Friends of Port Mouton Bay,
Contribution #15
March 2008

THE PROPOSED PORT MOUTON ISLAND SITE - UNSUITABLE FOR AQUACULTURE

Executive Summary

Friends of Port Mouton Bay (FPMB) have been gathering and presenting relevant information on salmon aquaculture in Port Mouton Bay since 2006, and are now offering this overview and updated report as a synthesis of our findings to date. FPMB regard our fisher(men and women) members as experts in pattern recognition. We have heard their descriptions of the particular features of this bay based on experience over generations including the changes they see occurring, and tested these patterns with scientific experiments and information to determine the site-specific nature of Port Mouton Bay.

This report begins and ends with evidence of the historic access to and the economic dependence on the fisheries of Port Mouton Bay spanning centuries with emphasis on the areas associated with the proposed and existing salmon farms.

The bathymetry is described with emphasis on the fact that the seabed west of Port Mouton Island forms an enclosed basin, unlike the seabed northwest of Spectacle Island which although partially enclosed has a deep corridor to the waters of the outer coast. Both sites are in depositional areas. This is a thread which runs through the report because the basin configurations reduce the flushing rate yet a high flushing rate is required for open net caged salmon aquaculture.

Fishermen describe the basin at Port Mouton Island as a place of collection or deposition, implying a low flushing rate except during major storms, especially with northeast winds. The flushing rate can be assessed from available data on currents, which cover many days in succession, and drogues, which drift with the currents and trace out the pathways of water exchange. The available current meter data, even though limited to the windy months of December, January and February, and the drogue data, limited to one calm day in March, indicate the flushing rate to be low in days of light winds. Summer data are required to assess prolonged low flushing rates, during which waters loaded with fish farm wastes re-circulate in contrast to the preferred situation where waste-laden waters move out of the bay, not to return. During strong wind episodes, fishermen predicted and our seabed drifters confirmed that materials collected in the Port Mouton Island basin would be swept out – onto sensitive shores.

This low flushing rate is evidently supportive of the natural marine ecosystem. Traditional ecological knowledge from local fishermen identifies the basin and waters on the sheltered west side of Port Mouton Island as a lobster nursery, moulting and migratory area, a critical habitat.

The flushing rate is not adequate for the purposes of the proposed open net cage salmon aquaculture site; too often wastes would not be flushed away. And wastes

would be discharged in large quantities equivalent to discharges from thousands of humans. These wastes include fecal particles and dissolved nutrients. The fecal particles accumulate on and cover the seabed and, in the extreme, form hydrogen sulphide gas. The dissolved nutrients support nuisance algae and deplete oxygen. These wastes lead to eutrophication, degraded habitat and loss of normal biodiversity.

Benthic habitat has progressively degraded during the existence of waste discharges at the Spectacle Island salmon aquaculture site. The presence of considerable algae in Port Mouton Bay within range of Spectacle Island reflects the nutrient enrichment from the existing site. Existing regulatory mechanisms and mitigative measures designed to keep sulphide levels within acceptable limits have not been successful in protecting benthic habitat in the Inner Harbour of Port Mouton Bay. The degraded area would be expected to expand with the addition of a second site

The FPMB trap-yield survey and lobster landings analyses reflect fishermen's experience that lobster habitat near the existing salmon farm has been degraded over a substantial area in recent years.

The low flushing rate arising from the basin configuration and relatively small tidal range cannot be altered. The high priority wild fishery and moss harvest and the critical habitat at the proposed site cannot be protected by mitigation.

Fishermen have been forced to abandon traditional inshore territories with resulting economic losses and increased safety risks. They are adamant that they cannot withstand the loss of the lobster and moss harvesting area off Port Mouton Island which they also use as a safe haven fishing area when storms are forecast. Their forefathers have been accessing the waters of Port Mouton Bay for generations.

Cumulative effects are significant between the existing site at Spectacle Island and the proposed site at Port Mouton Island with respect to such Valued Ecosystem Components as Marine Habitat, Critical Habitat and Fisheries Resources, and the Valued Socio-Economic Components of the Local Economy.

The case for protecting the habitat around Port Mouton Island is strong: The area has site-specific factors well-suited to the traditional fisheries and ill-suited for raising open-net caged salmon.

Further steps requiring discussion with DFO include:

FPMB request that DFO consider deploying an ADCP current meter at the proposed site for at least 29 days during the period July1 to August 15, 2008, for the purpose of confirming the occurrence in summer of prolonged periods with low flushing rate.

FPMB's survey of berried female lobsters in May, 2007, supported the observation that Port Mouton Island basin is a nursery area. This understanding could be improved with trap surveys for berried females in August when more females are likely to be present. FPMB request that such surveys be carried out cooperatively between FPMB fisherman and DFO.

Since Spectacle Harbour has traditionally been a commercial clam digging area, and since humans would not wish to eat diseased clams as were found here during the investigations of summer, 2007, has DFO considered a Temporary Shellfish Closure at Spectacle Harbour?

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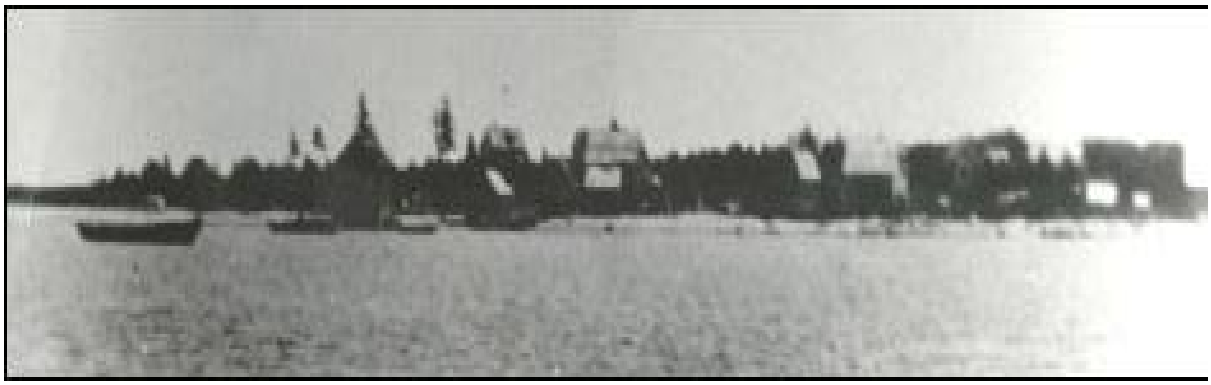
1 Fishing for over 200 years

Three local fishing fleets – Port Mouton, Central Port Mouton and Southwest Port Mouton – have taken shelter and harvests from the waters off Port Mouton Island for generations and have given protection to the nursery area they recognize it to be.

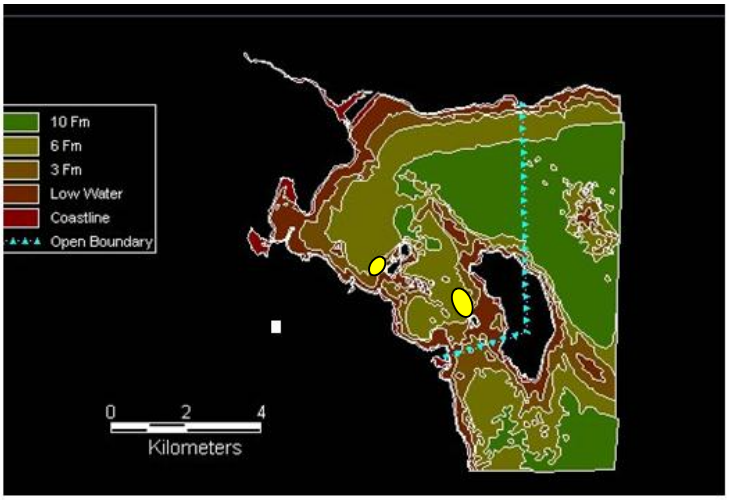
Some of today's fishermen are direct descendents from the settlers of 1783. And most come from several generations of fishermen who have spent all their lives around Port Mouton Bay.



