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Interactions between finfish aquaculture and lobster catches in a sheltered bay

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ABSTRACT

Interactions between open-net pen finfish aquaculture and lobster catches in a sheltered bay in Nova Scotia, Canada, were investigated using fishermen's participatory research in annual lobster trap surveys over seven years.

Fishermen recorded lobster catches during the last two weeks of May from 2007 to 2013. Catches for each trap haul were recorded separately for ovigerous and market-sized lobsters. Catch trends within the bay were compared to regional trends. Results of correlation analyses indicated that ovigerous catch trends were strongly affected by the fish farm's feeding/fallow periods. There was no significant correlation between trends for bay and LFA lobster landings.

Patterns of lobster catch per unit effort extending over considerable distance in Port Mouton Bay appear to be influenced by proximity to the fish farm regardless of year-to-year variation in water temperatures and weather conditions. Odours and habitat changes surrounding open-net pen finfish operations are potential factors affecting lobster displacement.

1. Introduction

American lobster (*Homarus americanus*) currently supports the most valuable fishery in Atlantic Canada. Increases in lobster landings in recent years have been linked to reduced predation related to the decline of the groundfish stocks (Boudreau and Worm, 2010), resulting in almost complete reliance for coastal communities on this high-value fishery (Steneck et al., 2011).

Management areas for the lobster fishery are large geographic units called Lobster Fishing Areas (LFAs). As part of the Canadian government's fisheries management regime, lobster fishermen are required to report landings and trap hauls to the Department of Fisheries and Oceans (DFO) (Coffen-Smout et al., 2013).

Concurrent with the increase in lobster landings has been the rise of open net pen finfish aquaculture. These operations are largely, but not exclusively, located in sheltered areas of the coastal zone which provide protection from heavy seas, suitable year-round temperatures and, depending on location, some tidal flushing (Milewski, 2001). The number of fish stocked per farm site can range from 200,000 to 700,000 depending on the farm production plan. In Atlantic Canada, the province of New Brunswick is the largest producer of farmed fish (30,359 mt in 2012) followed by Nova Scotia (6087 mt) (DFO, 2012).

Where traditional fisheries and aquaculture operate in the same area, conflicts have arisen (Wiber et al., 2012; Harvey and Milewski, 2007; Walters, 2007). Fishermen have reported that two years after a fish farm has been established within their area ovigerous or egg-bearing lobsters and herring avoid the area, (Wiber et al., 2012). Lobster, as well as crab and shrimp, mortalities have also been reported due to legal and illegal pesticides used to treat sea lice infestation on salmon farms (Wiber et al., 2012; Harvey and Milewski, 2007). Some aquaculture operators point to the record high lobster landings as proof that fish farms and aquaculture can co-exist and claim that net pens attract lobsters and increase local landings (Milewski, 2014).

Fishermen of Port Mouton Bay, Nova Scotia, are part of LFA 33 management area (Fig. 1). In recent years, they report abandoning historical lobster fishing 'territories' within the bay because of very low catches. This trend developed after 1995 when an open net pen Atlantic salmon (*Salmo salar*) farm began operating in the bay (Fig. 1). Fishermen believe these territories had been lobster spawning and moulting areas (Fishermen, pers comm.) Historical lobster trap surveys conducted by the federal Department of Fisheries and Oceans (Miller et al., 1989, unpublished records in DFO files 1946-7) support local ecological knowledge that Port Mouton Bay had been a destination for lobster migration.

Fishermen have detailed knowledge of their resource and fishing practices. This information can be quantified and applied to

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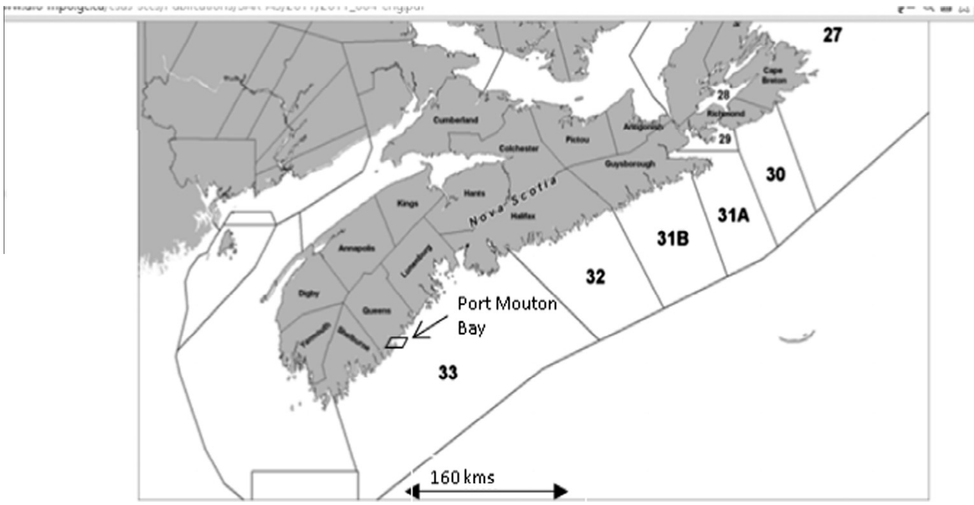

