navigation. It is necessary to request the permit in order to receive an official letter confirming DNR's position.

- A request for a License from the Navigable Waters Protection Act is necessary to receive the approval that the position and type of buoys are adequate for marine navigation.

- The Canadian Coast Guard should be advised of the site markers' position in order to broadcast a warning message to boaters.

- In 2005, an experimental permit was requested from DFO to perform data collection on the restored oyster beds and quahaugs reproductive sanctuaries as well as larval monitoring.

1.4 Public Outreach Strategy

- Fishermen and aquaculturists were informed of the work to be performed in each bay. Meetings were organized to take note of their enquiries and concerns regarding the proposed method for shellfish habitat restoration.

- Local Service District chairpersons for the involved communities were informed of the project.

- Residents were informed of the work to be performed by the SBWA with a press release distributed to multiple media groups.

- An open house was held on July 5, 2004, for the public to discover the Shellfish Restoration project. The open house was advertised in the Times & Transcript, l'Étoile and in several Church Bulletins.

- The Project Manager participated at a workshop on Nutrient Enrichment in Summerside (PEI) on March 30 and 31, 2005. A presentation was offered on the type of work the Association is performing and described in detail the Shellfish Restoration Project.

- A poster, created during this project, was presented at multiple workshops: Atlantic Canada Coastal and Estuarine Science Society, DELG, other groups' annual general meetings.

2 SHEDIAC BAY – OYSTER AND QUAHAUG ENHANCEMENT

2.1 Quahaug Reproductive Sanctuaries (Site 1–A and –B)

On June 27, 2004, two quahaug sanctuaries (40 m^2 each) were established in Shediac Bay (Fig. 2). Four thousand quahaugs (over 50 mm shell in length) were randomly distributed in each sanctuary (for a total of 8,000 quahaugs introduced). A density of 100 quahaugs/m^2 was attained in each sanctuary. The introduced quahaugs were harvested from an area in Grande-Digue that lies within the same coastal system as the sanctuaries. The sanctuaries, located in a temporarily closed shellfish harvesting area, were not marked to prevent the harvesting of the newly introduced quahaugs.

2.2 Oyster Habitat Restoration (Site 1–C)

The site identified in Shediac Bay (Site 1-C) is a former oyster bed characterized by a hard bottom covered with old oyster shells. During a preliminary investigation of the site, eelgrass (*Zostera marina*) patches appeared to be present in low density. Live oysters were not observed on the site despite the large amount of shell material. Depth on the site ranges between 2.4 and 3.0 m at high tide.

Oyster enhancement in Shediac Bay began on June 27, 2004, with the identification and observation of the 3,520 m^2 site (Fig. 2). The site was marked with four pink buoys and ABS pipes. Underwater pictures were taken by a SCUBA diver to document the site's condition prior to the introduction of shell material. The Aquaculture and Environment Science Division, DFO, recorded an underwater video on June 29, 2004.

Records of water temperature were taken in 2004 during each site visits and oyster condition was regularly evaluated to monitor the spawning period, in 2004 and 2005.

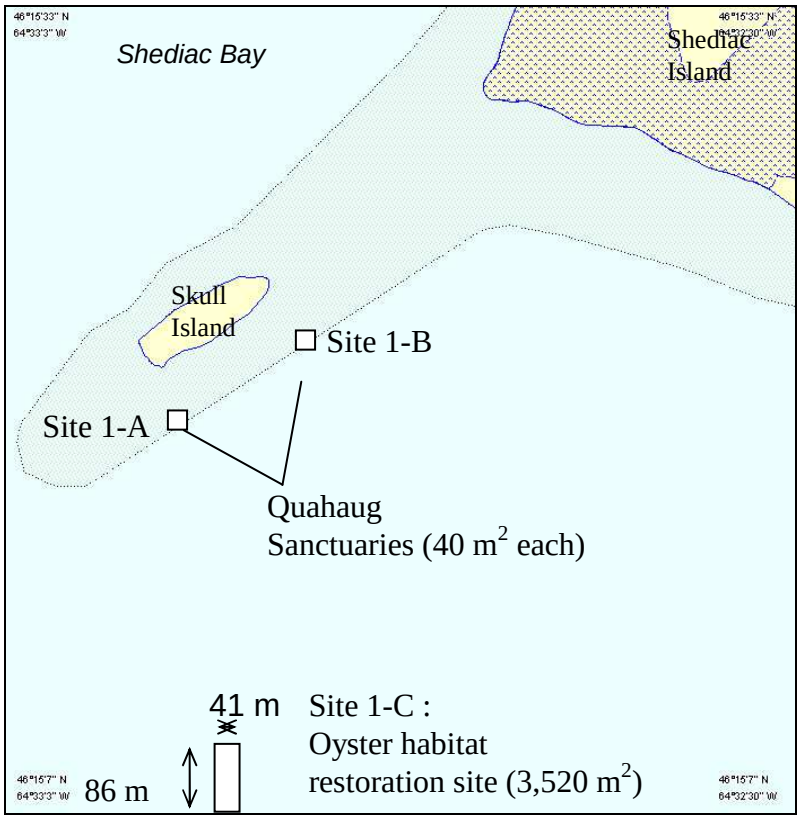

Figure 2. Quahaug sanctuaries (sites 1-A. and -B.) and oyster bed habitat enhancement site (site 1-C) in Shediac Bay.