Port Mouton Island – circa 1920, Queens County Times

2 Bathymetry

● Detailed bathymetry demonstrates that the location of the proposed site (0 on right) is in an enclosed basin, unlike site #835 (0 on left) which is only partially enclosed. Both sites are in depositional areas.



● The colored bathymetric chart (mar.dfo-mpo.gc.ca/science/ocean/ceice/ceice.html) of the area around Port Mouton Island confirms the that there is a basin between Port Mouton Island and Spectacle Island, that it is largely surrounded by islands and sills which restrict exchange of waters below 3 fathoms to one narrow channel, and that it is more of a closed basin than is the area west of Spectacle Island which is in unrestricted communication with the open coastal waters to the north and northeast down to at least 6 fathoms. This Port Mouton Island basin, with waters as deep as 8 fathoms at lowest normal tide, is an area relatively sheltered from storm currents and an area of deposition of sediments.

> ● (A) basin inside a sill at Port Mouton Harbour will naturally accumulate fine grained sediments where resuspension and bedload transport occur less frequently than at shallower depths. Fine sediments will also be more abundant in the lee of islands due to protection from wave impacts on (the) bottom (B.Hargrave, pers.comm.)

● Wastes from the proposed site would accumulate beneath the cage site, be displaced to the depositional area to the west of the cage site or be dispersed into a region of higher energy identified as gravel bottom on Hydrographic Chart #4240 (DFO Science Response Report 2007/009). Fishermen report that the area identified as gravel is actually patchy in gravel and patchy in mud – features which can be read from echo-sounders. Diver surveys for Aqua Fish Farms in March 2007 report 70% silt/30% sand at all stations comprising the boundaries of the proposed Port Mouton Island site.

3 Flushing Rate

● The proposed Port Mouton Island site is in a basin and is particularly slow to flush. Hydrodynamic conditions here provide conditions for deposition and accumulation of wastes during prolonged calm periods, and flushing toward sensitive shores in episodic wind events.

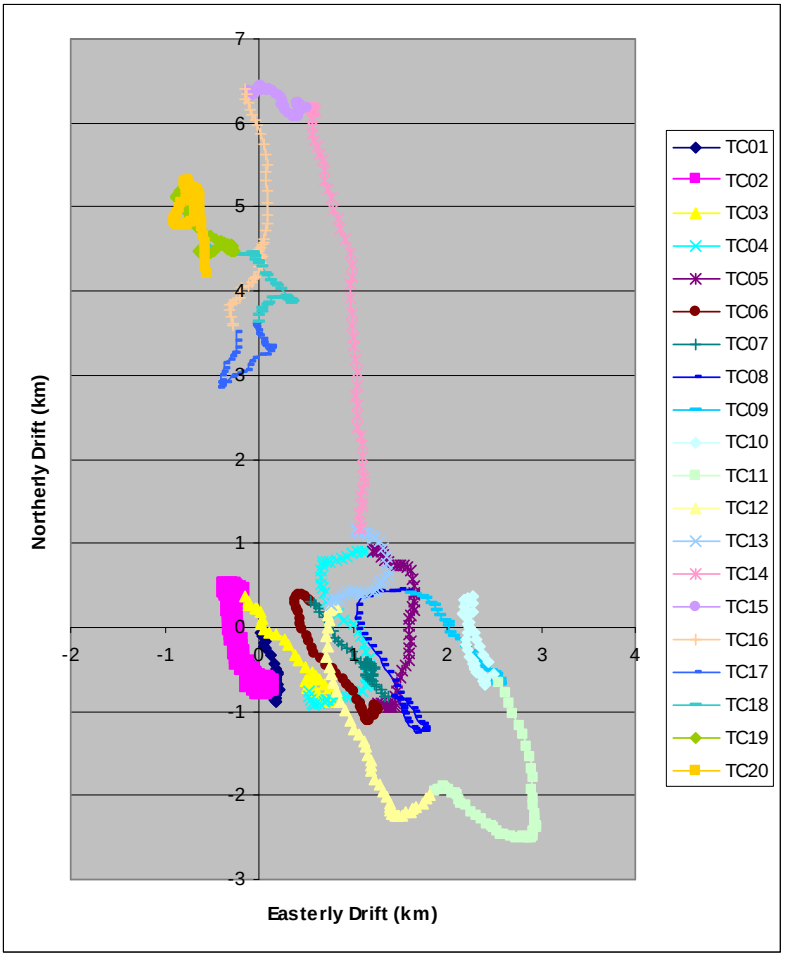


Figure 3.1 Progressive vector diagram for near bottom currents at the proposed site, showing 20 tidal cycles in December, 2006, and tendency to recirculate when winds are light.

● Fishermen described the area of the proposed site as a collection and depositional area, except during strong storms. During these storm episodes, debris or detritus in the area is swept out. This corresponds to observations of Friends of Port Mouton Bay (FPMB) from drifting drogues and seabed drifters and analysis of current meter data (FPMB Contribution #4)

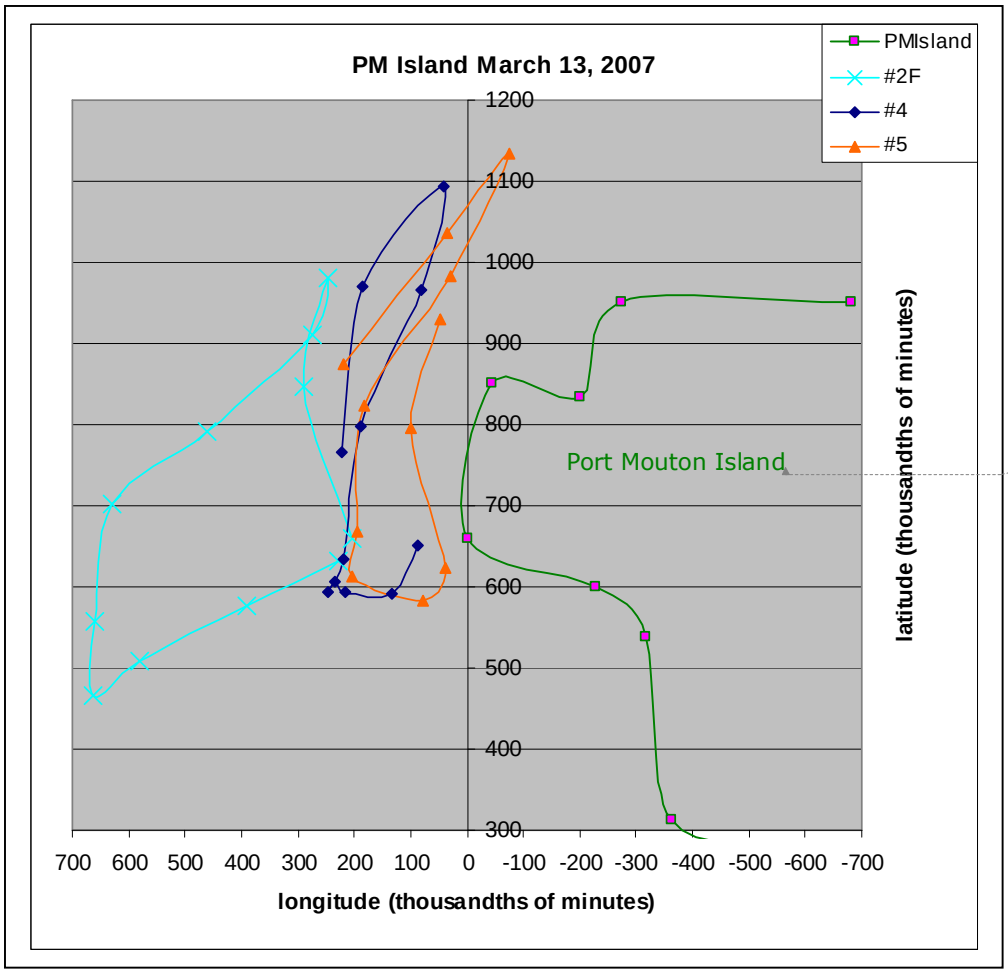


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Figure 3.2 Drift trajectories over a 12 hour tidal cycle for three near-surface drogues off Port Mouton Island, March 13, 2007, again showing tendency to recirculate rather than drift away.

