HABITAT UTILIZATION IN THE VICINITY OF THREE PROPOSED FINFISH AQUACULTURE SITES IN SHELBURNE COUNTY, NOVA SCOTIA

Context

On May 31, 2011, Fisheries and Oceans Canada's (DFO) Habitat Management Division, Maritimes Region, requested that DFO Science, Maritimes Region, provide advice regarding the utilization of habitat in the vicinity of three proposed finfish aquaculture sites in Shelburne Harbour and Jordan Bay, Nova Scotia (referred to as the Jordon Bay, Blue Island and Middle Head sites). The request for advice is in support of Habitat Management's review of an environmental assessment (EA) of a proposed aquaculture development project pursuant to the *Canadian Environmental Assessment Act*. Specifically, Habitat Management asked:

> Based on the type of habitat (as shown in the benthic video taken on June 6, 2011) and the site depths and locations (Figure 1, depths of 10-20 m) what are the potential uses of that habitat by lobster, groundfish, clams, scallops and quahogs?

DFO's Science Special Response Process was used to respond to this request due to the short deadline for advice of August 31, 2011. This Science Response report was developed and reviewed through email correspondence. No review meeting was held. This Science Response report is based on existing data sources from Shelburne and surrounding harbours, which are limited in number and of lower resolution and scale relative to the location and size of the three proposed aquaculture sites.

In summary: 1) lobster landings are relatively high in Shelburne Harbour and Jordan Bay; 2) planktonic lobster larvae have not been studied in Shelburne Harbour and Jordan Bay, although they are likely found throughout much of the area; 3) settlement by young-of-year lobsters within the Blue Island and Jordan Bay sites is possible, but it is expected to be low compared to settlement on the cobble bottoms at the Middle Head site; 4) adolescent and adult lobsters are likely present within the proposed aquaculture sites at various times of the year; 5) the presence of ocean quahog and numerous groundfish species has been noted within the area of the proposed aquaculture sites; and 6) sea scallop are likely within the proposed area; however, distribution data or density estimates do not currently exist. Additional research would be required to more fully address some of the points discussed in this response.

Background

Habitat Management, Maritimes Region, is reviewing an EA for three marine finfish aquaculture sites to be located in Shelburne Harbour and Jordan Bay, Nova Scotia (Figure 1), to determine if they are likely to result in negative impacts to fish and fish habitat. As part of the Federal EA process, DFO may provide advice to Transport Canada regarding any impacts that fall under DFO's mandate. In addition, DFO may provide the Nova Scotia Department of Fisheries and Aquaculture advice on the proposed aquaculture development. Refer to Canadian Environmental Assessment Registry reference number 11-01-61095 for more information regarding the EA of the proposed development project.

One component identified in the Habitat Management risk assessment of the proposed aquaculture development project, and of major concern expressed in public comments received by DFO, is the risk of the proposed development to fish populations.

