Fisheries and Oceans Canada
Pêches et Océans Canada

Aquaculture Collaborative Research and Development Program (ACRDP) Fact Sheet

Issue 6
May, 2010

Containment and Mitigation of Nuisance Tunicates on Prince Edward Island to Improve Mussel Farm Productivity

Summary

The mussel aquaculture industry in Prince Edward Island has been severely impacted by the introduction of four invasive tunicate species since 1998. Two solitary tunicates, the clubbed (*Styela clava*) and vase (*Ciona intestinalis*) tunicates, and two colonial tunicates, the violet (*Botrylloides violaceus*) and golden star (*Botryllus schlosseri*) tunicates, are challenging the sustainability and productivity of this vital industry. Initial efforts were directed toward controlling the spread of these tunicates. Recently, to ensure sustainability of the PEI mussel industry, efforts have been focused on mitigation measures to reduce the impact of tunicate infestation on mussel farms.

Introduction

Mussel aquaculture has grown into a vital industry in PEI since its beginning in the 1970s. This industry has successfully overcome many challenges throughout its brief history. Its most recent challenge, dealing with bio-fouling due to invasive tunicates (Figure 1), is impacting the sustainability and productivity of farms within infested waters.

In PEI, the clubbed tunicate (*Styela clava*) was reported in Brudenell River in 1998 and became the first Aquatic Invasive Species (AIS) to challenge mussel culture operations. Since then the species has spread to Murray River, Malpeque Bay (March Water) and the other mussel farming estuaries within Cardigan Bay (St. Mary's Bay, Montague River, Brudenell River and Cardigan River) (Figure 2). The invasive colonial tunicates, violet (*Botrylloides violaceus*) and golden star (*Botryllus schlosseri*), were first reported in 2004 on mussel farms in Savage Harbour and have spread to St. Peters Bay, Tracadie Bay, Rustico Bay, March Water and estuaries of Cardigan Bay. In late 2004, the vase tunicate (*Ciona intestinalis*) was reported on mussel farms in Montague River and has since spread to the other mussel producing estuaries in Cardigan Bay and Murray Harbour. Since 1998, the industry, in collaboration with government agencies, has worked relentlessly to control the spread and minimize the impact of these invasive tunicates. They are now faced with the challenge of restoring the sustainability and productivity of their industry.

The most important consequence of tunicate infestation on mussel farms has been associated with the additional effort and cost of operating in the presence of these invading bio-fouling organisms. Vase tunicate infestations quickly overtake mussel socks, resulting in competition for food, loose attachment of mussels subsequently leading to mussel loss, and increasing average sock weight (four to five fold) which, in turn, taxes equipment and crews.

As well, tunicate infested socks add to the cost of harvest, transporting harvested socks and processing. The mussel industry was initially able to respond successfully to the clubbed and colonial tunicate infestations, but has been severely challenged by the addition of the vase tunicate. The latter, presents a greater challenge because of the exceptional fouling capacity, affecting productivity by limiting the mussels' access to food.

Methods

Containment

To assist in managing against the spread of invasive tunicate species to non-infested waters, Fisheries and Oceans Canada (DFO), in collaboration with the aquaculture industry, has restrictions in place to prevent the transfer of product within, or into, PEI from tunicate infested waters. In support of this licensing requirement, all waters within the province infested with invasive tunicates are designated as "restricted waters" (Figure 2).

With cooperation of the aquaculture industry, protocols governing the movement of product from restricted waters were developed. The application of the licensing requirement and protocols has been effective in reducing the spread of invasive tunicate species to non-infested areas. This approach has been instrumental in restricting the most problematic species, the vase tunicate, to the northern and southeastern area of the province.

Mitigation

A variety of technological innovations were produced from this project to enable mussel producers to effectively manage their crops against nuisance tunicates. Equipment was developed and improved upon by industry to reduce

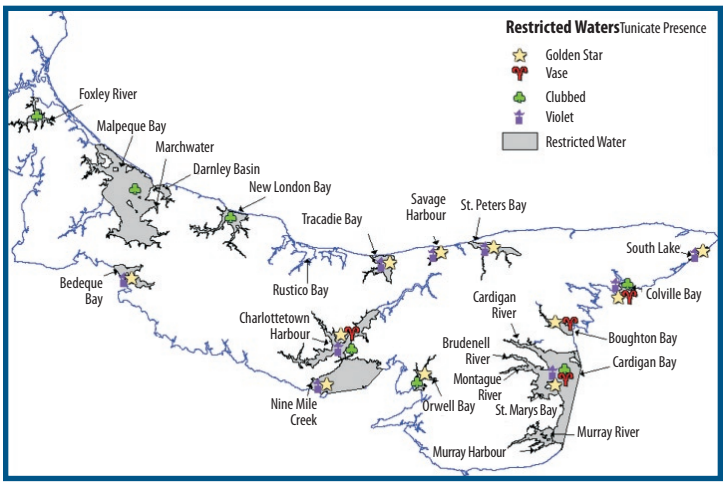

Figure 2.
Map of invasive tunicate presence and areas classified as restricted waters in PEI in 2009. (Map, produced by Fisheries and Oceans Canada, is a graphical representation and is not intended to be used for legal description or to calculate exact dimensions or area).