• In the Port Mouton Island basin, on a March day with light winds, over a 12-hour tide cycle, near-surface drogues traced out tracks that practically returned to their starting points, indicating very little 'new' water being available to flush wastes away – a very low flushing rate. The basin-shaped bathymetry (topography) at Port Mouton Island is conducive to these approximately circular paths (tidal eddies), especially in the deeper portion of the basin where relatively dense water would likely accumulate.

• The drogue and the current meter data together provide a realistic picture of flushing rate on the site under light winds, a rate lower than a theoretical (tidal prism) flushing rate (Gregory *et al*. 1993). Although drogue drift speeds were higher at the proposed site than at existing site #835, the paths of the currents in both

cases traced out almost-closed tidal eddies resulting in very low flushing rates. In both cases, the flushing rate would be much lower than the theoretical flushing rate for the entire Port Mouton Bay (*ibid*). This is to be expected because the theoretical flushing calculation assumes that pristine water enters on the flood tide, that complete mixing occurs, and that ebb tide waters leave the bay permanently, carrying wastes, in this case, with them. These conditions are not experienced at Port Mouton Bay during light winds.

● There are strong flushing events during episodes of strong winds. We have described seabed drifters which were released in the basin in January and February, 2007, then were recovered on the shores of the Kejimkujik National Park, a few kilometres to the south, just after a northeasterly storm in mid-April (FPMB Contribution #4). Drifters were also recovered on Summerville Beach (after periods of strong south-east winds), and on Wobamkek Beach and South West Port Mouton Beach. Spectacle Ledge, in the path of the transport direction from southeast winds indicated by the winter 2007 current meter record, is also a prime lobster fishing ground.

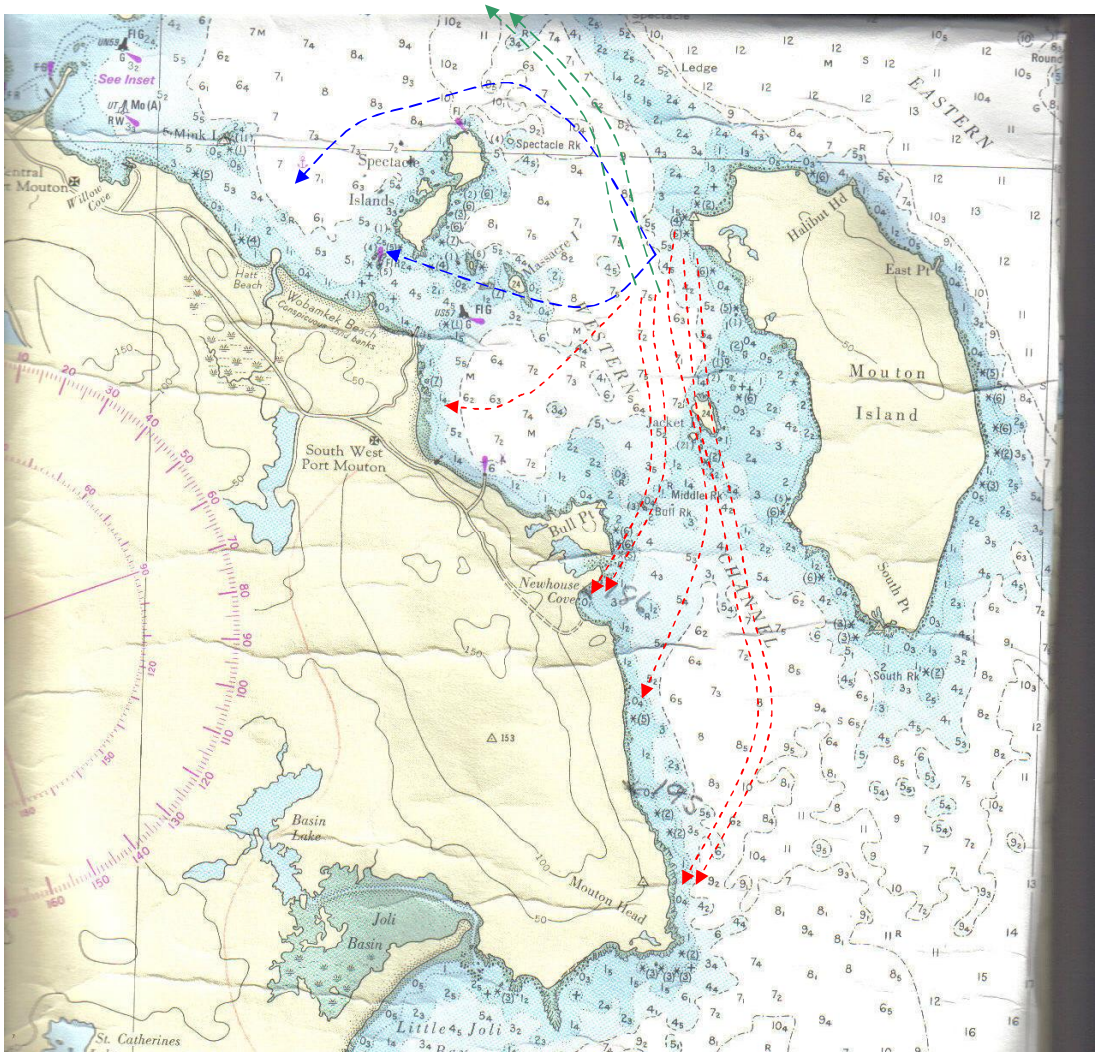

Figure 3.3 Seabed drifter release points near Port Mouton Island in January/February 2007, and recovery points in April and later.

• The overall pattern, especially in summer (where data on currents are lacking but data for winds are available) is periods of light winds lasting for as long as ten days, interspersed with wind episodes. The light wind periods are expected to be periods of low flushing rate in the basin with currents driven by the tidal eddies alone. However, data for summer conditions are sparse. Current meter data was recorded for short time periods in two locations at Spectacle Island and at Port Mouton Island in August 2001. The data are consistent with our previous analyses of drogues and current meter records, and exhibit periods of recirculation. The data are the subject of discussion with DFO. (For detecting recirculation, drogues and current meters provide complementary information.) .

We anticipate, based on wind records which show long periods of light winds for summer compared to only short periods in winter (Table 3.1), that the flushing rate will be low over a longer period in summer than in March, 2007.

Table 3.1 Comparison of January and July Wind Statistics – DFO Atlas, Nova Scotia Shore

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Month	**Speed Range** (knots)	**Direction**	**Frequency – winds over 20 knots** (%)	**Total frequency – winds over 20 knots** (%)
JAN	20 - **45+**	N	7	
		E	5	
		S	3	
		SW	5	
		W	15	
		NW	13	48
JULY	20 – **30**	S	3	
		SW	8	
		W	2	13

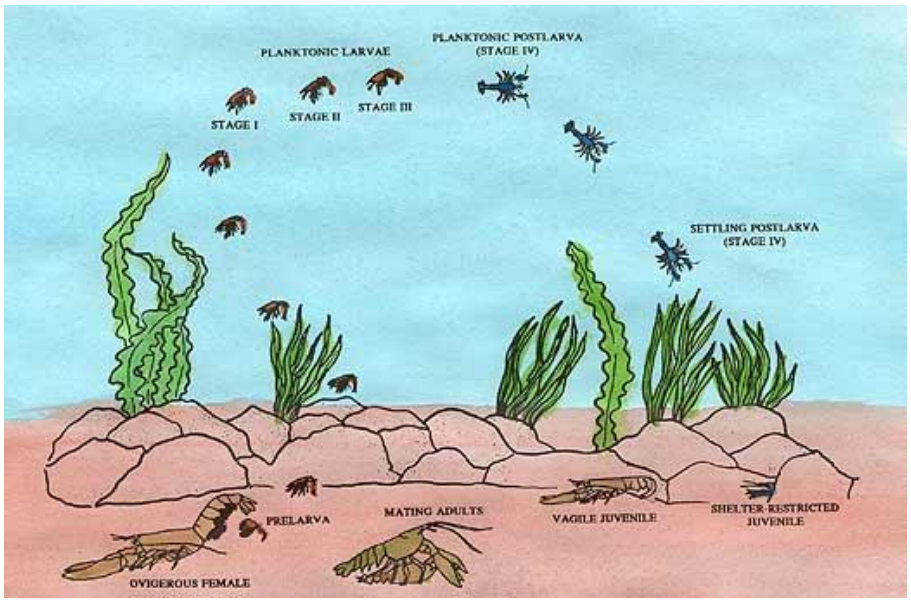
January presents winds greater than 20 knots much more frequently and reaching higher extreme speeds than July.