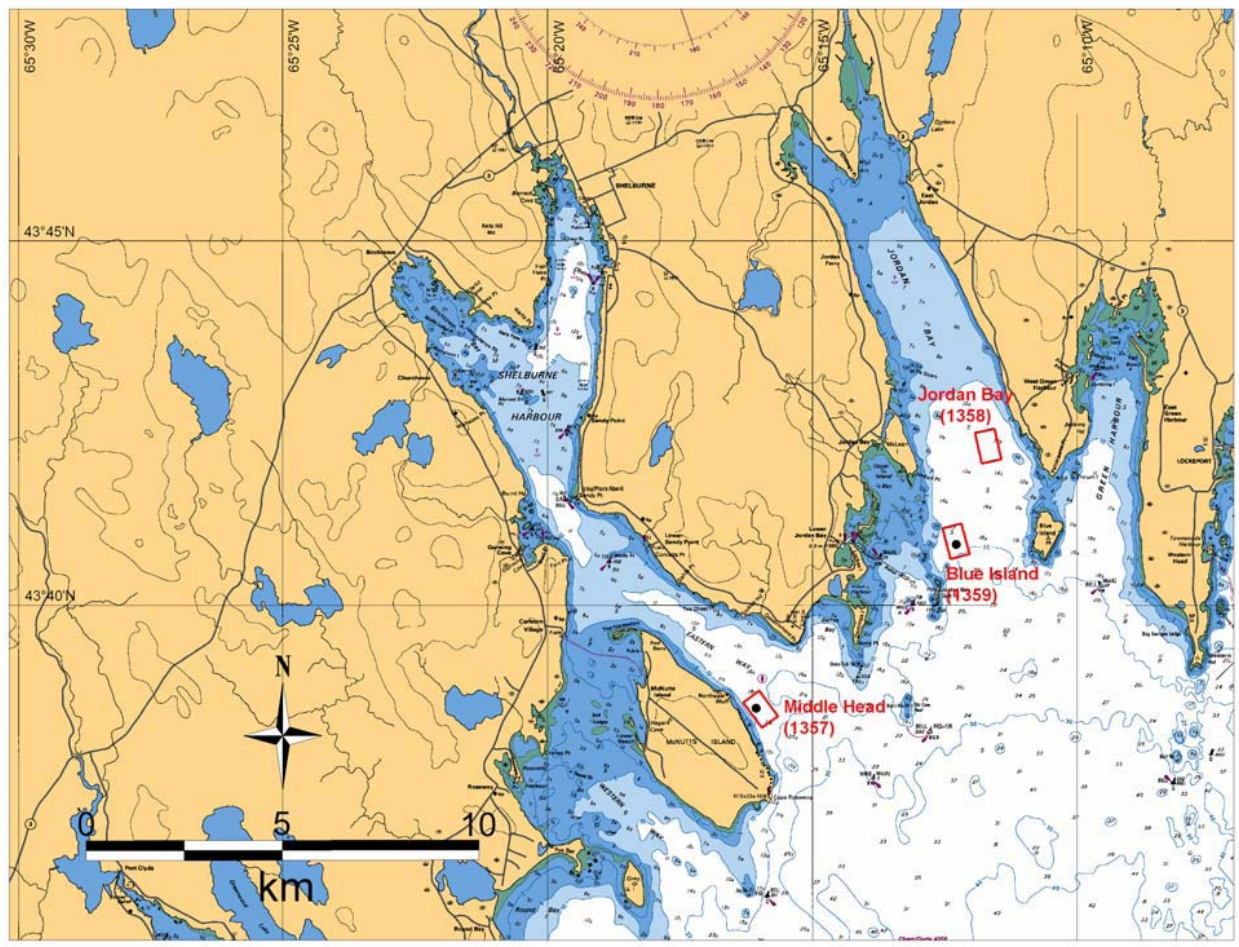

Figure 1. Map of the Shelburne area showing locations of three proposed salmon aquaculture sites. Black dots indicate current meter deployments; the Jordan Bay current meter deployment was within the proposed site boundaries, but the exact location was not available. The background map is Canadian Hydrographic Service chart 4241: Lockeport to Cape Sable (2002).

Analysis and Response

Lobster Landings

Landings from the lobster fishery in Lobster Fishing Area (LFA) 33 are derived from mandatory reporting logs completed by commercial fishermen. Fishermen report their daily catch in weight, their daily effort (number of traps hauled), and the location. The proposed aquaculture sites are located within Grids 304 and 305 (Figure 2).