On July 20, 2004, shelling occurred with the addition of 28,700 lbs. of crushed softshell clam material on the seafloor. Shelling was performed by spreading shell material contained in 100 lbs. totes. The conservation of the eelgrass beds was an important aspect of the habitat restoration project; therefore, efforts were taken to maintain the integrity of the habitat by using a lower shell density on the benthos.

As a result of poor settlement in 2004, 800 lbs. (1.6 oysters/m^2) of adult oysters (measuring over 8 cm in shell length) were introduced on the restored bed on October 21, 2004.

2.2.1 Oyster Habitat Monitoring

Bottom Oyster Spat Recruitment

The 2004 monitoring of oyster recruitment success occurred on October 21, 2004 in Shediac Bay. A total of eight samples were randomly taken within a 0.09 m^2 quadrat at each site.

An initial observation of the restored bed was performed on July 5, 2005 to observe the status of the site following the first winter. The observation also allowed us to evaluate the survival capacity of the adult oysters introduced in 2004. A total of six samples were randomly taken by a SCUBA diver using a 0.09 m^2 quadrat.

The final monitoring session occurred in the fall (October 4) to assess the 2005 recruitment success on the restored oyster bed. A total of five samples were randomly taken by a SCUBA diver using a 0.09 m^2 quadrat.

Surface Oyster Spat Collection

The 2005 larval settlement pattern was monitored in Shediac Bay by placing oyster spat collectors at 15 sites throughout the Bay (Fig. 3). Two bags were installed per site and were used as duplicates for a total of 30 samples. The collectors were constructed of cylindrical mesh (15 mm) bags filed with local oyster shells (4930.72 cm^3). The collectors were installed at the water surface on navigational buoys on July 15, 2005. The collectors were retrieved on September 18, 2005.

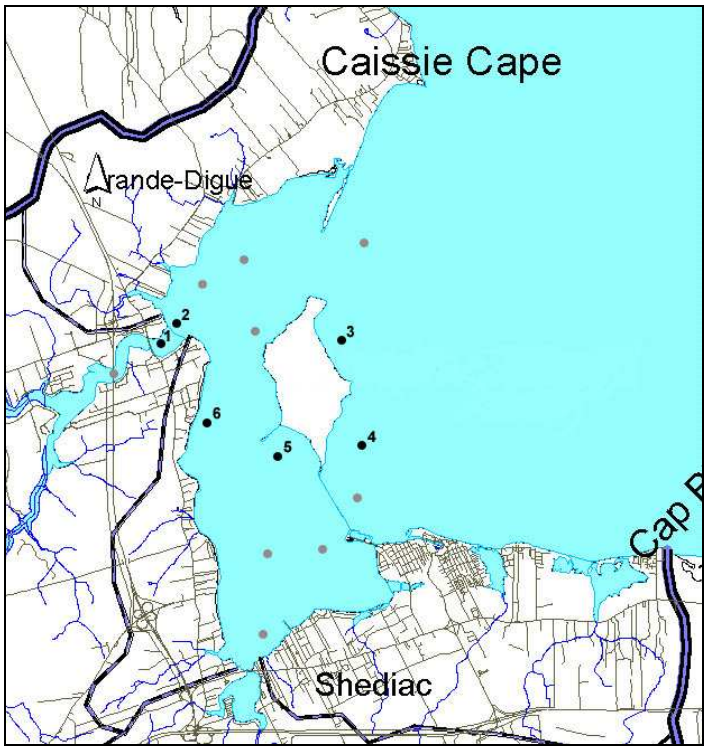

Figure 3. Surface oyster collectors sampling sites in Shediac Bay in 2005. Black dots indicate retrieved collectors; grey dots indicate lost or destroyed collectors.

2.2.2 Oyster Habitat Results

Bottom Oyster Spat Recruitment

During the final monitoring in the fall of the year 2004, no oyster spat was observed on the restored bed; therefore, oyster recruitment was unsuccessful at that location during the 2004 season.

On July 10, 2004, we observed spawned oyster in approximately 50 % of the oysters from Shediac Bay. Water temperature was 20.5 ^{o}C at that time.

The initial follow-up observations performed in the spring of the year 2005 tend to show that introduced adults on the restored bed survived over the winter.

In the fall of 2005, the final monitoring was performed and it indicated that the natural recruitment at the restored oyster bed was greater than during the previous year (Fig 4). The average measured juvenile oyster density in 2005 was 24.44/m^2 (SE=13.33/m^2). The size of the juvenile oyster collected ranged from 8-22 mm. Recruitment appears to be more successful in 2005, considering that there was no recruitment observed in 2004.