the impact of invasive tunicates, specifically the clubbed tunicate (*S. clava*) and the vase tunicate (*C. intestinalis*), on mussel crops. Many of the technologies developed in eastern PEI for *C. intestinalis* have involved the use of a machine that employed multiple high-pressure nozzles to wash off or pierce the fouling tunicates (Figure 3). Since these physical-based techniques were less effective on the clubbed tunicate, chemical-based technologies were developed. One such treatment involved the delivery of a lime solution to mussel socks infested with *S. clava*. These technologies, used mainly in the March Water area of Malpeque Bay, also attempted to reduce the amount of lime entering the environment by incorporating a lime recovery system into the design.

Figure 1.
The four invasive tunicate species found in PEI. From left to right: the clubbed tunicate (*Styela clava*), violet tunicates (*Botrylloides violaceus*), golden star tunicates (*Botryllus schlosseri*), and vase tunicate (*Ciona intestinalis*)

Figure 3.
Technology developed by mussel producers in eastern PEI to reduce the level of *C. intestinalis* fouling on mussel socks. The technology uses high-pressure spray nozzles to remove tunicates from the mussel socks.

The effectiveness and feasibility of newly developed treatment techniques from this project were assessed through a joint project between Fisheries and Oceans Canada and the Atlantic Veterinary College (AVC) to investigate new farm management practices. A study was conducted in 2008-2009 with a grower in St. Mary's Bay to determine the timing of optimal treatment for the high-pressure wash. Preliminary data from this area suggested that sock treatments starting in mid-July and followed by two additional treatments, three and six weeks later, resulted in higher mussel productivity. For the purposes of this fact sheet, data on the untreated socks (control) and on the treated socks (using the optimal treatment strategy of three applications beginning in mid-July) will be presented. A total of eight socks were sampled from the untreated control socks and the treated socks, in both the fall and spring after treatments had been applied. These socks were evaluated for tunicate fouling, by weight, and mussel density.

Results

Containment

Fisheries and Oceans Canada's requirement for a license issued under Section 56 of the Fisheries (General) Regulations to move bivalves from tunicate infested waters within the province has been successful in containing and slowing the anticipated spread of all four tunicate species. The application of a 'like to like' policy, whereby transfers of mussels can only occur between bays with similar AIS profiles, is supported by mussel growers. The cultured mussel industry is cognizant of the harmful consequences to their industry if efforts are not undertaken to contain the spread of invasive tunicates.

Mitigation

There was a substantial reduction in tunicate fouling on mussel socks as a direct result of high-pressure water treatment (Figure 4). An average 40% reduction in tunicate biomass was observed during the fall sampling of this trial, with the application of three separate treatments, when compared to the untreated control socks. However, when socks were sampled again in the following spring approximately 99% mortality in tunicates was observed due to mass winter mortalities of tunicates on both treated and untreated socks (Figure 5).

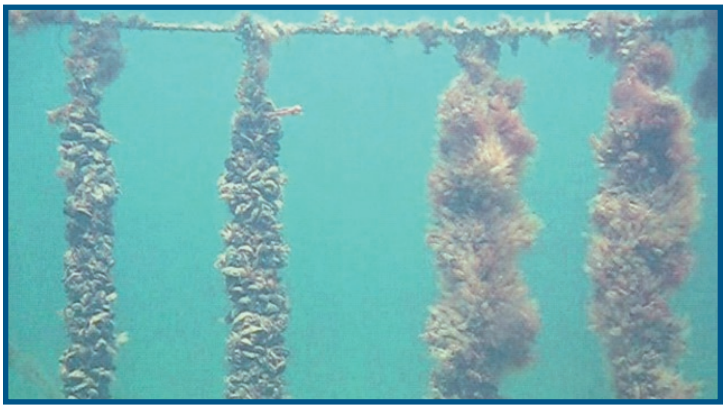

Figure 4.
Socks on the left have been treated three times, as opposed to the socks on the right, which have never been treated. The picture was taken shortly after the third treatment.

Treated socks had approximately double the mussel density compared to control socks with densities maintained through the winter months (Figure 6). This shows that the treatment is not only reducing tunicate biomass, but also stimulated a mechanism that enables the mussels to have tighter attachment to the mussel socks. Mussel growth lost due to heavy fouling on untreated socks can only be regained during the winter-spring period after natural mass mortality of tunicates occurs. This gain, however, still remained 40% below that of the treated socks.

Preliminary research has shown that even a one-time spray application of hydrated lime on mussel socks is sufficient to reduce clubbed tunicate fouling to a manageable level. It has been estimated that the lime treatment causes

mortality in approximately 90% of the clubbed tunicates. This is consistent with observations by mussel producers.

