Revitalizing the Bras d'Or Lakes for Oyster Development

Aquaculture Association of Nova Scotia Workshop Proceedings 2012

Workshop Participants

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Workshop participants. Photo courtesy of Dr. J. Ronquillo of the Nova Scotia Agricultural College

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AANS, editor

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Introduction

Oysters are an important part of First Nation culture and as a source of income for aquaculture farmers along the Bras d'Or Lakes (hereafter referred to as "the lakes") in Cape Breton, Nova Scotia. Prior to 2002, it was estimated that the annual production of oysters was approximately $600,000 to $700,000 per year, employing 150 part-time harvesters. In the 1990s and early 2000s, communities along the lakes shorelines invested heavily in infrastructure to grow the industry, including a hatchery in Eskasoni and oyster processing facilities built in Little Narrows and Chapel Island. A total of $7 million had been invested in capital equipment and seed just prior to 2002, with the aim of developing a $5 - $10 million annual industry within five years.

In 2002, the massive mortality of oysters led to the first detection of the parasite *Haplosporidium nelsoni*, also known as MSX, in the lakes. MSX attacks the oyster tissues and weakens the animal until it eventually dies. The outbreak devastated the communities along the shorelines as oysters are an important part of First Nation diets and Nova Scotia's economy. The disease does not cause harm to human health. The agent that transfers MSX to oysters is unknown. For this reason MSX infected oysters must be contained within the lakes to prevent potential disease transfer. Since the MSX outbreak, oyster aquaculture activity along the lake's shorelines has plummeted.

The workshop attracted industry producers, various levels of government, First Nation communities and academia from around the maritime provinces. A total of 40 people participated. The topics discussed included: the social-economic importance of oysters, past research results and what industry requires for the future. A facilitated discussion was led by Dr. Neil Ross. Participants listed the needs for the industry in order to develop the oyster sector in Cape Breton.

Presentation Abstracts

Increased Virulence and Declining Impact of an Introduced Pathogen: *Haplosporidium nelsoni* in Chesapeake Bay Oysters, Nancy Stokes, Eugene Burreson & Ryan Carnegie – Virgina Institute of Marine Sciences (VIMS)

MSX first appeared in Delaware and Chesapeake Bays, USA, in the late 1950's. Two years after its emergence in each system, oyster mortalities reached 90-95% where salinity exceeded 12-15 ppt. Fifty years later, there are still many questions about MSX: which intermediate hosts are involved in its still-unsolved lifecycle; how the pathogen spreads and triggers new outbreaks; and why *Crassostrea gigas*, the natural host, experiences nothing like the disease displayed in *C. virginica*.

Oyster production in Chesapeake Bay remains a fraction of historical levels due to a combination of MSX-intensified disease caused by *Perkinsus marinus*, and stresses due to overharvesting, habitat depletion and decreasing water quality. Several approaches have been tested to restore oyster populations within the Chesapeake Bay; including unsuccessful introduction attempts of non-native species (*C. gigas*, *C. ariakensis*) and more promising plans, such as habitat restoration, establishment of sanctuaries, and selective breeding of MSX survivors.

Research at VIMS has shown that some wild oyster populations in the Chesapeake Bay have been adapting to MSX. However, MSX still exerts considerable disease pressure on naïve oysters, as shown in the following study. Each spring oysters from Ross Rock, a low-salinity reef in the Rappahannock River where MSX is absent, are deployed in the York River at VIMS, where MSX is endemic and are sampled weekly in October. Over the last 20 years maximum annual prevalence has remained above 70%. In contrast, oysters from Wreck Shoal in the James River, with higher salinity and MSX, have experienced a declining trend of maximum MSX prevalence over the past 20 years. To test whether this decrease was due to location or to development of resistance, oysters from four populations were deployed at VIMS, Ross Rock (MSX-free) and Aberdeen Rock in York River and Wreck Shoal (both MSX-endemic), and one selectively bred, MSX-resistant strain originating from Delaware Bay. Maximum MSX prevalence was higher in the Ross Rock oysters (83%) than in Delaware Bay (54%), Aberdeen Rock (29%) and Wreck Shoal (25%) oysters, and the percentage of infections reaching moderate or greater intensity were higher in Ross Rock oysters (54%) than in the other groups (9-17%) as well.