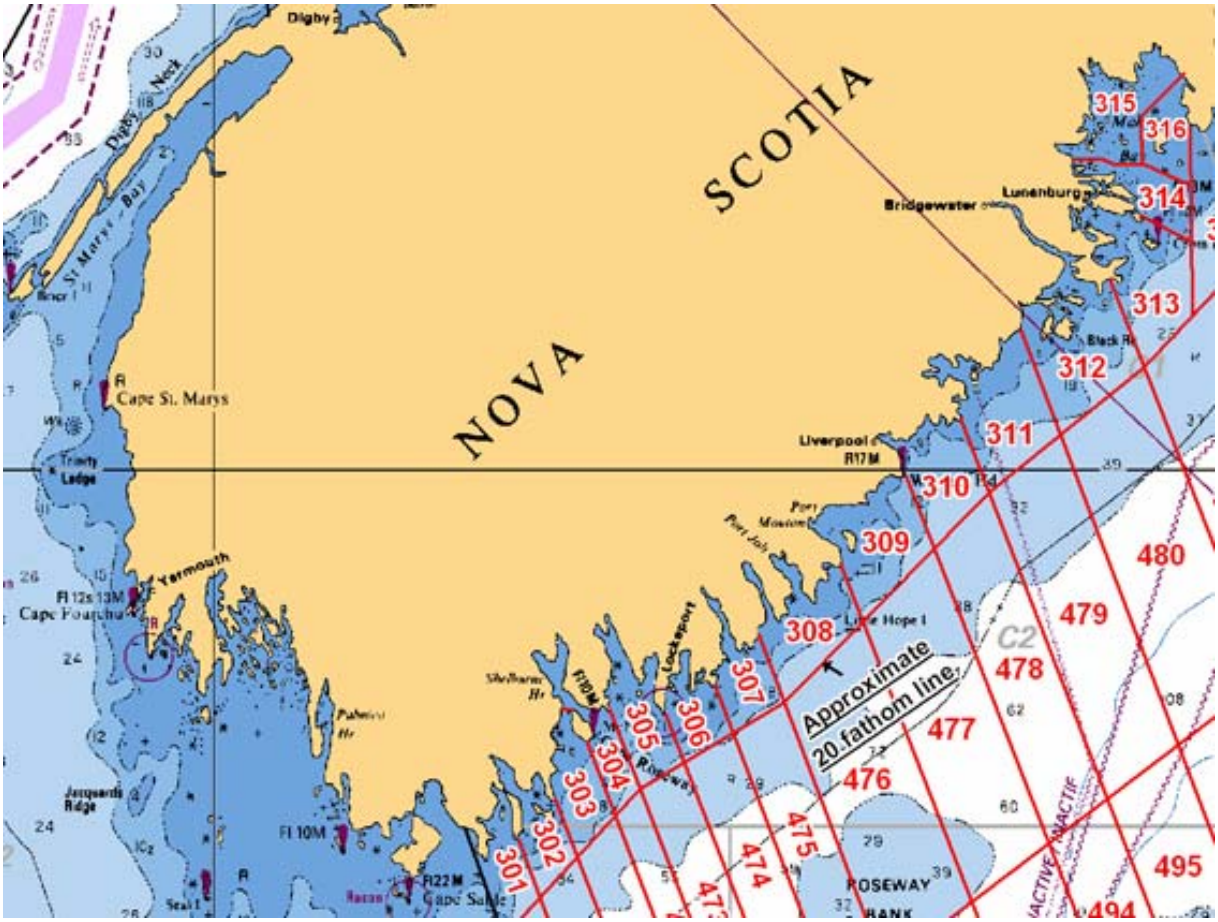

Figure 2. Grids of Lobster Fishing Area 33 used to track reported landings from mandatory logs of commercial lobster fishermen.

Landings are presumed to be reflective of abundance in heavily exploited lobster fisheries (Tremblay and Claytor 2009). In Shelburne Harbour and Jordan Bay, a relatively large portion of landings come from Grids 304 and 305 (Table 1). Between 2006 and 2011, landings within Grids 304 and 305 accounted for 2.4 to 7.2% of landings reported for LFA 33. While these landings appear low, they are comparable to landings within adjacent grids. Grids 303 and 306 located outside Shelburne Harbour and Jordan Bay adjacent to Grids 304 and 305 also have relatively high lobster landings. It is not possible to estimate the proportion of lobster landings of Grids 304 and 305 that may come from the areas surrounding the proposed aquaculture sites, since lobsters are not uniformly distributed throughout the grid.