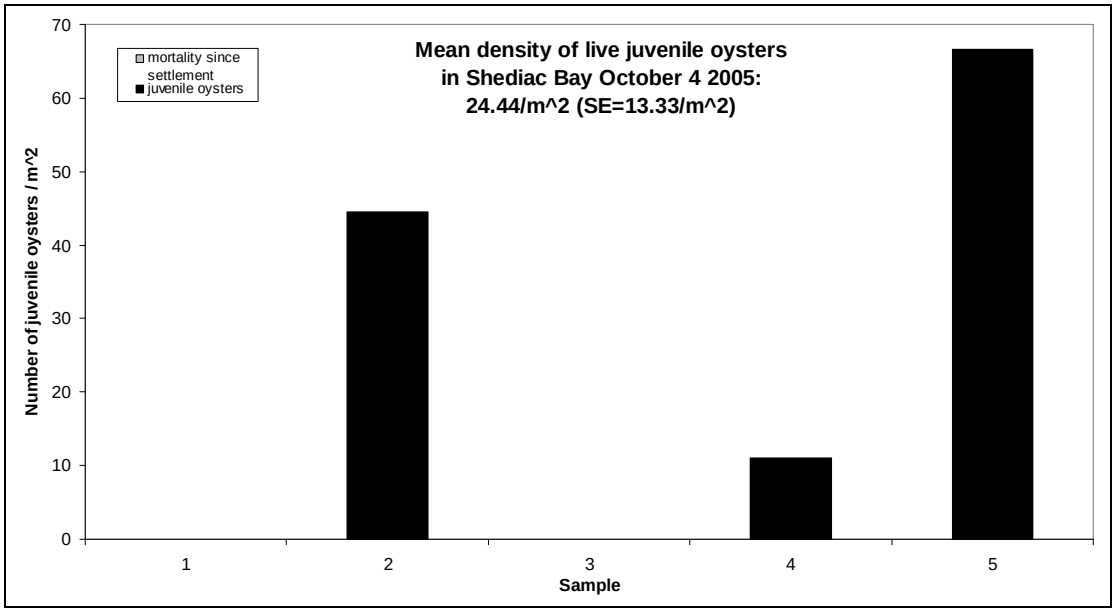

Figure 4. Fall 2005 bottom oyster spat recruitment success from the Shediac Bay's restored bed.

Surface Oyster Spat Collection

Surface oyster recruitment was measured at six locations, as described on Figure 3. The remaining collectors at the nine other sampling locations were either lost or destroyed to a point where measurements were not possible.

Oyster spat recruitment was significantly higher at the mouth of the Shediac River (Fig. 5) (ANOVA: F=76.7, P=0.00046), where brackish water is predominant. Our results also tend to show that surface oyster spat recruitment was high over the restored bed (site 5), which was not replicated on the benthos of the same site. The size of the juvenile oyster collected ranged from 5-32 mm. Oyster spat mortality rate was low at every sampling site.

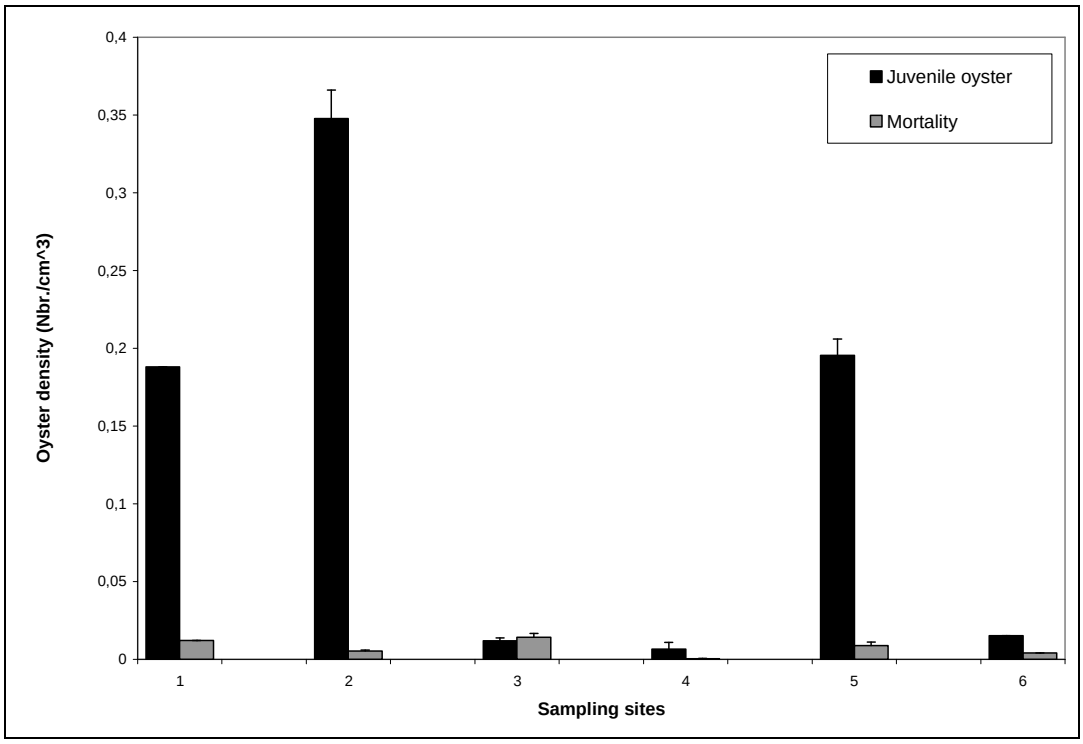

Figure 5. 2005 surface oyster spat recruitment success in Shediac Bay. Sampling sites locations refer to the Figure 3.