A third study examined the relationship of oyster size to the impact by MSX. Four oyster size classes (<50 mm, 50-76 mm, 76-100 mm, >100 mm shell height) were sampled monthly from April to October 2008 from two locations endemic for MSX, Broad Creek in the lower Rappahannock River and Lynnhaven River near the mouth of Chesapeake Bay. MSX levels were lower in the Lynnhaven, where salinity is high and stable, than at Broad Creek where salinity is lower and more variable. The most serious infections in Broad Creek samples generally occurred in sub-market oysters. These data collectively suggest that wild oyster populations in areas where salinity is never low enough to suppress MSX are developing resistance to the pathogen and reefs in these areas should be protected through conservation and restoration efforts.

The Importance of Oyster History, Dr. René E. Lavoie - Retired shellfish biologist, & Anita Basque – Apaqtukewag Fishery

Originally a fresh water glacial lake, the Bras d'Or became salty 4-5,000 years ago. Before contact with Europeans, First Nations of the Atlantic seaboard of North America were using oysters extensively, as evidenced by the numerous shell middens they left behind, some pinpointed to be 2,400 years old.

At first indifferent to oysters, Europeans settlers soon started to exploit them as fertilizers, as ground shell for chicken feed, as food for themselves, and as a commercial fishery. Official landings between 1906 and 1911 ranged between 80,000 and 240,000 pounds. The Bras d'Or oyster was a very small part of the Maritimes industry until malpeque disease came to mainland Nova Scotia and to New Brunswick in 1955. The resulting oyster shortage meant increasing fishing pressure. In 1958, the Bras d'Or landings were 336,000 pounds. There was also much interest in leases but no organized effort to provide seed for them. By 2002, landings had plummeted to 26,000 pounds.

Diseases made matters worse. MSX was detected in the Bras d'Or Lake in 2002; it had spread to North Harbour (Aspy Bay) by 2006. In 2007, malpeque began to cause mortalities in the Boom Island area. In 2003, the Department of Fisheries and Oceans Canada (DFO) closed the fishery and the Unama'ki Chiefs closed the food, social and ceremonial harvest. Mitigation efforts included the creation of oyster sanctuaries in Boom Island, Nyanza Bay & Little Narrows by DFO in 2004, and the creation of an oyster reef near Lewis Island in South Dennis Basin by the Eskasoni First Nation in 2007.

2002 MSX Outbreak and Research Update, Mary Stephenson – Department of Fisheries and Oceans

In 2002, MSX disease was detected within the Bras d'Or Lakes. As the responsible authority, DFO was required to report the event and demonstrate how disease controls were being implemented to the World Animal Health Organization. DFO Science provided advice to the Fisheries and Aquaculture Management Branch for the establishment of MSX management zones based on MSX disease distribution, human activities and the oceanographic connectivity of the lakes. Oyster harvest protocols were developed to prevent the spread of MSX, and activities within the MSX-positive zone of the lakes were closely monitored through conditions of licence and the Nova Scotia Introduction and Transfer Committee.

In 2004, to provide protected areas for oyster enhancement, oyster sanctuaries were established and seeded with oyster spat exposed to MSX. Sanctuaries in heavily-infected areas of Nyanza Bay and Morrison's Cove experienced mortalities and elevated prevalence's of MSX. A third sanctuary, at Boom Island, continues to be monitored and, although little mortality has been observed, MSX and malpeque disease have been detected. Oyster disease surveillance by DFO is ongoing using histopathology for MSX disease detection, Real Time PCR (qPCR) to generate a numeric value representative of the intensity in individual oysters of the parasite *Haplosporidium nelsoni*, the causative agent of MSX, and in-situ hybridization for confirmation only. The prevalences by qPCR are generally higher than by histology therefore applying both these tests helps in managing inadvertent spread of the disease if histology alone was used. It also provides insight into the dynamics of MSX that may be linked to environmental parameters at specific sites such as the areas within the lakes where *H. nelsoni* may have been detected by qPCR but MSX disease is not being expressed, such as South Basin, West Bay and St. Andrew's Channel. Currently, the MSX positive zone is defined as the lakes and extends to the Atlantic shore of Cape Breton, including Aspy Bay, St. Ann's Harbour and Mira Bay, with no transfers to outside this zone of oysters for re-soaking. Reports of detection of MSX are now mandatory to the Canadian Food Inspection Agency (CFIA), who is the responsible authority for aquatic animal health in Canada.