Table 1. Estimated lobster landings in tonnes (t) from mandatory reporting logs. Landings are presented by year (for 2006-2011 calendar years) for Grids 303, 304, 305, and 306 located in LFA 33 (refer to Figure 2 for grid locations). The ranks from high (1) to low (50), and proportion of Grids 304 and 305 landings relative to LFA 33, are also presented by year.

Season	Landings (t) by Grid				Grid 304		Grid 305	
	303	304	305	306	rank by landings in LFA 33	proportion of LFA 33 landings (%)	rank by landings in LFA 33	proportion of LFA 33 landings (%)
2006-2007	118.9	131.5	183.1	168.4	9	5.2	2	7.2
2007-2008	98.1	123.5	152.1	133.7	8	4.9	3	6.0
2008-2009	129.8	196.3	149.3	184.7	3	5.9	9	4.5
2009-2010	104.5	133.2	146.6	173.4	10	4.0	8	4.4
2010-2011	104.5	149	86.8	172.9	7	4.1	19	2.4

Habitat Characteristics

The geology and geomorphology of the coastline largely determine lobster habitat characteristics along with the axis of orientation of the coastline (orientation to prevailing winds) and its degree of complexity (presence of islands, shallows and bays). Hudon (1994) suggested that lobster generally like more exposed areas with a rectilinear shoreline as opposed to complex embayments generally characterized by muddy bottoms. However, this general assertion does not mean that muddy bottoms are not important in certain areas, or for certain life history stages and events. Lobsters may excavate burrows in mud bottoms; mud bottoms may be used more extensively at certain times of the year, such as during spring and fall migrations. This may explain why the Shelburne area generally has higher landings than the other areas measured in LFA 33.

The geology of Shelburne Harbour is a mixture of muddy substrate in the inner harbour and bedrock and sand or sand/gravel in the outer harbour (King and Hynes 2003).The north side of McNutts Island is characterized as primarily muddy; however, there are data points that identify sand, rock and boulder substrates in equal frequency as the muddy substrate. King and Hynes (2003) indicate Outer Jordan Bay is comprised of sand, gravel, and till/bedrock. It is unclear how the substrate of Jordan Bay changes towards the inner harbour; however, it is presumed the substrate transitions to a finer substrate. A shoreline characterization from Laflamme et al. (2005) indicates that the inner shoreline is primarily gravel on the western shoreline and bedrock on the eastern shoreline.

Lobster Habitat Utilization (10-20 m water depth)

Lobster Larvae

Planktonic lobster larvae are likely in the water column from July through to late-September. In most years, the highest abundances would be expected from mid-July to mid-August (Tremblay and Sharp 1987; Miller 1997). Field studies in different areas indicate that the vertical distribution of lobster larvae varies with time of day and larvae stage.

Little is known about the larval dispersal or retention along the South shore of Nova Scotia as detailed circulation models are lacking. In this area, larval exchange may occur along the coast, but a portion of larvae are likely retained in the local areas.

Miller (1997) examined larval distribution along the south shore of Nova Scotia from Sambro to Jordan Bay. The highest abundance of stage IV larvae was found in the western portion of the study area with concentrations in the area from Jordan Bay to Port l'Herbert 2.5 to 10 times greater than areas to the east.

It is highly likely that lobster larvae are found from July to early September over a large part of Shelburne Harbour and Jordan Bay; however, it is not possible to determine the relative abundance of larvae within the areas of the proposed aquaculture sites. To determine this, a field study of the seasonal distribution of planktonic lobster larvae would be needed.

Newly Settled Lobsters

During the postlarval stage, lobsters leave the surface waters, and begin to settle preferentially on substrates that provide shelter, in particular hard bottom with cobbles. Newly settled lobsters are also common in habitats containing gravel bottoms or eel grass. Once post-larvae find suitable habitat, they tend to remain near the shelter to avoid predation. The bottom habitat at the proposed aquaculture sites appears to be of low quality for the settlement of lobsters with the exception of Middle Head. Bottom video (taken June 6, 2011) indicates that bottom habitat at Middle Head consists primarily of cobble and gravel, while the bottoms habitat at Jordan Bay and Blue Island consists primarily of sand ripple and sand ripple and gravel, respectively. Based on this video, the possibility that there are some patches of cobble that would provide shelter for settled lobster can not be eliminated. However, with the exception of the Middle Head site, the habitat appears to be of low quality with respect to initial settlement.