2.2.3 Oyster Habitat Discussion

In Shediac Bay (site 1-C), a former oyster bed was enhanced by the addition of crushed shell material on the sea floor. During the 2004 monitoring session, there was no recruitment either observed on the benthos of the restored bed or on the shell

bags placed on two of the marking buoys delimiting the site. Results obtained with the deployment of spat collector bags in Shediac Bay indicated that the overall surface settlement success was poor for the entire Bay that season. This result could be attributed to the fact that crushed shells were used instead of whole shells. Crushed shells offer limited available surface for larval fixation. Moreover, it has been observed by MacKenzie (1983) that oyster shells smaller 2.5 cm are easily disturbed, thus limiting the potential or recruitment.

The apparent absence of adult oysters on the Shediac Bay restored site further suggests that larval recruitment on the former oyster bed is poor. Therefore, to enhance the brood stock, adult oysters were added to the restored site. The seeding of large sexually mature oysters should ensure a good survival rate and a high reproductive contribution to next year's recruitment.

The 2005 monitoring session confirms the generally low annual bottom oyster recruitment success in Shediac Bay. The recent surface recruitment monitoring, however, suggested that oyster larvae were well distributed in the Bay in 2005. Better surface recruitment success was observed at the mouth of the Shediac River which could be supported by the fact that a large oyster population is established in the associated estuary. Historical data confirm that oyster recruitment is not consistent in Shediac Bay and that spat collection can be very poor for few consecutive years (Needler, 1932a and b). Also, the low bottom oyster spat recruitment on the Shediac Bay restored bed can be attributed to the larvae being flushed out of the area during tidal changes. It, however, suggests that a large proportion of oyster larvae are dying before settling on a proper substrate.

Recruitment success can vary due to fluctuating environmental and hydrological conditions. Oyster spat recruitment can be influenced by different factors including water quality, the status of the surrounding oyster population, water current patterns, presence or absence of predators, water salinity and water temperatures (Hadley *et al.*, 1997). Therefore, if the restored bed is maintained to limit siltation, it will remain a good oyster recruitment habitat for future years.

3 COCAGNE BAY – OYSTER ENHANCEMENT

3.1 Oyster Habitat Restoration

A preliminary observation of the Cocagne Bay site (site 2) occurred On June 26, 2004 (Fig. 6). The 3,710 m^2 site was marked with four ABS pipes and reflective tape. Underwater pictures were taken by a SCUBA diver to document the site's condition prior to the addition of shell material. The Aquaculture and Environment Science Division, DFO, recorded an underwater video in June 2004.

The site is characterized by a thick layer (15 cm) of silt mixed with shell fragments. Eelgrass patches cover most of the site's surface. The presence of live oysters on the site suggested that it was suitable for oyster recruitment. Depth ranges between 1.2 and 1.8 m at high tide.

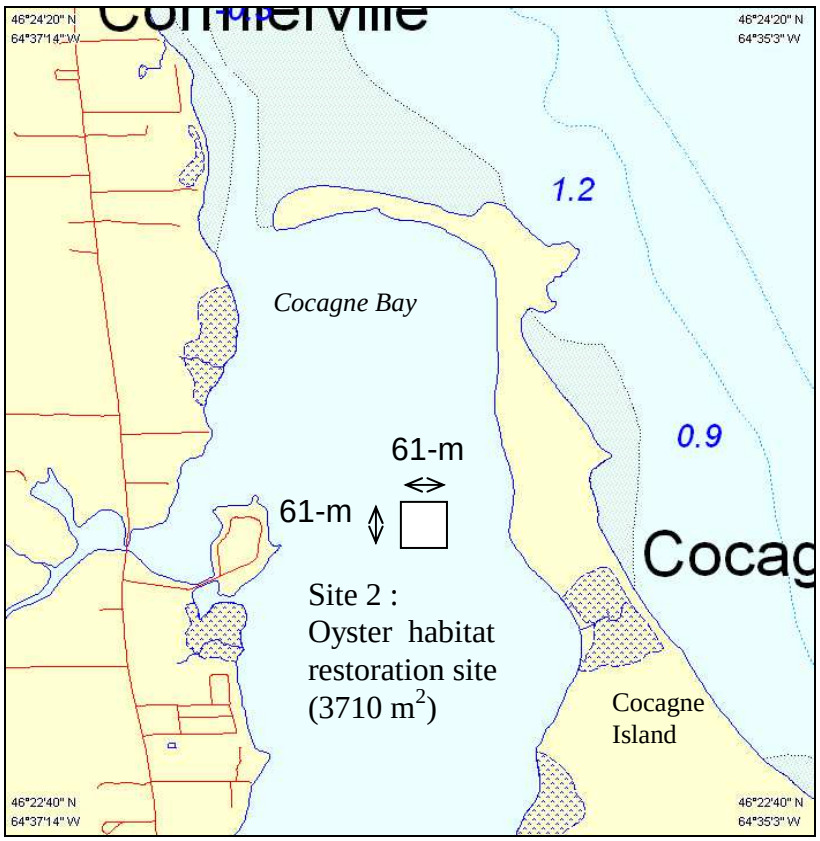

Figure 6. Oyster bed habitat enhancement site (site 2) in Cocagne Bay

The addition of shell material (25,000 lbs.) occurred on July 13, 2004. The majority of the shell material consisted of whole clam shells. The shelling method used in Cocagne Bay was the same as in Shediac Bay. The conservation of the eelgrass beds was also an important aspect of the habitat restoration project in Cocagne Bay.