Initiation of a Bras d'Or Lake breeding program and broodstock management for resistance to MSX, Bénédikte Vercaemer - Department of Fisheries and Oceans, Allison McIsaac & Philip Drinnan – Eskasoni Fish & Wildlife Commission

With the decline of the Bras d'Or Lake oyster (*Crassostrea virginica*) populations, stock enhancement is one approach supported by many stakeholders, including DFO and First Nations. Aquaculture and hatcheries technologies can stabilize and improve tolerance of oyster stocks to MSX disease, but the potential for decrease in genetic diversity must be addressed. The first R&D project was to initiate a breeding program for MSX tolerance with a rotational breeding plan, performing crossing of oysters from specific sites and testing the progenies in field sites within the lakes. However, the direct and/or indirect effects of the MSX parasite on the gametogenesis and spawning of the oyster were not clear and MSX infection impeded on the abilities of adult oysters to properly reproduce. Temperature and salinity are two factors influencing the activity of the MSX parasite. A second R&D project proposed to identify critical time-temperature-salinity combinations to ensure proper gametogenesis and spawning of MSX infected oyster brood stock, and to make recommendations for ongoing MSX resistant oyster breeding programs and for future restoration programs.

Oceanographic modeling of the Bras d'Or Lakes, Bruce Hatcher – Cape Breton University

The structure and circulation of water in the Bras d'Or estuary is complex because of the rugged topography, great water volume, and narrow connections to the surrounding ocean. Astronomical and barometric tides, gravity, wind, waves and freshwater inflow all interact to force the movement of water within the channels. The circulation serves to connect the disparate habitats of the ecosystem by transporting nutrients, plankton, larvae and pathogens. Understanding this ecological connectivity provides insights to the dynamics of marine populations, including oysters and the epidemiology of their parasites.

In 2007, using funds from the AquaNet TriCouncil grant, a team of researchers from Cape Breton, Dalhousie and Prince Edward Island universities developed a three-dimensional numerical model of the hydrodynamics of the Bras d'Or estuary for application to the oyster metapopulation. The model predicts current velocity, temperature and salinity in twenty depth layers at 500m horizontal resolution. An application to the forensic reconstruction of the alternative hypotheses concerning the introduction and spread of the MSX oyster pathogen throughout the estuary is described. To become fully operational for near real-time prediction (such as the effects of oyster aquaculture or the spread of malpeque disease), the model requires further development of the environmental forcing functions, and improved spatial resolution in the areas of the estuary with narrow channels and small embayments. With the ongoing assistance of the Bedford Institute and Oceanography and the Unama'ki Insitute of Natural Resources, work is underway to meet these requirements.

A proteomic approach to the study of MSX (*Haplosporidium nelsoni)* in the Eastern Oyster (*Crassostrea virginica)*: insights into the parasite in two environmental systems, Victoria Savoie-Swan – Atlantic Veterinary College, University of Prince Edward Island

Infections of the Eastern oyster, *Crassostrea virginica*, with the parasite *Haplosporidium nelsoni* (MSX) can be identified through current diagnostic methods (histology and PCR) but not reliably described in terms of their disease progression. The reasons why some infected oysters from the same environmental population succumb to infection while others survive cannot be predicted. The mechanisms that play a role in host susceptibility are not known for this parasite.

Two studies were established to describe the proteins found associated with MSX infections of *C. virginica.* In the first, conducted at VIMS, oysters from a naïve environment were collected and a sample of their haemolymph collected before deployment in a closely monitored site with continued seasonal pressure from MSX. Comparison of initial samples with haemolymph collected at two weeks and two months post-deployment from the same individual oysters proved advantageous in identifying protein changes over time and with exposure to MSX associated with infection and specific to intensities established at the time of final harvest. Unique proteolytic enzymes were identified in the initial haemolymph samples from those individuals who went on to develop the highest intensity infections and increased enzyme activity was associated with medium to high intensity infections over time.

The second study examined oysters from three distinct areas in the lakes; Lynches River, with no prior evidence of MSX infection; East Bay, with some previous infections identified and Nyanza Bay, with multi-year identification of active infections. PCR and histology tests were carried out and all three sites showed MSX prevalences in the range of 28 to 30%. However, Lynches River samples showed no evidence of infection through histology. This identified an area, in which MSX pressure likely exists, as evidenced through the identification of the parasite through PCR, but active infections are not becoming established. Environmental studies and experiments using a similar approach to that used at VIMS, such as targeting individuals over time in different areas of exposure, may help understand why oysters in this region do not succumb to MSX.