Adolescents and Adults

There are no published field studies on the small-scale distribution and abundance of adult lobster in Shelburne Harbour and Jordan Bay; however, Tremblay and Claytor (2009) reported that the western portion of the south shore (including Shelburne Harbour and Jordan Bay) along with Southwest Nova Scotia had the highest relative abundance of pre-recruits along the coast based on catch rates in Fisherman and Scientist Research Society (FSRS) traps. Estimates of eggs per trap haul showed hot spots in the east as well as the west.

The presence of lobster was also noted on in the bottom video (taken June 6, 2011). Roddick and Miller (1992) provide evidence of seasonally high abundance of lobsters in August and September in Port l'Hebert (east of proposed sites). As many studies have indicated that lobsters move to shallower, warmer waters in summer, it can be generalized that similar inshore bays in the western portion of the south shore also likely have elevated concentrations in summer. However, no specific density estimates of lobster within the proposed area exist.

Environmental Canada (Laflamme et al. 2005) indicates that the southern portion of McNutts Island and outer eastern shore of Shelburne Harbour are lobster fishing areas. Likewise, in Jordan Basin the data indicate that the shoreline around Blue Island is also associated with lobster fishing along with a large portion of the adjacent bay, Green Harbour. These data agree with the literature, suggesting the favourable habitat of cobble, boulder and rocky reef substrates as opposed to the sheltered muddy areas towards the inner portions of Shelburne Harbour.

In the early 1980s, DFO scientists (led by A. Campbell, then at the St. Andrews Biological Station) conducted a series of intensive diver- and trap-based studies on the use of shallow coastal habitats off McNutts Island to investigate the ecological interactions between juvenile lobsters, rock crabs, and Jonah crabs. These surveys included multiple samples each year, and

were conducted for several years. Unfortunately the principal multi-year population survey data has never been published. However, a departmental report based on an assessment of different approaches to census juvenile lobster population densities provides an example of the potential significance of subtidal habitats along this part of the Nova Scotia coast. Bernstein and Campbell (1983) characterized their study site along the western shore of McNutts Island as an area of consistently high juvenile lobster densities. Using mark-recapture data and direct sampling of underwater quadrats by divers, they were able to derive population size estimates for lobsters >20 mm carapace length. Both approaches yielded similar population density estimates, with a much lower standard error for the diving-based approach. For their 45,000 m^2 study area off the western shore of McNutts Island, they estimated a population size of 4,932 lobsters (standard error 257).

In order to determine the degree to which the proposed areas contain adolescent and adult lobsters, relative to surrounding areas, studies of abundance at different times of the year would be required. Understanding how lobsters utilize the habitat in the proposed areas would also require more directed field studies. Based on the prior studies by Campbell and other regional DFO scientific research on lobster habitat occupancy by defined life cycle stages, it is likely that the principal early juvenile habitats are restricted to shallow water (<25 m depth) habitats of cobble, boulder, and rocky reef, and that lobsters move to exploit a wider range of bottom habitats as they increase in body size. Within the regions of the three proposed sites, the bottom contours are relatively tightly spaced from the mid tide level to approximately 10 m water depth, then the slope becomes shallower across the 10 - 20 m depth range within the requested lease areas. This slope gradient appears to be quite common among the three lease areas, and in particular for the Middle Head site on the eastern side of McNutts Island, is in contrast to more extensive shallow subtidal areas to the west of McNutts Island. These steep initial gradients (0 – 10 m) likely contain settlement habitat, but as a consequence of the gradient, actually represent relatively restricted areal extents (i.e., in comparison to gentler gradients over the same depth range). In this context, in addition to the actual depth range within the proposed lease areas, the distance from the lease area to these fringing shallow water habitats (<10 m depth) may be significant in terms of determining the proximity of the proposed lease areas to primary settlement and early juvenile production areas within this coastal system. In the case of the Jordon Bay site, this habitat (adopting the 10 m contour for comparison) is between 300 – 500 m from the eastern site boundary; within 100 - 500 m of the western side of the Blue Island site; and 0 – 100 m from the western side of the Middle Head site. In addition to the existing baseline bottom samples taken within the three lease areas, survey information from these adjacent shallow water habitats should be acquired.