<u>FPMB request that DFO consider deploying an ADCP current meter at the proposed site for at least 29 days during the period July1 to August 15, 2008, for the purpose of confirming the occurrence in summer of prolonged periods with low flushing rate.</u>

● DFO's Traffic Light Decision-Support System (DSS) for ranking potential salmon farm sites lists tidal exchange volumes (as indicated by drogue and current meter studies) first in the section on near-field criteria, but a score is not assigned. Yet a high flushing rate is a requirement of fundamental importance to avoid waste accumulation, nuisance algae, oxygen depletion and loss of habitat - a requirement not met in Port Mouton Bay.

4 Critical Habitat

• Traditional ecological knowledge from local fishermen views the basin and waters on the sheltered west side of Port Mouton Island as a lobster nursery, moulting and migratory area (FPMB Contribution #2). This is also the place for the proposed salmon aquaculture site.



Life stages of lobster
The Lobster Conservancy www.lobsters.org/research/research/html

• Evidence for this nursery area is based on observations (circa 1970) of significant numbers of large berried female lobsters unintentionally caught in gill nets placed in the safe haven area near Port Mouton Island. Fishermen responded to this problem by *ceasing* to use this safe haven for protecting nets. It was further observed that berried lobsters were not caught in nets which were actively fishing outside the harbour.

> "Some organisms require a specific habitat at a critical phase in their life. Such habitats are generally called "essential". The linkage between a species and a specific habitat may functionally control the carrying capacity of the environment for that species. For lobsters, there is considerable research suggesting habitats supporting broodstock lobsters and those that serve as nursery grounds are most essential"…… Newly settled lobsters remain near

their settlement site for the first several years, rarely venturing out of the nursery habitat (Steneck et al. 1998).

● The lobster trap survey conducted by FPMB in May 2007 (FPMB Contribution #10) found three to four times as many berried lobsters/trap-haul in the area west of Port Mouton Island as in other parts of Port Mouton Bay (Figure 6.2). This is evidence that berried lobsters are more frequently found here in spring.

FPMB's survey of berried female lobsters in May, 2007, supported the observation that Port Mouton Island basin is a nursery area. This understanding could be improved with trap surveys for berried females in August when more females are likely to be present. FPMB request that such surveys be carried out cooperatively between FPMB fisherman and DFO.

● This nursery area is next to Port Mouton Island facing south-west breezes of summer and in a basin surrounded and protected by other islands, ledges and a submerged sand bar - all providing a mechanism for retaining lobster eggs and larvae. Local fishermen report that settled juvenile lobsters – about 10 cm in size - are found in this basin in lobster traps and when rocks and kelp are disturbed at low tide by Irish Moss and rockweed harvesting. Locations of observations of juvenile lobsters around the margins of the basin at Port Mouton Island include the eastern shore of Spectacle Island, the western shore of Port Mouton Island and Jackies Island (Donaldson Fisher, Todd Leslie, Richard Lawson, Richard Broughm, Brian Fisher, Clyde Fisher, pers.comm.) Juvenile lobsters of this size are 3-4 years of age. (R. Miller, pers.comm.) This basin area west of Port Mouton Island has also been identified as a depositional area to which wastes from the proposed site would be displaced (DFO Science Response Document 2007/009)

● An area where berried female lobsters congregate and where settled juvenile lobsters are present is essential habitat and worthy of protection. The proposed use as a site for salmon cages is incompatible with a lobster nursery.

● Our perspective is that the low flushing rates could be instrumental for critical habitat here – providing an additional factor for retention of larvae within the basin - but a low flushing rate is a fundamental disadvantage for an open cage fish farm.

5 Discharge of Wastes

● The rate of discharge of wastes at the proposed Port Mouton Island site would be substantial.

● While neither antibiotics, pesticides, nor antifouling chemicals are addressed here, the Appendix presents modeling for discharges of fish feces, nutrients and dissolved oxygen. The source strengths of these waste discharges in the peak month, assuming 300,000 mature fish in the cages, are: ~200 kg Organic Carbon /day, ~100 kg Nitrogen /day, ~15 kg Phosphorus / day, and 1200 kg Dissolved Oxygen /day. For comparison, the human equivalent discharges are ~12000 humans (Organic carbon) and 10,000 humans (nitrogen) http://www.che.iitb.ac.in/faculty/gks/studproj/cfa_2002/anand_gautam.PDF.

● This ecosystem at Port Mouton Island must be considered in the light of the negative experience of the existing aquaculture site at Spectacle Island. The proposed site would contain more fish and be in a more enclosed area.

• Source strengths (discharges), flushing and dilution are addressed in the Appendix.

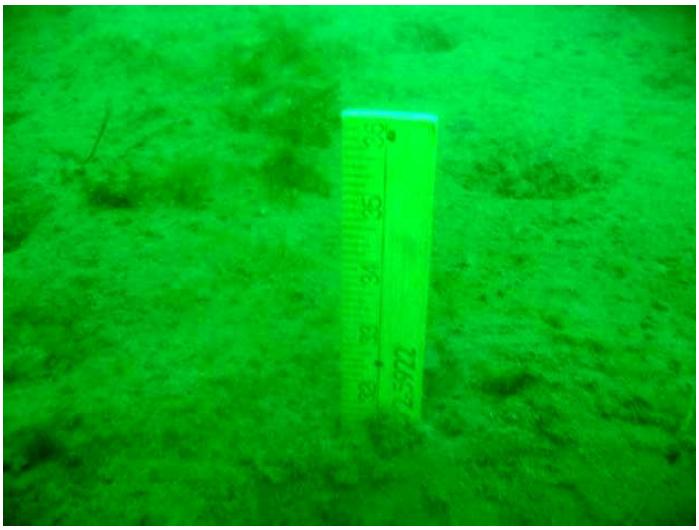
6 Effect on Habitat

Habitat has progressively degraded since the existence of waste discharges at the Spectacle Island salmon aquaculture site. The degraded area would be expected to expand with the addition of a second site (FPMB Contribution #1). The impacts described below on the environment, commercial fisheries and the communities around Port Mouton Bay are unacceptable.

6.1 Environmental Monitoring Program

● Existing regulatory mechanisms and mitigative measures designed to keep sulphide levels within acceptable limits have not protected benthic habitat in the Inner Harbour of Port Mouton Bay. The proposed fallowing intervals do not guarantee recovery of the site and the ability of the surrounding area to support benthic animals.

● Although sulphide levels have continuously indicated anoxic levels at existing site #835, none of the reference stations beyond the site boundaries have registered high sulphides. Nevertheless habitat has been lost, particularly for lobster, crab, scallops and Irish moss. As a result, FPMB are not confident that these regulatory mechanisms can protect the benthic habitat near the proposed Port Mouton Island site, a site which is three times larger and in more restricted, basin bathymetry.