Fig. 1. Location of Port Mouton Bay, Nova Scotia (Canada), within Lobster Fishing Area (LFA) 33.

discern trends within fisheries (Berkes, 1999; Neis et al., 1999; Hutchings and Ferguson, 2000; Johannes et al., 2000; Hutchings et al., 2002; Maunder et al., 2006; Garcia and Charles, 2007; Miller et al., 2010; Wiber et al., 2011, 2012). Information on lobster catch-per-trap-haul or catch per unit effort (CPUE) reveals important trends and patterns (Tremblay et al., 2011).

This study combines fishermen's local knowledge, participatory research and established scientific methods to examine lobster catch data in the vicinity of an established finfish farm over a seven year period.

2. Methods

Fishermen recorded lobster catches within Port Mouton Bay during the last two weeks of May for seven years (2007–2013). This period represents a time when higher numbers of lobsters historically migrate into the bay. Catches for each trap haul were recorded separately for ovigerous and market lobsters. Market lobsters are defined as having a carapace length of at least 82.5 mm. Catch-per-unit effort (CPUE) was calculated as a function of kilograms caught per trap haul for market lobsters and numbers caught per 1000 trap hauls for ovigerous lobsters. Data for market lobsters, not collected in 2008, was resumed in 2009.

Catch statistics were compiled for each of five contiguous regions of Port Mouton Bay (Fig. 2). Regions were delineated geographically based on historic fishing territories, areas where the same fishermen occupy the same territories year after year. Region 2 includes the Atlantic salmon farm site which was fallowed from late July 2009 until June, 2012, and then re-stocked with Rainbow trout (*Oncorhynchus mykiss*) (Fig. 2). Fallowing refers to a temporary cessation in production at the farm site.

Data for lobsters landings in LFA 33 for 2007–2010 were taken from Tremblay et al. (2011); those for 2011–2013, were derived from landed value and average price per pound in the Department of Fisheries and Oceans, Maritimes Region Economic Update (DFO, 2013). DFO Statistical Lobster Fishing Area LFA 33 includes and is spatially much larger than Port Mouton Bay.

Pearson's correlation analysis was carried out between the CPUE for ovigerous and market lobster in each fishing region and the fish farm's feeding/fallow period and lobster landings for LFA 33. A one-sided t-test was used in significance testing.

Bottom temperature data for Port Mouton Bay was provided by a temperature recorder placed in a trap in Region 4. The recorder was operated by the Fishermen and Scientist Research Society, a partnership between fishermen and scientists whose goal is to promote the sustainability of the marine fishing industry in Atlantic Canada.[1]

3. Results

Overall, the number of trap hauls was lowest in all fishing regions in the bay during the periods of fish farm operation (2007, 2008, 2009 and 2013) compared to years of fallow (2010, 2011 and 2012) (Table 1). Each trap haul represents costs in time, fuel and bait – fishermen optimize their catch per unit effort, otherwise costs may exceed revenue. The average number of fishing days lost to poor weather during the two-week survey period was slightly less in 2013 (2.4 days/boat) than in 2011 (2.6 days/boat).

The farm was operating at an estimated 50% capacity in July, 2009, documented by an aerial photograph (Loucks et al., 2012).

During operation of the fish farm in 2007, 2008 and 2009, CPUE for ovigerous lobsters was low in all regions (Fig. 3). During the fallow period (2010, 2011 and 2012), CPUE for ovigerous lobsters increased markedly everywhere except in Region 2. In 2013, with the fish farm restocked, all regions again showed low CPUE, although Region 5, the outermost region, showed a pattern of some resemblance to LFA 33 landings.

Market lobster CPUE in 2007, 2009–2013 ranged from 0.15 to 0.3 kg/trap haul in Region 2 (Fig. 4). Lobsters were caught in peripheral areas of Region 2, but not near the fish farm. In the other regions, market lobster CPUE ranged from 0.1 up to 0.6 kg/trap haul. During the fallow period Regions 1, 3 and 4 adjacent to the fish farm generally showed increased CPUE. In 2013, with the farm re-stocked, market lobster CPUE were again at low levels – from 0.1 to 0.4 kg/trap haul (Fig. 4).

The feeding/fallowing period sequence at the fish farm and the LFA 33 pattern of landings were each tested for correlation with the five regional patterns for ovigerous lobsters (Table 2). A corresponding set of 10 correlations was prepared for market lobsters (Table 3).

The feeding/fallow period at the fish farm had an effect on CPUE for ovigerous lobsters in Regions 1, 3, 4 and 5 at the 95% confidence level (Table 2). Region 2 was unresponsive. Feeding/fallowing explained 57–72% of the variability in CPUE for ovigerous lobster in Regions 1, 3, 4, and 5. In Region 2, CPUE for ovigerous lobster

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