A Novel Process for MSX "Removal" from Infected Oysters, Rod Beresford – Unama'ki College

The MSX oyster parasite has devastated the lakes oyster industry. The impact of this parasite is compounded by the fact that (1) there have been significant mortalities in various locations throughout the lakes, and (2) the resulting, albeit necessary, restrictions for oyster movements has essentially paralysed the industry. The exact relationship between temperature and disease development has been documented using field data, however, few (if any) laboratory-based temperature experiments have been undertaken to try and determine the role of temperature in the development of disease in individual oysters. Oysters were initially held using Instant Ocean™ in separate tanks at 10°C, 15°C, and 20°C for 12 weeks, then sampled to evaluate parasite development and disease progression. The results from experiments were surprising. Based on repeated experiments using specific temperatures, we have determined that under suitable laboratory conditions, oysters are able to reduce the prevalence and intensity of MSX infection. Furthermore, mortality of the oysters held under these conditions has been reduced to 0%.

Initial studies were carried out for 12 weeks. However, a subsequent time trial demonstrated that the most sig-

nificant parasite removal occurs in the first four weeks. Therefore, depending on the specific circumstances and desired outcomes, infected oysters can be treated for shorter or longer periods of time (longer periods of time resulting in greater parasite removal that may or may not be necessary). Current studies are underway to determine the role of other factors such as nutrients. Future studies will investigate whether this process is effective on a much larger scale so that it may be employed in a commercial oyster aquaculture operation.

Potential Futures, Robin Stuart – Ocean Stuart Consulting

There is tremendous potential around the lakes for oyster aquaculture. Revitalizing the oyster industry in the Bras d'Or Lakes is going to require a well thought out and developed plan. It will take a collaborative effort involving a number of demonstrated technologies and techniques such as recent MSX-clearing findings at CBU, the use of up-wellers to increase production, off bottom culturing techniques such as the Oyster Grow, hatcheries and environmental management methods as employed by Waycobah to rebuild the industry.

Malpeque and MSX are big threats to the oyster industry in Cape Breton. Oyster stocks can be transferred within the lakes but nothing can be transferred from outside the lakes. The industry needs to use resistant stocks, as DFO has done in the past, to rebuild an industry. Removing these movement restrictions, which are overseen by DFO, would benefit the farming industry and wild stocks, which need resistant stocks to survive. As well, the industry needs local diagnostic capabilities to obtain results in a timely manner by using existing infrastructure, such as the research hatchery in Eskasoni.

The public's support is mandatory for moving this initiative forward. Without DFO and community buy-in, rebuilding an industry will be more challenging. Improved communication between all vested groups is needed, including between DFO and the Nova Scotia Department of Fisheries and Aquaculture regarding shellfish health.

O**yster culturing methods,** Charles Purdy – Bay Enterprises Ltd.

Having a long family heritage of involvement with the oyster industry, interest in the recreational and commercial fishery began early and eventually evolved from a hobby into a full time commitment when he took over management of the family farm at age 13. He moved from commercial fishing to lease-based oyster and quahog production to hatchery operations to grow out and, finally, to export marketing.

When trying to decide which oyster culturing methods should be applied to a site, it is important to know the location and the environment. Bay Enterprises Ltd, is located in the Malagash Basin, near MacNab's Bay and Tatamagouche Bay. The inner reach of the Basin is not deep and, at first glance, it does not appear as an idealistic site to farm oysters. It is an anomaly where oyster thrive despite high turbidity and low tides that leave the sandy bottom exposed. Due to various reasons in the past (e.g. poor forestry and agricultural practices, diseases etc.) the wild oyster populations decreased and, what was once a productive bay was filled with silt. Oysters were reintroduced to the north shore through aquaculture. New oyster beds were built using empty shells, and de-silting devices were also used to remove unwanted particles from the oyster beds.

A mechanized Ecoharvester harvesting system and CFIA-approved processing facility were required in order to harvest the oysters growing on the bottom. Several trips to Europe have given Bay Enterprises Ltd, technical ideas to adopt on their farm. Both bottom and suspended culturing methods have been used over time.