Diver's photo of waste on ocean bottom near Spectacle Island ~ 400 m from site #835 at Spectacle Island

● A diving survey conducted by FPMB (FPMB Contribution #13), using local knowledge to target and explore the boundaries of depositional areas, found

waste distributed over an area estimated at 10 times the size of Spectacle Island site #835. Limits of time and resources prevented a complete survey. FPMB are not confident in the use of acceptable limits of sulphide levels as a measure of normal benthic fish habitat when FPMB divers have found 30-90 cm of waste adjacent to the reference stations. Because the unconsolidated nature of this waste in the far-field would likely provide aerobic conditions in the top 2 cm sampled, it would not yield high sulphides or low oxygen values. Parameters being used by the Environmental Monitoring Program depend on anoxic conditions and the presence of white sulphur bacterial *Beggiatoa* mats - late-stage measures of the degree of environmental damage. Our perspective is that the sulphide analyses provide a one-sided test: high sulphides indicate anoxic conditions and waste accumulation but low sulphides do not guarantee the absence of wastes and their effects.

● Since there is a significant lag time between improvement in sediment chemistry and recolonization of the impacted area by benthic animals, establishing fallowing periods simply on the basis of chemical improvements probably prevents recovery of the site's ability to support benthic fauna. (J. Harvey and I. Milewski, 2008). As a result, FPMB are not confident that the proposed fallowing procedures will protect benthic habitat at the Port Mouton Island site.

● Traditional biological community taxonomic analysis is the most sensitive approach to detect changes in benthic habitat conditions. FPMB have taken a step in this direction with the Lobster Trap Spatial Survey (§6.1).

● FPMB are committed to monitoring the recovery of the Inner Harbour benthic ecosystem.

6.2 Algae

● The presence of considerable algae in Port Mouton Bay within a radius of Spectacle Island reflects the nutrient enrichment from the existing site # 835. Algae not previously experienced in earlier years in lobster traps, on shorelines and in tidal pools and which were observed throughout the spring, summer and fall season of 2007 indicate a link to a continuous source of nitrogen..A Bay of Fundy study suggests that dissolved wastes such as nutrients released from point sources of enrichment, such as salmon farms have the potential to reach the intertidal zone and affect the rate of algal mat production (Robinson et al. 2005).

Algae on rocks at Carter's Beach, a Protected Beach, September 2007

Algae in the tidal pool at Carter's Beach, a Protected Beach, June 2007

• In the summer of 2007, large amounts of algae at the Clam Pond near Bull Point appear to have caused discoloration of clam tissue which precipitated a Precautionary Shellfish Closure in Port Mouton Bay. This algae had not occurred here during the previous 20 years (J. Maxwell, summer resident, pers.comm.) The feasibility of the drift path from the Spectacle Island site to the shore near Bull Point was demonstrated in August 2007 using a surface drifter when winds were favorable for transport in that direction. That dissolved aquaculture wastes disperse widely establishes the possibility

of cumulative interaction between site #835 and the proposed site because Bull Point is much closer to Port Mouton Island than to Spectacle Island.

• The presence of the invasive species *Codium fragile* in Port Mouton Bay will be exacerbated by higher nutrient levels.

• During the Precautionary Shellfish Closure, laboratory analyses of clams from several locations in Port Mouton Bay found no evidence of algae toxic to humans. Clams in Spectacle Harbour only were diagnosed with *Gonadal neoplasia.* a disease of cell abnormalities. This disease is associated with environmental conditions such as heavy metals, high sulphides and anoxic events (Smolarz et al. 2005) which are present at the nearby Spectacle Island site #835. A local clam digger, Eric Roy reported abnormalities in clams from Spectacle Harbour in 2006.

• Since Spectacle Harbour has traditionally been a commercial clam digging area, and since humans would not wish to eat diseased clams as were found here during the investigations of summer, 2007, has DFO considered a Temporary Shellfish Closure at Spectacle Harbour?

6.3 ***Lobster Trap Survey***

• Fishermen of Port Mouton Bay have abandoned historical lobster fishing 'territories' because of low catches. This is credible evidence (Maurstad *et al*, 2007) that lobster catches are reduced in the Inner Harbour in the vicinity of the salmon aquaculture site near Spectacle Island.

• Further evidence is provided by the lobster survey conducted in late May, 2007, which produced yields for five contiguous areas in Port Mouton Bay. The catches (pounds of lobster) and catch-per-unit -effort (pounds of lobster per trap-haul) were significantly lower for Region 2 than for any of the other areas. Region 2, in the Inner Bay, includes the existing salmon aquaculture farm west of Spectacle Island and as recently as 5 years ago was a prime lobster fishing region supporting as many as 1200 to 1500 traps (Bob Swim, pers. comm.) (Figure 6.1). The results of this survey strengthen the likelihood that the salmon aquaculture wastes are adversely affecting the habitat in Region 2. (FPMB Contribution #10, June, 2007[1])

In §6.4, Fig. 6.3, data show the Port Mouton fleet catches per boat in May to be only half as large as those of the Hunts Point fleet. This suggests that even Regions 4 and 5 with the largest catches per trap haul (Table 6.1) are producing lower catches than Hunts Point and that adverse effects are likely more widespread than Region 2.

[1] We have followed a reviewer's recommendation that we present lobster catches per trap-haul instead of catches per trap-fishing-day.

Table 6.1 Results of Lobster Trap Survey, May 2007, including areas largely abandoned for fishing since ~2002

Region #	Number of trap-hauls	Total Catch (lbs)	Catch per unit effort (lbs/trap-haul)
1	1880	978	0.5
2	490	157	0.3
3	1389	806	0.6
4	789	636	0.8
5	1465	1228	0.8

- Fishermen report that a known lobster migration route toward the Inner Harbour of Port Mouton Bay appears to have changed with lobsters preferring to move east towards Hunts Point when previously they moved inshore over Spectacle Ledge. Lobsters will avoid a 'nephaloid layer' of suspended particles on the seabed which irritates their gills (Barry Hargrave, pers.comm.) Other factors influencing avoidance could be the lobsters' acute sense of smell (odors from the fish farm) or absence of prey (e.g. crab).

- In December 2007, 14 lobster boats were identified using the safe haven area in Region 3 (Fig. 6.3.1) for shelter and lobster and crab fishing. Fishermen reported very good lobster catches in the safe haven area ranging from an average of 3 lbs/trap haul to a high of 8 lbs/trap haul (Brian Fisher, Michael Swim, pers.comm.) In contrast, catches in Region 2 were reported as negligible (Richard Broughm, pers.comm.). Regions 2 and 3 were both considered prime lobster fishing grounds before the salmon farm at Spectacle Island.