Additional Fishery Resources

Limited information is available concerning the distribution and abundance of scallops, groundfish, clams and quahogs in the Shelburne Harbour and Jordan Bay area.

Ocean Quahog prefer areas composed primarily of medium to fine grain sand (Cargnelli et al. 1999). Rowell and Chiasson (1983) noted the presence of Ocean Quahog during an inshore survey that included sites in Shelburne Harbour, Jordan Bay and Green Harbour (Figure 3).

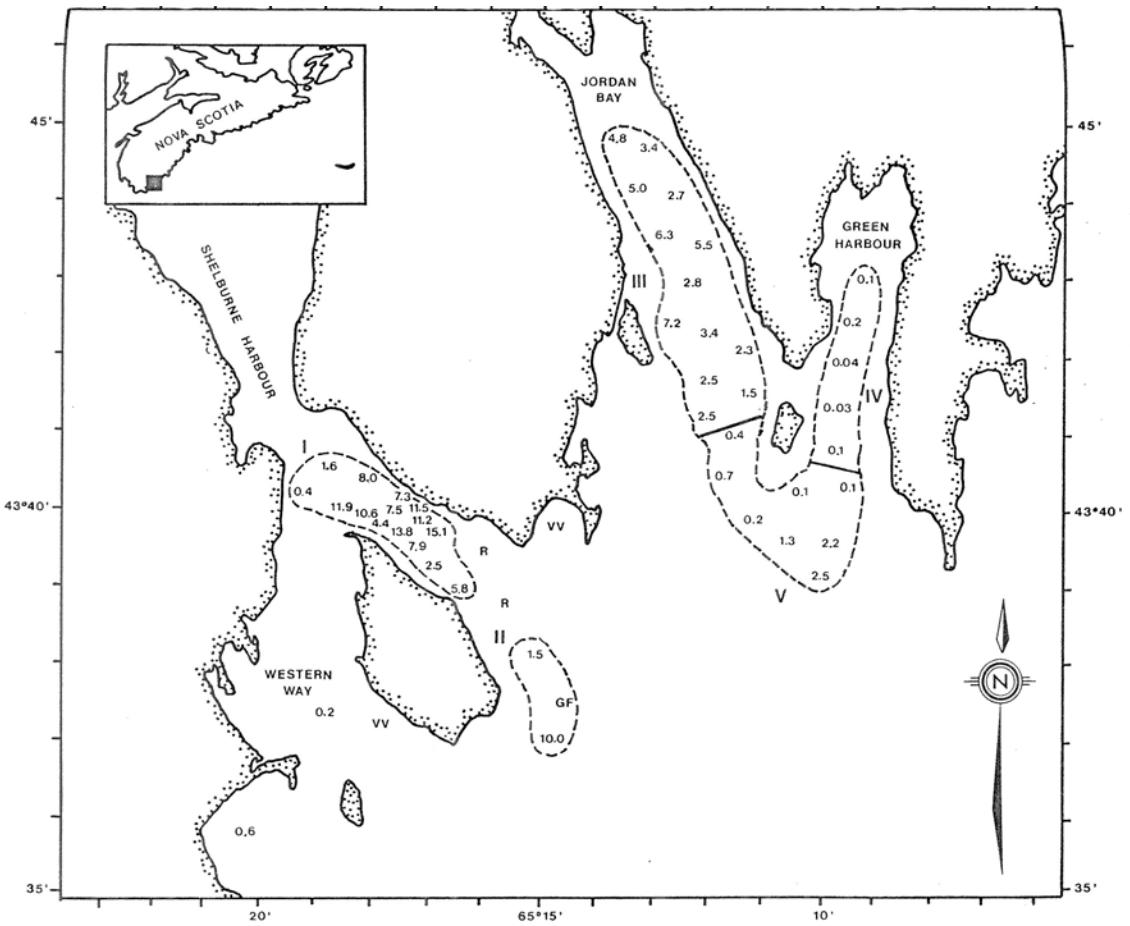

Figure 3. Areas surveyed and quahog densities from Rowell and Chaisson (1983).

Simon and Campana (1987) noted the occurrence of numerous groundfish species including Atlantic Cod, Haddock, Pollock, White Hake, herring, skate, and flounder during an exploratory bottom trawl survey on inshore waters of southern Nova Scotia, which included sites within Shelburne Harbour and Jordan Bay. However, there are no published studies in recent years that have examined the utilization of habitat by groundfish within this specific area.

An inshore survey of Nova Scotia that sampled areas near Shelburne Harbour and Jordan Bay was conducted in 2006 (DFO 2007). The two closest sampling sites were Port LaTour and Port Mouton. This survey used a range of gears, including beach seine, lobster trap, and gillnets, sampling in shallow waters to 20 m, and along a transect to 100 m depth. Catch data indicated the presence of a wide variety of fish and invertebrate species including ground fish, small pelagics, crabs, lobster, scallops, sea urchins, etc.

At-sea catch data from one long-ling and forty-one lobster fishing trips were analyzed as part of the DFO_FSRS Inshore Ecosystem Project (den Heyer et al. 2010). Bycatch data from lobster traps, aggregated by LFA 33, included finfish species such as Monkfish, Longhorn Sculpin. Shorthorn Sculpin, Atlantic Spiny Lumpsucker, and Sea Raven.

There is a small commercial scallop fishery in south western Nova Scotia. Logbook data for this fishery indicates fishing in the area occurs outside of the bays (Figure 4); however, the MARFIS database only contains logbook data from 2001 to the present. Roddick and Miller (1992) reported scallop fishing had occurred up in Port L'Hebert located east of the proposed sites

prior to 1987, but it did not examine Shelburne Harbour or Jordan Bay. Sea scallops are generally found in seabed areas with firm sand, gravel, shells and cobble substrate. While it is probable that scallops are present within the vicinity of the proposed aquaculture sites given the presence of the sand and gravel bottom, distribution data or density estimates do not currently exist.