Overview of Oyster Regulations, Lorne Penny – Department of Fisheries and Oceans

As the Chief, Resource Management for the Eastern Nova Scotia (ENS) area, Lorne Penny is responsible for leading and coordinating the commercial fisheries, aboriginal fisheries, aquaculture and recreational fisheries files. As such, some of his duties include: resource management planning, chairing stakeholder consultations, implementing conservation harvesting plans and supervising ENS area licensing operations. The ENS Area remains committed to working in collaboration with stakeholders to identify and promote common interests towards the sustainable development of fisheries and aquaculture resources for the benefit of present and future generations.

In an effort to promote sustainable aquaculture development and awareness, ENS area staff have embarked on two conservation education initiatives; the Aqua Garden Project and the Aqua-Ed Site. These create unique educational opportunities for elementary school students and local property owners to explore and learn more about the Bras d'Or Lakes ecosystem.

Discussion

The vision for the oyster industry in the lakes was discussed, along with industry, research and regulatory needs. These comments will be incorporated in the Cape Breton Oyster Industry Needs Assessment project for the Aquaculture Association of Nova Scotia. The vision is to develop a viable oyster aquaculture industry in the Bras d'Or Lakes.

Industry Needs

To build an oyster aquaculture industry, farmers will need to: access seed stock, adopt new technologies and a communication strategy. It is uncertain what seed stock exists in the lakes since few farmers have been operating over the past decade.

Industry needs flexibility for both bottom and suspended culture. Adopting existing technologies that have been developed and applied will help minimize risks. Farmers are creative with the materials that are available. The top facilities are not required to run a hatchery operation. Knowledge and information sharing are fundamental for co-developing the industry. The industry needs a comprehensive strategy for culturing oysters that follows regulatory needs.

An important question was raised - who is the industry? The existing industry will need investors and will have to work with the federal and provincial regulators in order to develop the industry.

Coordination between interested groups will also be required to ensure that a solid plan is developed to minimize risks. Business and technical training should be offered to ensure proper tools are available for the future industry. Community groups, as well as other industry participants from outside the lakes need to be involved in future plans.

Regulatory Needs

The Department of Fisheries and Oceans has divided Cape Breton into two management regions: the Maritimes and the Gulf regions. The lakes fall under the Maritimes Region. After the MSX outbreak, a policy was put in place to restrict movement of the oysters within the lakes. Zones were developed to improve management because of industries concerns. The policy has changed, and now oysters can be transferred within the lakes. It is much easier to change federal policies than regulations.

Policies will have to change if industry wants to import Malpeque-resistant oysters into the lakes. The Eastern Shore Oyster Board is a good starting mechanism for requesting import of Malpeque-resistant oysters; however, Introductions and Transfers (DFO) should also be involved. It would likely be permitted to raise oysters in a CFIA-approved quarantine facility and transfer them into the lakes. Given the complex diseases in the region, any hatchery will need to be on the lakes.

Research Needs

Tools must be developed to rapidly detect the presence of the MSX parasite and to measure the resistance of Malpeque. It is not mandatory for DFO to report on Malpeque. Malpeque was a horrific disease and it caused ample damage in the Gulf until resistance was built up in remaining stocks. Any future research should acknowledge Malpeque or it could wipe out the industry again. MSX- and Malpeque- resistant oysters have not been bred, and it would be difficult to do, given the lack of knowledge on both diseases. The degree of resistance cannot be measured in MSX positive oysters and measuring Malpeque is more challenging because the causative agent is unknown.

Accessing research funding can be difficult. Part of the challenge is that few professors are dedicated to shellfish research in Atlantic Canada and the National Research Council stopped aquaculture research. DFO have expertise, but their resources are limited. NSERC does have industry focussed research funds that require University involvement. NRC's Industrial Research Assistance Program (NRC-IRAP) does support industry-led research projects, and the DFO ACRDP and AIMAP programs do have some funds for research relevant to industry in specific areas.

Know the environment. Over the past decade the environment has likely changed, it will be important to determine whether or not the existing environment can support the proposed aquaculture plans.

Future Direction

A more focused workshop is planned for Fall 2012. Several models have been presented at this workshop including: (1) availability of seed stock, (2) allowing oysters to develop natural resistance to MSX, (3) using a hatchery to cultivate oysters, and (4) import malpeque-resistant oysters. The workshop will determine who will be responsible for carrying out the proposed work and what funding opportunities are available given the nature of the work. Details about how each model will be carried out will be addressed. The aquaculture industry will need several champions for each model in order to make the oyster industry viable.

Notes

Figure 1: The Bras d'Or Lakes located in Cape Breton, Nova Scotia

Workshop hosts:

Ross Scinergy Inc.

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