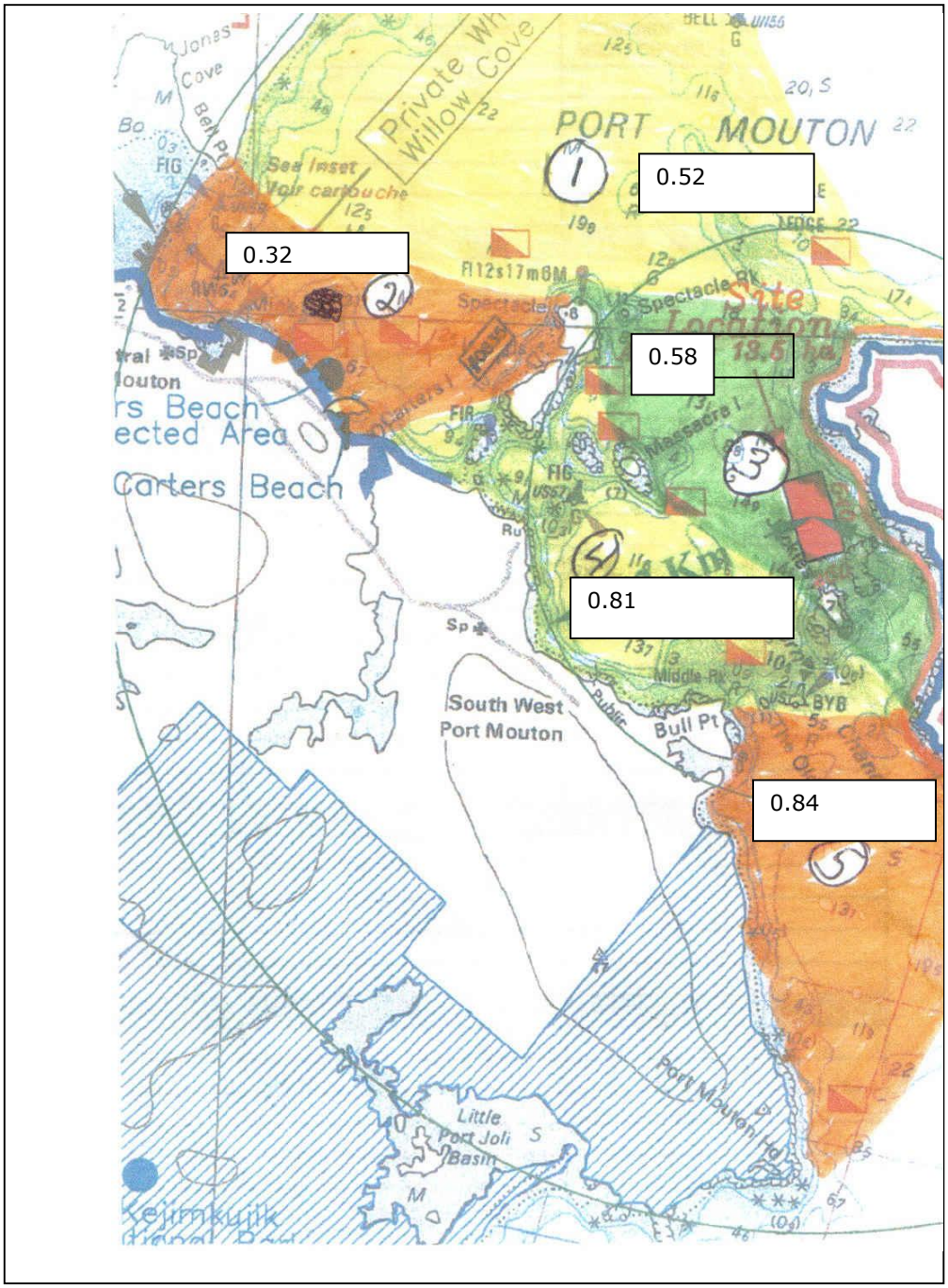


Figure 6.3.1. Average yield in pounds of lobster caught per trap-haul in Port Mouton Bay, May 15-31, 2007 (Re-calculated from pounds of lobster caught per fishing day FPMB Contribution # 10).

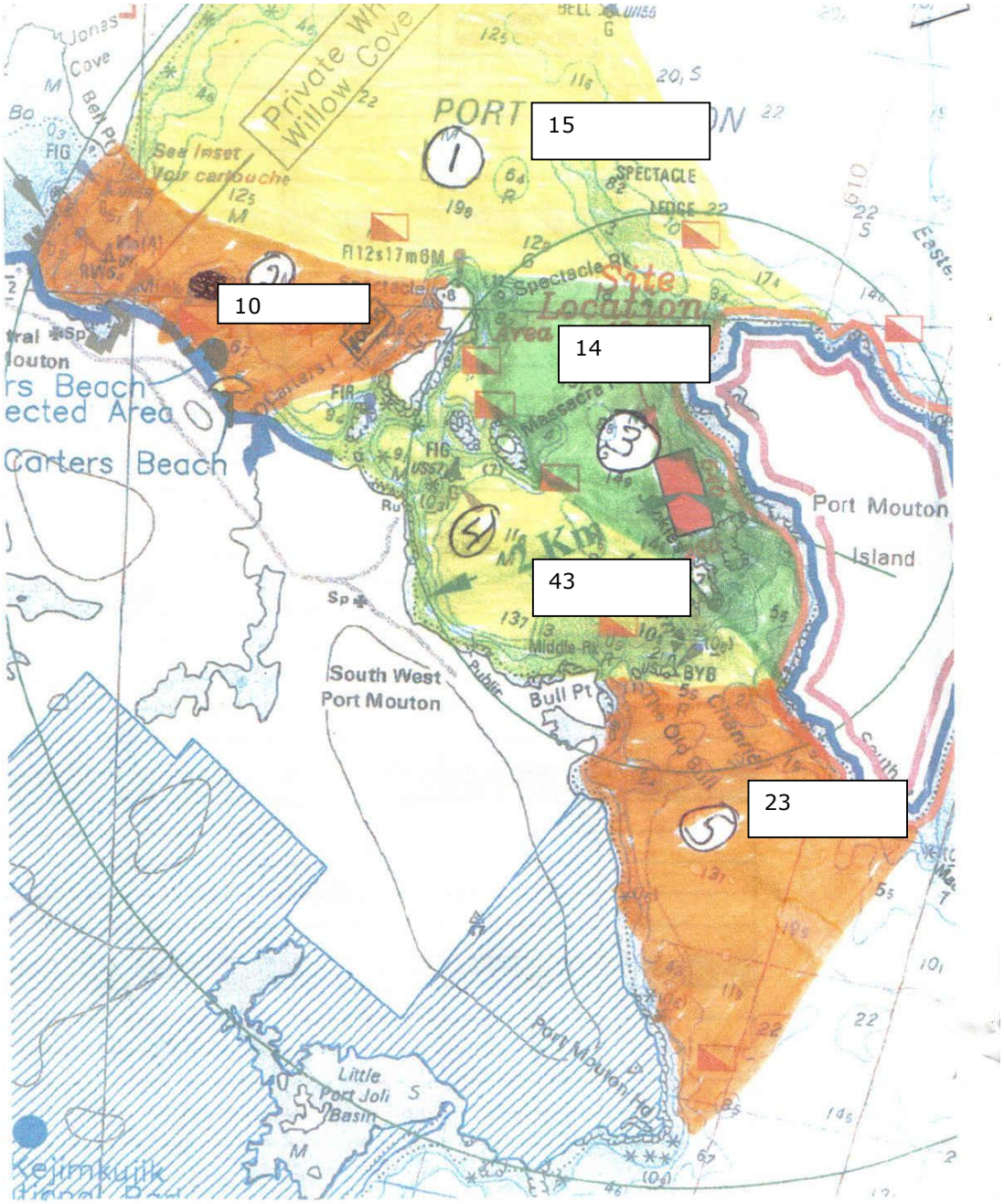


Figure 6.3.2. Numbers of seed-bearing lobsters reported per 1000 trap-hauls for the five regions surveyed. in the latter half of May, 2007

6.4 Lobster Landings Data

● Fishermen also compare catches with those in neighbouring fleets. In the last two weeks of May 2007, Port Mouton fleet catches were, by this informal measure, lower than those of Hunt's Point by a considerable margin (Figure 2.6).

● Analysis of landings data from fishermen's logs indicates that Port Mouton Bay landings have fallen below those of Hunt's Point in May, 2005 to 2007.

●The Landings report makes the case that May catches are most sensitive to effects from Site #835, and answers the question, 'Are lobster landings increasing in Port Mouton Bay?'. That report concluded that Port Mouton landings from fishermen's logs were comparable with those from the Hunt's Point fleet in 2004, falling to 50% of Hunt's Point catches in 2007.. (The Port L'Hebert Port Joli fleet is intermingled with the Port Mouton fleet.) (FPMB Contribution #14, 2007)

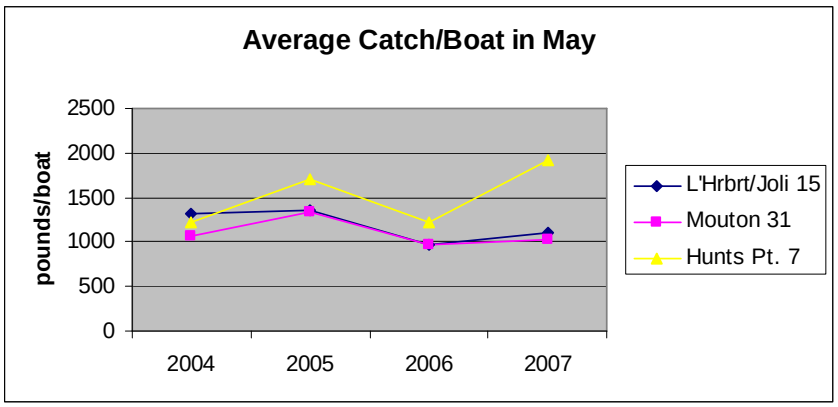


Figure 6.4 Catch (pounds) per boat in May for three fleets – Port L'Hebert/Jolie, Port Mouton and Hunts Point (courtesy of DFO statistics, provisonal).