Records of water temperature were taken in 2004 during each site visit and in 2004 and 2005 oyster condition was regularly evaluated to establish the spawning period.

3.1.1 Oyster Habitat Monitoring

Bottom Oyster Spat Recruitment

During the 2004 season, monitoring for oyster recruitment success occurred on October 20, 2004 in Cocagne Bay. A total of eight samples were randomly taken within a 0.09 m^2 quadrat.

Following the first winter season, an initial observation was performed July 5, 2005. Samples were taken on the Cocagne restored oyster bed to measure the survival rate of the oysters recruited in 2004. A total of six samples were randomly taken within a 0.09 m^2 quadrat. Underwater pictures were taken during this session; however, a technical problem with the camera prevented the film to be deployed.

3.1.2 Oyster Habitat Results

Bottom Oyster Spat Recruitment

A mean bottom recruitment density of 784.72 ± 348.98 juvenile oysters/m^2 (mean ± SE) was observed on the restored beds in 2004. The high variability likely results from two samples that did not contain juvenile oysters. The highest density observed was 2811.11 juvenile oysters/m^2 (Fig. 7). The size of the juvenile oysters collected ranged from 3-10 mm. Mortality since settlement was estimated by counting former visible oyster cement rings. The mortality rate seems proportional to the amount of live oyster found in each sample.

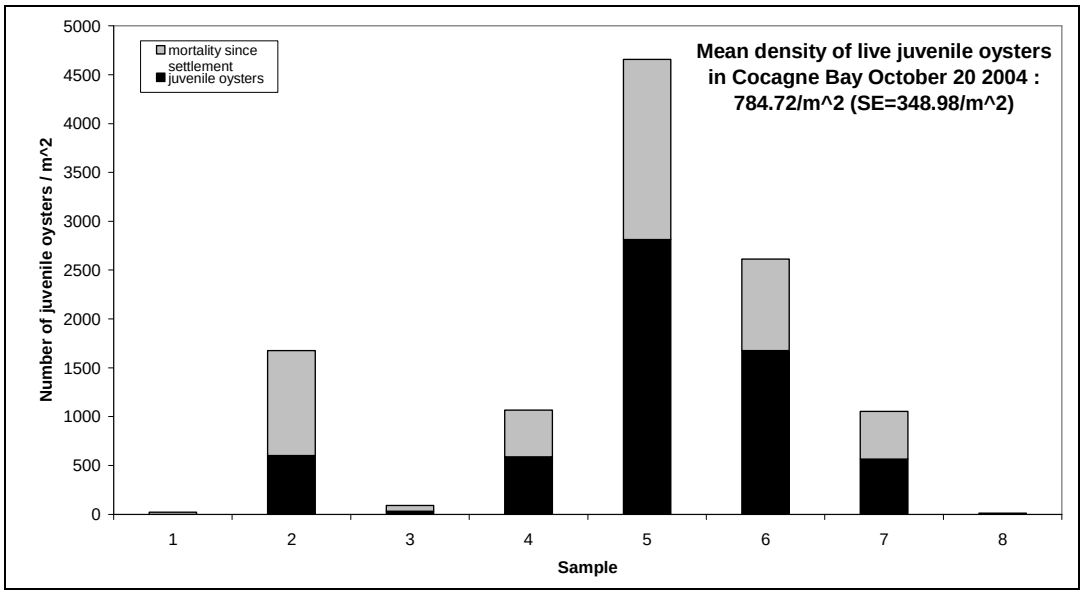

Figure 7. Fall 2004 bottom oyster spat recruitment success from the Cocagne Bay's restored bed.

The winter survival rate of the newly settled oysters was measured in the early summer of 2005. The survival rate is 11.8%, passing from 784.72 juvenile oysters/m^2 in fall 2004 to 92.59 juvenile oysters/m^2 in July 2005 (Fig.8).

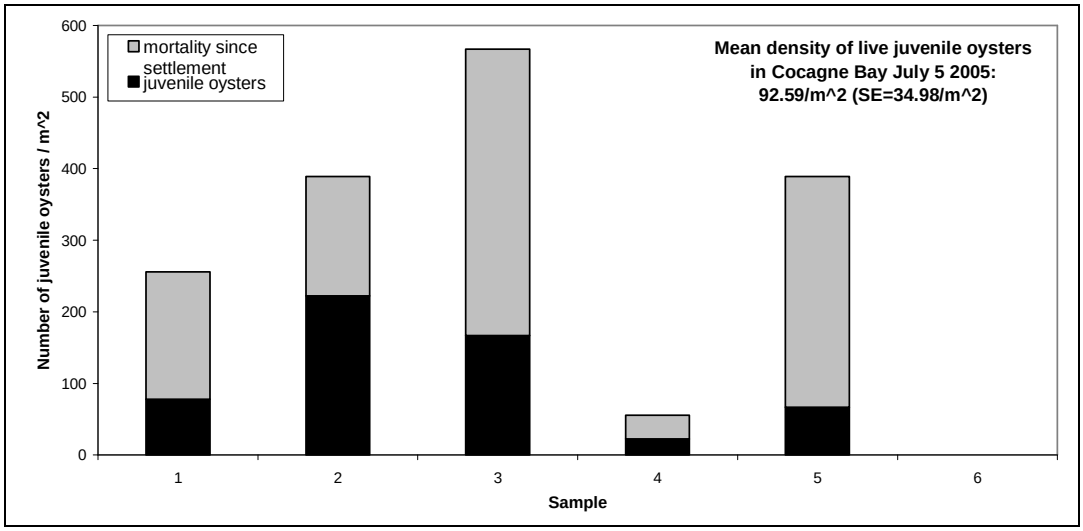

Figure 8. Spring 2005 bottom oyster spat recruitment success from the Cocagne Bay's restored bed.