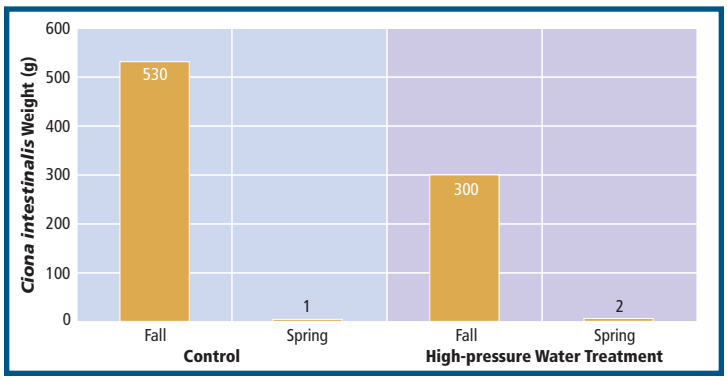

Figure 5.
Average *Ciona intestinalis* weight on untreated control socks and treated socks. Samples were taken in the fall 2008 and spring 2009.

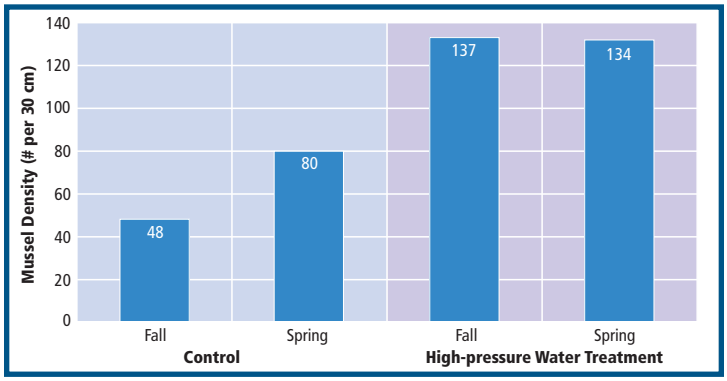

Figure 6.
Average mussel density (per 30 cm of sock length) on untreated control socks and treated socks. Samples were taken in the fall 2008 and spring 2009.

Conclusions

Efforts to minimize the impact of tunicate invasion on mussel aquaculture operations are ongoing in PEI. Containment approaches have halted the spread of *C. intestinalis* from the north shore of PEI and on the shores of neighboring provinces within the southern Gulf of St. Lawrence. This approach is based on a co-management agreement with industry through their participation in a newly implemented Introduction and Transfer (I&T) subcommittee and in self-regulatory efforts. This subcommittee is mandated to make recommendations to the PEI Introductions and Transfers Committee on implementing measures to control and contain the spread of invasive tunicates. The application of a 'like to like' policy for permitting the transfer of bivalves from tunicate infested waters has been effective. The industry is also leading other industries and other organizations (Research Agencies, Non-Governmental Organizations) in efforts to control AIS through their innovation and support for research.

The PEI mussel industry is leading the development of treatment techniques and strategies to mitigate the impact of AIS, particularly on shellfish aquaculture operations. To date, the collaborative efforts and support by industry, government and academia has resulted in the continued viability of the mussel industry in areas affected by invasive tunicates. The physical and chemical techniques developed and enhanced through this collaborative management effort focus on re-establishing the sustainability of the mussel industry in PEI and assisting other areas and industries in dealing with the ongoing threat. Several prototypes of treatment techniques are now available and are being used and enhanced by the industry to re-gain and improve productivity. These technologies will also play a key role in the development of an Integrated AIS Management strategy. Control measures will be integrated with treatment measures to minimize the impacts of AIS on existing and future industries as well as on the aquatic ecosystem ensuring the future sustainability of the PEI mussel aquaculture industry.

This ACRDP project (MG-07-04-009) was a collaborative effort among the Department of Fisheries and Oceans (DFO Science), Prince Edward Island Aquaculture Alliance (PEIAA), the Prince Edward Island Department of Fisheries, Aquaculture and Rural Development (DFARD) and the Atlantic Canada Opportunities Agency (ACOA). For further information, please contact Thomas Landry at **Thomas.Landry@dfo-mpo.gc.ca**.

For further information on this and other ACRDP projects, visit:
http://www.dfo-mpo.gc.ca/science/aquaculture/acrdp-pcrda/main_e.htm

One aspect of this study is currently the topic of a primary publication in preparation: Ramsay A, Paetzold SC, Davidson J (in prep.). Optimization of high-pressure water application to control tunicate fouling and increase mussel productivity.

Published by:
Aquaculture Science Branch
Fisheries and Oceans Canada
Ottawa, Ontario K1A 0E6

ISSN 1919-6806 (Print),
ISSN 1919-6814 (Online)
DFO/2008-1493

French version and alternative formats available through:
http://www.dfo-mpo.gc.ca/science/enviro/aquaculture/acrdp-pcrda/index-fra.htm