6.5 Endangered Species

• The shorelines adjacent to the proposed site – Port Mouton Island and Southwest Port Mouton Beach - are essential habitat for nesting and feeding of the Piping Plover *(Charadrius melodus)* listed as Endangered Species by COSEWIC (Committe on the Status of Endangered Wildlife in Canada).

Significant habitat areas of the Endangered Species Piping Plover - Carter's Beach, Wobamkek Beach, South West Port Mouton Beach, Back Beach on Port Mouton Island and Summerville Beach - as well as the entire Port Mouton Island as an area of conservation concern are shown in the Significant Habitats maps from Nova Scotia Department of Natural Resources Figure 6.5.1 below.

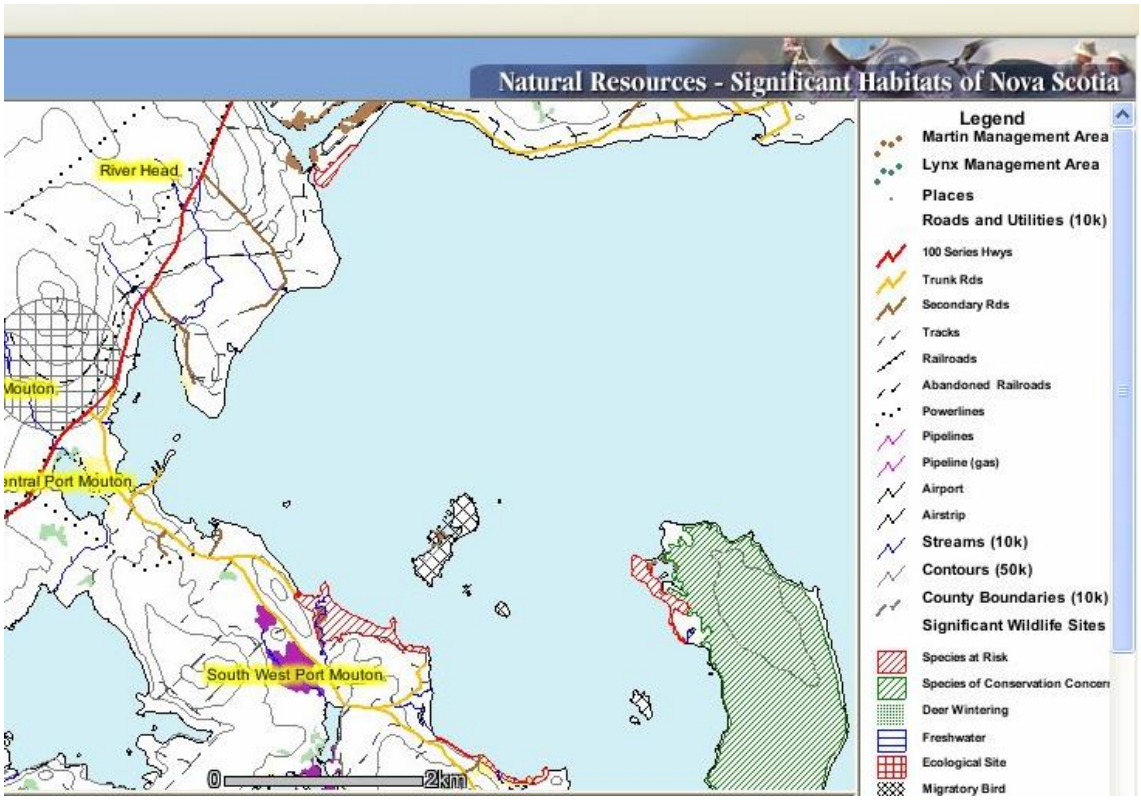


Figure 6.5. Significant Habitat Map showing essential habitat (red ///) of endangered species Piping Pover at Back Beach, Port Mouton Island (a candidate for Protected Beach status), South West Port Mouton Beach, Carter's, (a Protected Beach) and Summerville Beach (a Provincial Park). Port Mouton Island is an area of Conservation Concern. (Nova Scotia Department of Natural Resources).

• The Piping Plover depends on benthic marine invertebrates and to a lesser extent, terrestrial invertebrates for food. Foraging takes place in tidal pools and in the intertidal zone. The publication Birds of North America provides the following information on the feeding habits of the Piping Plover:

> On ocean beaches the wrackline is preferred foraging habitat for chicks followed by vegetated dunes (Elias et al. 2000). Adults and chicks also forage in the intertidal zone, however, flightless chicks can be thrown by rough surf (Hecht pers. comm.). Bays and pools are favored by chicks when available (Loegering and Fraser 1995, Goldin and Regosin 1998, Elias et al. 2000) ….. Coast birds frequently forage during low or falling tide (Cairns 1977, Staine and Burger 1994).
> Threatened/endangered status prohibits collecting; sensitivity to human disturbance makes sampling food on territories difficult and possibly unwise if birds are present.

Nevertheless, Nova Scotia breeders fed on marine worms (2.5–7.5 cm long) at rate of 58 worms/h; also smaller worms and tiny crustaceans (Cairns 1977).
At ocean and lagoon beaches of Magdalen Islands, QC, invertebrates found in fecal samples were: Gastropoda, Amphipoda, Coleoptera (Cicindelidae, Carabidae, Staphylinidae, Curculionidae, and unidentified), Diptera, and Hymenoptera (Shaffer and Laporte 1994).
(Haig, Susan M. 2004. Piping Plover (Charadrius melodus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/002 doi:bna.2)

● Friends of Port Mouton Bay have documented waste, apparently from the existing fish farm at Spectacle Island, in the intertidal zone of Carter's and Wobamkek Beaches and large algal accumulations in tidal pools in this area. The proposed site is expected to similarly impact the adjacent Back Beach on Port Mouton Island as well as South West Port Mouton Beach which is the shoreline adjacent to the basin, as well as Summerville Beach in episodic south-east wind events.

● Salmon aquaculture is incompatible with the essential habitat of the breeding piping plover.

7 Mitigation – not feasible.

● The fundamental hydrodynamic constraint in the basin at Port Mouton Island is the low flushing rate for wastes discharged in large quantities. This constraint, a product of the relatively deep basin bathymetry, the relatively small tidal range, and prolonged periods of light summer winds, *cannot be relieved by mitigation*.

● The fundamental biological constraint in the basin at Port Mouton Islnd is the need to protect this habitat, which is essential for broodstock and juvenile lobster, and to protect the wild fisheries - lobster, bait-fish and Irish moss. This constraint also *cannot be relieved by mitigation.*

●The fishermen cannot give up this Port Mouton Island territory to which they have historical access and on which they have historical economic dependence.

8 Safe Haven

● The proposed Port Mouton Island site has been traditionally used by lobster fishermen as a 'safe haven' for traps in stormy weather. It is not feasible to land traps ashore in advance of a storm because of constraints of time, distance from the wharf and space at the wharf. Lobster traps become stationary and sheltered as soon as they reach the deep water of this basin.

Lobster boats at 'safe haven' near Port Mouton Island, December 2007

● The safe haven is more than a 'secure parking place'; traps placed here are regularly hauled for lobster fishing. This same area is very important for the lobster bait fishery of crab and mackerel, which provides independence from purchased bait.

● The December–January period of the 2007/08 lobster season was particularly stormy and the safe haven was used by a significant number of boats, particularly during the period December 17,2007 - Jan 2, 2008. A check on December 20-22 identified 14 boats tending lobster traps in the safe haven (Fishing captains: James Conrad, Michael Swim, Phillip Huphman, Richard Demings, Robin Fisher, Peter Burgess, Richard Lawson, Richard Broughm, Burnell Allison, Todd Leslie, Aubrey Bush, Borden Daury) as well as boats engaged in crab fishing activity. Fishermen reported very good lobster catches in this safe haven area ranging from an average of 3 lbs/trap haul to a high of 8 lbs/trap haul.