The 2005 bottom oyster recruitment was measured on October 4. A mean density of 92.59 ± 34.98 juvenile oysters/m^2 (mean ± SE) was observed on the restored beds. The highest density observed was 256.56 juvenile oysters/m^2 (Fig.

9). The mortality rates presented includes mortality from the 2004 and 2005 recruitment seasons.

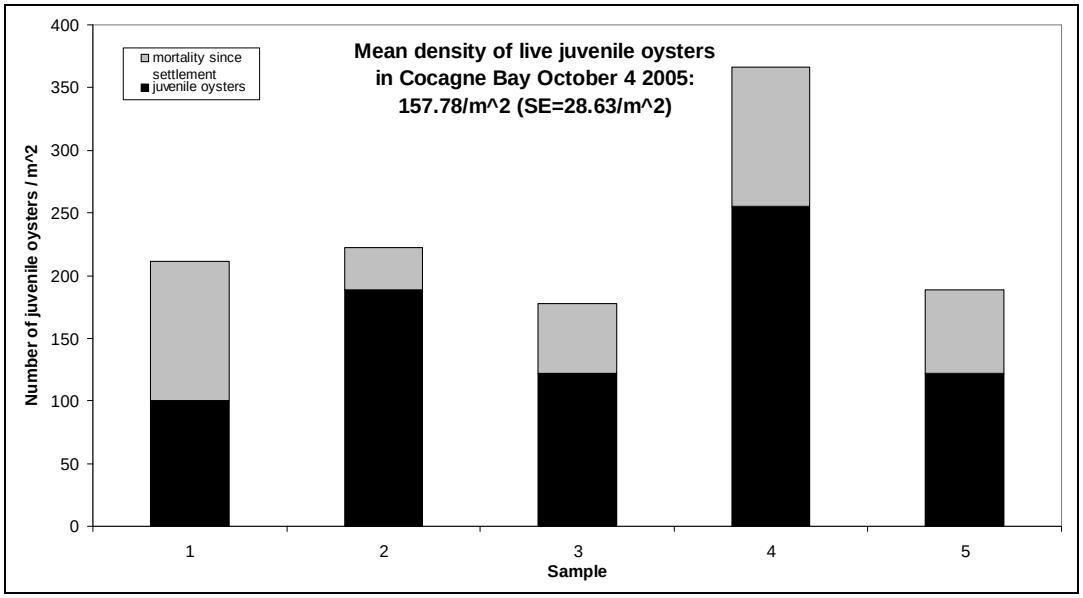

Figure 9. Fall 2005 bottom oyster spat recruitment success from the Cocagne Bay's restored bed.

The overall mean bottom recruitment success measured in Cocagne Bay in 2004 appeared to be higher than in 2005. Variability was very high within the 2004 samples, creating an insignificant difference between both seasons (Fig. 10). Also, the Cocagne Bay recruitment success remained higher than in Shediac Bay for both studied season.