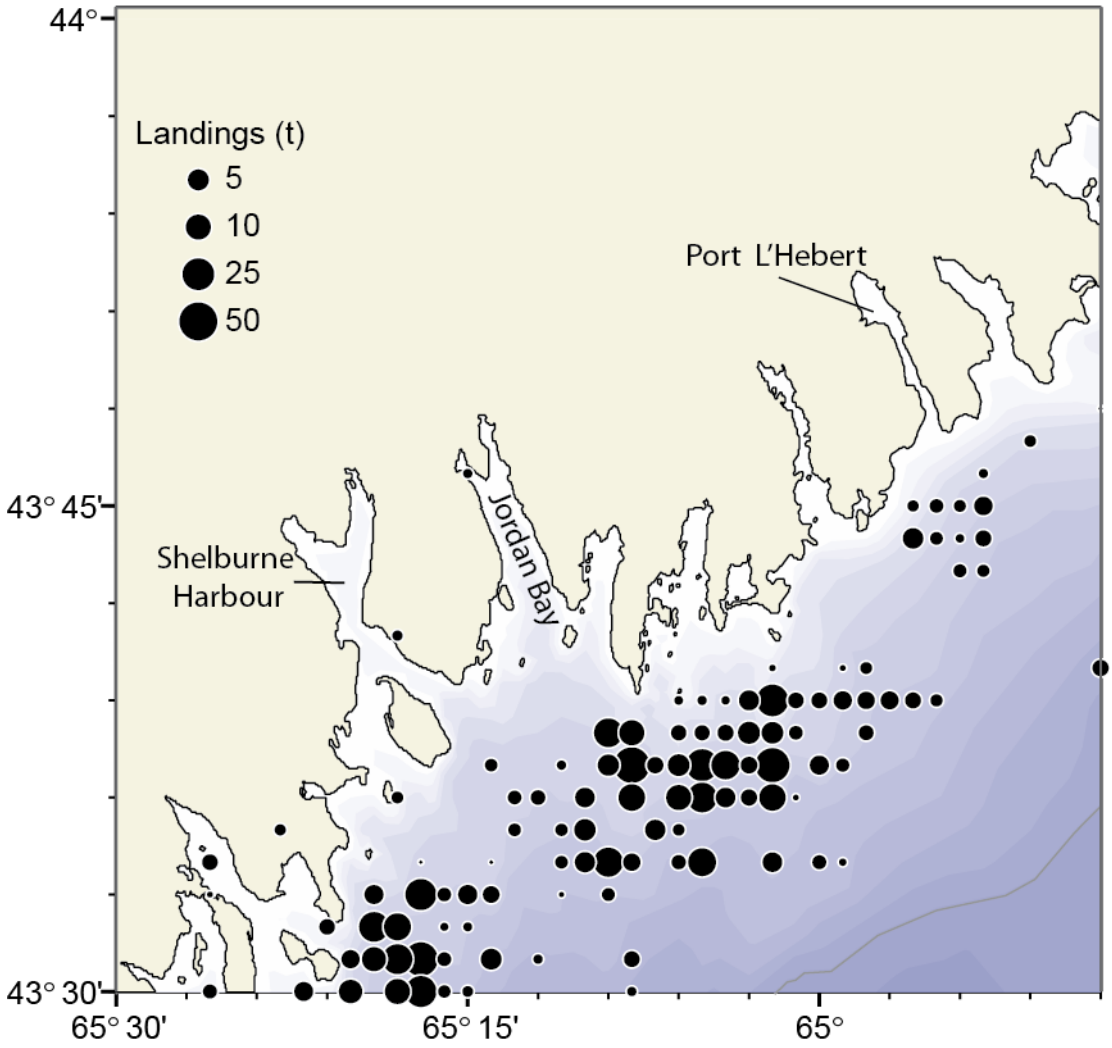

Figure 4. Reported scallop landings from logbook data from January 2001 to October 2011. Landings are aggregated by one minute square.

Conclusions

Lobster landings are relatively high in the reporting Grids 304 and 305 in Shelburne Harbour and Jordan Bay. With available data, it is not possible to estimate the proportion of landings that come from the proposed sites as lobsters are not uniformly distributed about the bottom.

Planktonic lobster larvae have not been studied in Shelburne Harbour, although they are likely found throughout much of the area. The importance of the area relative to lobster use of other areas remains unknown. To address this question, field studies of the distribution of planktonic larvae are required.

Settlement by young-of-year lobsters in the proposed aquaculture lease areas is most likely at Middle Head. Settlement is expected to be low at the Jordan Bay and Blue Island sites as bottom habitat is low quality habitat for settling lobsters. However, based on some historical surveys in the local area, and other regional lobster settlement studies, lobster settlement may be expected to occur primarily in shallow (< 25 m depth) and complex (mixtures of gravel, cobble, boulder, and reef) habitats fringing these bays and islands.

Adolescent and adult lobsters are likely within all three areas at various times of the year. Lobsters could use these areas for foraging or as a migration route. To determine the importance of the areas to adolescent and adult lobsters relative to surrounding areas, further field studies would be required.

The presence of Ocean Quahog and numerous groundfish species has been noted within the area of the proposed aquaculture sites.

Sea scallop are likely within the proposed area; however, distribution data or density estimates do not currently exist.

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