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Far-Field Impacts of Eutrophication on the Intertidal Zone in the Bay of Fundy, Canada with Emphasis on the Soft-Shell Clam, *Mya arenaria*

S. M. C. Robinson[1] (✉) · L. M. Auffrey[2] · M. A. Barbeau[3]

[1]Department of Fisheries & Oceans, Biological Station, 531 Brandy Cove Road, St. Andrews, New Brunswick, E5B 2L9, Canada
robinsonsm@mar.dfo-mpo.gc.ca

[2]210 Herve Street, Dieppe, New Brunswick, E1A 6Y7, Canada
lauffrey-arsenault@rogers.com

[3]Department of Biology, University of New Brunswick, Bag Service #45111, Fredericton, New Brunswick, E3B 6E1, Canada
mbarbeau@unb.ca

Abstract A study was conducted in the Bay of Fundy, Canada in 2000–2003 to examine the effects of *Ulva*-dominated algal mats on the population dynamics of the soft-shell clam (*Mya arenaria*) and the possible role of Atlantic salmon farming in this interaction. A far-field linkage of the salmon farms to the intertidal zone was determined by the use of zinc : lithium tracers. A combination of laboratory and field-based experiments were conducted to assess the effects of algal mats on the recruitment, production (growth and survival) and behaviour of the clams. The results indicated that increased zinc concentrations were found in intertidal sediments located > 1 km from the nearest salmon site. This implies that if the fine particulates from the salmon site were being transported that distance, then the dissolved fraction could also travel that far, providing it was not absorbed by other nutrient sinks along the way. The algal mats were found to negatively affect clam recruitment and behaviour. The experimental results were not as clear for negative effects on biological production, but growth was found to be lower than expected and survival on the beach was low. The economic cost of the eutrophication to the beaches might be substantial (estimated > 100 000 $CAD per clam beach). One solution would be an integrated culture philosophy where additional crops are intentionally grown and harvested so that a potential liability could become an asset to the marine coastal economy.

Keywords Mya arenaria · Ulva-Enteromorpha · Algal mats · Salmon aquaculture · Bay of Fundy

1 Introduction

1.1 Defining the Problem

There is a growing recognition, on a global basis, that the fresh waters and near-shore marine coastal zone of most industrialized countries have been undergoing a period of increased enrichment of inorganic and organic nutrients over the last several decades, generally known as eutrophication [1, 2]. Eutrophication, in its most basic form, can be defined as "an increase in the rate of supply of organic matter to an ecosystem" [3]. The typical increases in anthropogenic activities near coastal zones (e.g. housing developments, agriculture, golf courses, food processing plants, fossil-fuel combustion) are directly correlated with increased nutrient levels, such as nitrogen and phosphorus, in coastal waters [2, 4]. This addition of nitrogen and phosphorus from a large suite of anthropogenic activities has resulted in changes to the marine coastal ecosystems to an extent that we are just beginning to understand. Fresh-water models of eutrophication do not seem to apply directly to marine systems and we are discovering that there are a suite of biological and physical filters that can control and modify the effects of the inorganic nutrients [1]. While many communities are now controlling much of the organic loading of municipal waste, far fewer municipalities are also treating the inorganic fraction through bacterial denitrification processes. As a result, the