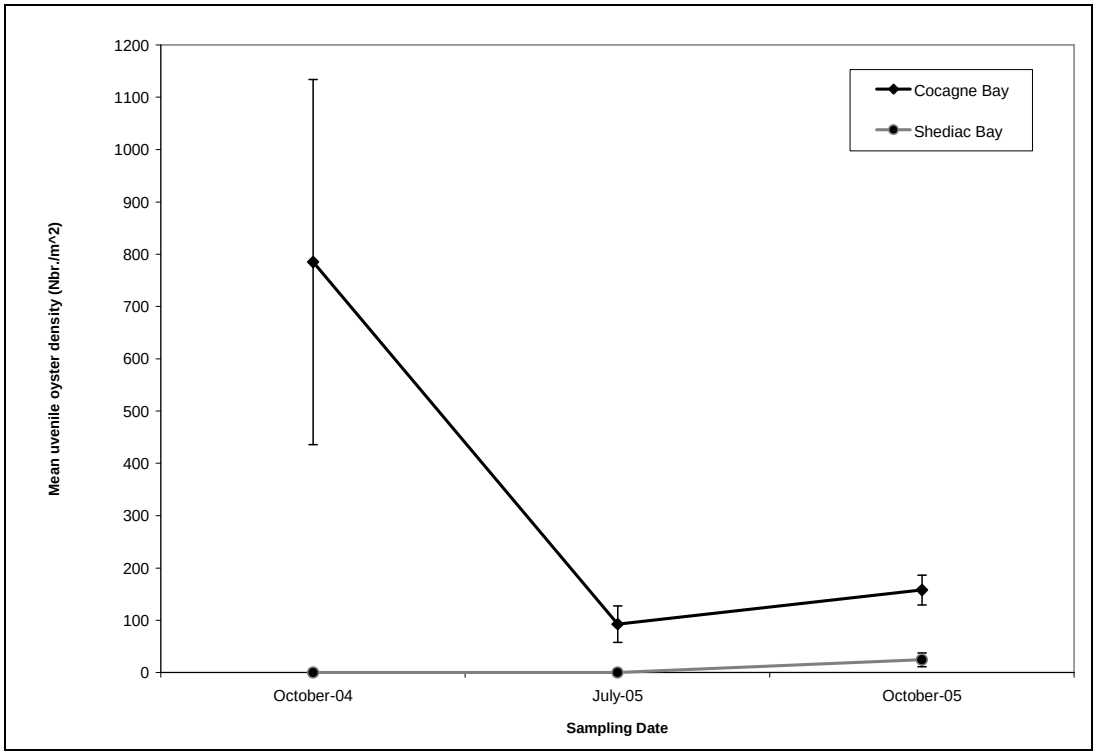

Figure 10. Overall mean bottom oyster spat recruitment success from Shediac and Cocagne bays' restored bed.

3.1.3 Oyster Habitat Discussion

Based on the relatively good recruitment success, the objective of enhancing oyster beds in Cocagne Bay was achieved. Settlement success was observed to be higher on whole shells and local oyster bunches rather than on crushed shell material. The initial presence of live oyster bunches on the restored site also suggested recruitment success in that area. Moreover, the proximity of oyster aquaculture operations likely contributed to larval recruitment on the restored site.

4 RECOMMENDATIONS

After local aquaculturists expressed concerns of contamination from re-suspended sediments (the site is located within a temporarily closed harvesting area), the SBWA sought the advice of governmental agencies to determine the risks of such work. It was decided that desilting would not be performed in Shediac Bay (as initially proposed) even though assurances of low risk were obtained. Further, large eelgrass patches were present on the restoration site and it is likely that the eelgrass beds would have been negatively affected by the desilting technique. Therefore, it is recommended that future site identification investigations consider eelgrass beds and sediment characteristics to limit the use of this technique.

Oyster larvae settlement pattern and survival are influenced by flow, salinity and temperature. A hard substratum composed of shell as well as the presence of adult oysters will also affect the recruitment success. Oyster larvae usually settle where flushing currents are low, where water quality is good and where adult oyster's densities are high. Therefore, it is recommended that future identification of restoration sites consider all these characteristics.

The SBWA will be pursuing surface and bottom oyster spat monitoring over the years to better understand the recruitment pattern in Shediac Bay. Moreover, quahaug reproductive sanctuaries will be visited annually to monitor the survival success of the introduced specimens.

Complete shells should be used as shelling material because of the greater surface area and stability offered to settling larvae. Further, whole shells seem to remain suspended on softer substrata, which create a more durable habitat restoration site.

5 CLOSING STATEMENT

The Shediac Bay Watershed Association is confident that the habitat restoration projects performed in both Shediac and Cocagne bays were successful by enhancing shellfish habitat. Despite less conclusive results for the Shediac Bay area, it is clear that this project allowed us to better understand the oyster recruitment dynamics in the Bay. Much has been accomplished and much remains to be done to fully understand the oyster dynamics in Shediac Bay.

We remain optimistic that the work performed by the Shediac Bay Watershed Association will be perused in future years by maintaining the oyster beds and by monitoring the evolution of the restored habitats.

The Shediac Bay Watershed Association believes that some aspects of the project, have the potential to benefit the development of future shellfish restoration projects in the area.

We appreciate the honour of working with the Department of Fisheries and Oceans – Small Craft Harbour Division and thank you for your consideration.

Respectfully submitted by the Shediac Bay Watershed Association,

Dominique Audet SBWA, Project Manager	William Murray SBWA, President

6 REFERENCES

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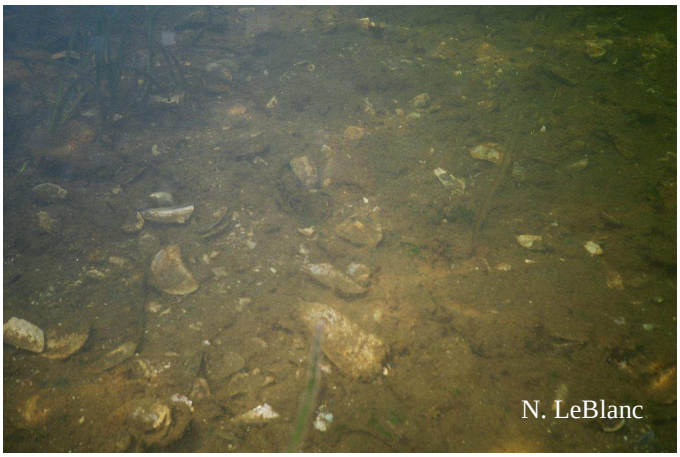
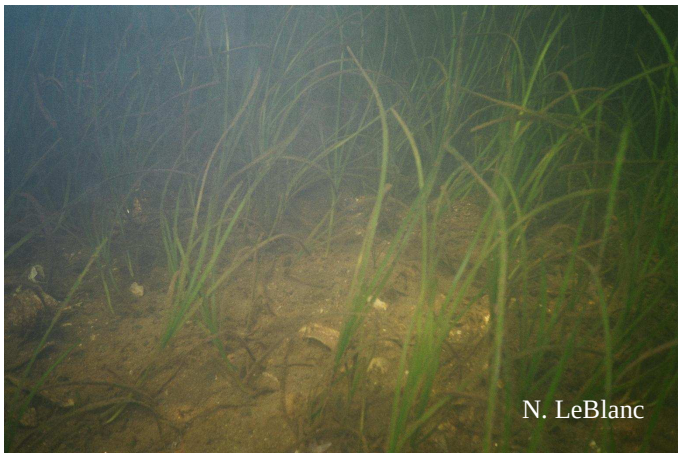
Needler, A. W. H., 1932b. Investigation on the oysters and hydrography of the Shediac area in the summer of 1932. pp.1-35.

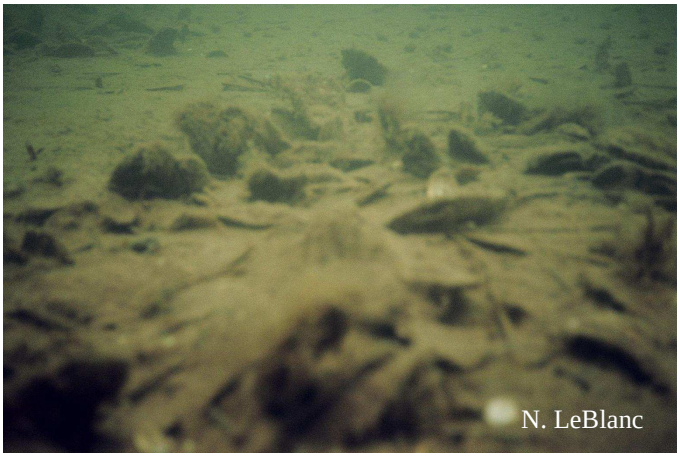
7 APPENDIX A – PROJECT PICTURES



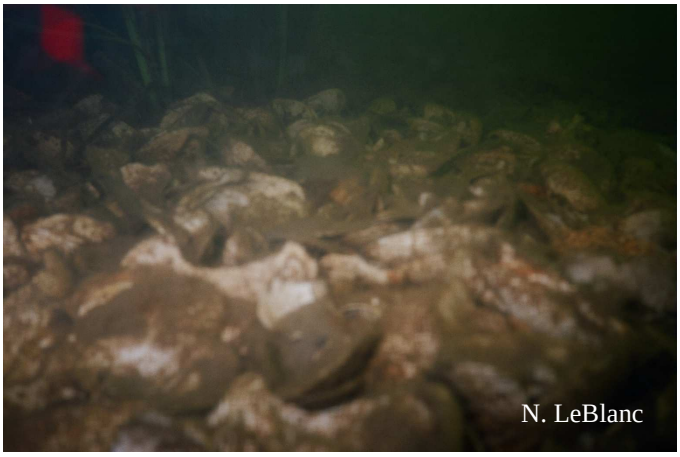


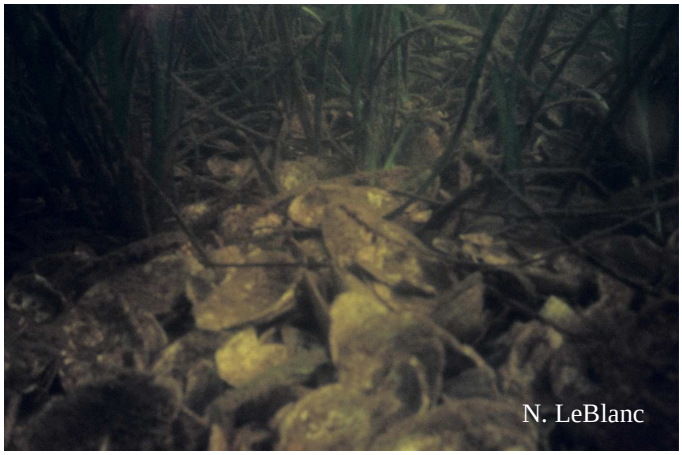
Underwater photographs of the sea floor taken in Shediac Bay (site 1-C) on June 27, 2004 prior to the addition of shell material.

Underwater pictures of the sea floor taken in Shediac Bay (site 1-C) on July 6, 2004 after the addition of shell material.



Underwater photographs taken of the sea floor in Cocagne Bay (site 2) on June 26, 2004 prior to the addition of shell material.





Underwater photographs of the sea seafloor in Cocagne Bay (site 2) taken on July 6, 2004 after the addition of shell material.

Quahaug planting in Shediac Bay (site 1-A and –B), June 27, 2004.

Shelling technique used in Shediac site 1-C) and Cocagne Bay (site 2), July, 2004.

Shell material used in Shediac Bay (site 1-C), July 20 2004

Shell material used in Cocagne Bay (site 2), July 13 2004

Adult oysters introduced in Shediac Bay (site 1-C), October 22, 2004.

Juvenile oysters fixed on introduced shell in Cocagne Bay (site 2), October 20, 2004.

Bottom recruitment monitoring performed on October 4, 2005 (site 1-C).

Oyster spat collectors used in Shediac Bay during the 2005 season