- This safe haven at Port Mouton Island is crucial for not only the fishermen, but for any seafaring vessel caught in a storm. Having all or part of this area restricted by fish farm assets such as nets, area marking flyers, etc. poses grave and deadly danger. Areas that offer such protection from the storms of the North Atlantic should not be compromised.

- The prediction of an increase in magnitude and frequency of storms in the Atlantic region associated with climate change consistent with recent trends toward greater extremes and higher frequencies of such events as winter cyclonic storms (Natural Resources Canada, 2007) highlights the increased importance of the safe haven at Port Mouton Island in the future.

9 Economic Losses

● Lobster fishermen in Port Mouton Bay have experienced real economic losses in the Inner Harbour of Port Mouton Bay related to the existing aquaculture site at Spectacle Island. Lobster fishermen face more such economic losses and increased safety risks from a second displacement if the proposed aquaculture site is permitted. Fishermen, the environment and the communities around Port Mouton Bay are bearing the costs described below without receiving any benefit from aquaculture activity.

Existing Site #835

● The loss of lobster habitat in the Inner Harbour of Port Mouton Bay has been demonstrated in the Friends of Port Mouton Bay Trap Survey of May 2007.(FPMB Contribution #10) The **loss** was also reflected in the FPMB analysis **of lobster landings** from fishermen's logs of May 2007 (FPMB Contribution #14). This part of the season (when the Inner Harbour would have been most actively fished in the past) recorded total lobster landings per boat for Port Mouton half as large as those of the neighbouring community, Hunts Point. An estimated 1200-1500 lobster traps are no longer placed in the Inner Harbour due to the loss of habitat there (Bob Swim, pers.comm.).

● A survey of fishers submitted by FPMB in January of 2007 reported additional economic losses from:

- **fouled or contaminated gear** due to algal accumulation on traps,
- **increased bait cost** due to scarcity because of loss of habitat for crabs,
- increased **fuel and time costs and gear losses** due to displacement from the inner harbour to more distant and less sheltered (offshore) locations,
- **a loss of sheltered fishing area** (inshore) for winter fishing
- and the **costs of investing in larger boats** since the decline of inner harbour fishing.

● **Irish moss harvesters** have **lost valuable shoreline areas** around Spectacle Island in the vicinity of the existing aquaculture operation.

● A very important consideration is the **increase in safety risk** for fishermen in small boats who must travel longer distances offshore away from sheltered locations.

Proposed Port Mouton Site

● Fishermen would face more of the economic losses and increased safety risks outlined above in greater magnitude from a second displacement if a proposed aquaculture site is permitted at Port Mouton Island - economic losses from:

- **fouled or contaminated gea**r due to algal accumulation in traps,
- **increased bait cost** due to scarcity because of loss of habitat for crab and mackerel,
- **increased fuel and time costs and gear losses** due to displacement to more distant and less sheltered locations,
- a **loss of sheltered safe haven and fishing area**,

· the **costs of investing in larger boats** for travel to more distant locations
· and the very important **increase in safety risk** for fishermen in small boats who must travel longer distances away from sheltered locations.

● This area is actively used for **lobster and bait fishing** (both crab and mackerel), as a **safe haven** for lobster traps, and **Irish moss harvesting**. That this basin is also a **nursery area**, an essential habitat for lobster broodstock has implications beyond the vicinity of Port Mouton Island.

● Further displacement of lobster fishermen will bring **increased and non-productive competition for territory** with neighbouring community fleets. The fishermen state that they cannot give up any more territory and particularly this strategic territory near Port Mouton Island.

10 Cumulative Effects

● Cumulative effects between the existing site at Spectacle Island and the proposed site at Port Mouton Island have been projected in previous reports by FPMB with respect to such **Valued Ecosystem Components** as **Marine Habitat, Critical Habitat** and **Fisheries Resources**, and the **Valued Socio-Economic Components** of the **Local Economy**.

● Marine Habitat – The plumes of dissolved nutrients from both sites are expected to overlap with resulting cumulative effects from algae. The proposed site will enlarge the already degraded habitat for lobster, crab, scallops, clams, mussels, mackerel and Irish moss. Continued degradation of an ecosystem is likely to lead to ecosystem shifts, be cumulative in nature and have unpredictable recovery potential.

● Critical Habitat – The Inner Harbour at Port Mouton Bay, once a prime lobster fishing ground, was an area to which lobsters migrated. The proposed site at Port Mouton Island will further interfere with this migration and at the same time will displace a very critical spawning and nursery area producing adverse effects reaching beyond the immediate area of Port Mouton Bay.

● Fisheries Resources - The proposed site at Port Mouton Island will impact the remainder of the inshore lobster fishing, bait fishing and Irish moss harvesting areas in Port Mouton Bay, and undermine these activities to the point of unprofitability.

● Local Economy – The local economy around Port Mouton Bay is dependent upon Valued Socio-Economic Components - commercial, wild fisheries, and tourism including seaside parks, seven world-class beaches, recreational fisheries and recreational diving. All of these activities rely in turn on a healthy marine ecosystem.
The current aquaculture enterprise has already degraded the marine ecosystem in Inner Port Mouton Bay. Habitat has been lost for the commercial lobster and crab fishery and recreational scallop diving and beaches once pristine are now the receptors of algae, waste residue and foul odors. The community has borne opportunity costs without receiving benefits. The unsuitability of the proposed site and resultant impacts would further jeopardize the reputation and success of Port Mouton's commercial fisheries and tourism interests.

11 Historical Access to Lobster Fishing in Port Mouton Bay

Fishermen at Port Mouton come from generations of people who for over 200 years have made their living from the sea here; some of them are directly descended from the United Empire Loyalists who settled here in 1783. The historical lobster data from 1946-47 described below contain the names of fathers, grandfathers and in at least two cases, great-grandfathers of present-day fishermen, underlining the long-term inter-generational investment in and the historic economic dependence on the lobster fishery in Port Mouton Bay.

A study on lobster tagging and lobster landings at Port Mouton in the 1946-47 lobster season recorded by the Federal Department of Fisheries reflects the specific areas where fishermen were lobster fishing at that time (Unpublished records in DFO data files, R. J. Miller, pers. comm.)

1000 lobsters were tagged and liberated within and beyond Port Mouton Bay in the pre-season period of November 1946. Notes on the recovery of 569 tagged lobsters during the lobster season provide the recovery location and the captain of the boat.

Landings data for December 1–14, 1946 and March/April 1947 detail the location of the catch and the captain of the boat for a selected number of boats which fished both winter and spring lobster seasons. Boats which fished lobster in the winter season but which were engaged in the ground fishery during the spring season were not included. Few tagged lobsters were recovered in May and there is no information on location of catches in May, a time when water temperatures are higher and fishing activity moves shoreward.

Although the information provided is not a complete census of all boats engaged in lobster fishing and does not provide complete temporal and spatial coverage, this information is a good indication of the level and location of lobster fishing effort in Port Mouton at that time.

A total of 71 boats are identified: 14 from Port Mouton, 16 from Central Port Mouton and 41 from South West Port Mouton. Since many of the boats would have had a crew of two, certainly more than 100 persons were engaged in fishing lobsters at that time. Today 40 lobster boats currently operate from Port Mouton Bay, many boats with a crew of three.

The historical maps below show the location of fishing activity and therefore are a good indicator of territories occupied by fishermen as the season progressed.

An integration of the information from the detailed landings data for a selected number of boats and from the lobster tag recoveries provides the following pattern of activity:

> There was consistent fishing activity by fishermen from (North) Port Mouton in early December from Bell's Point to Broad River extending to Spectacle Ledge. (These locations occupy the eastern portion of the present degraded zone). These boats moved further outward to the east and south of Port

Mouton Island and to Brazil Rocks in March and April and moved shoreward in May.

There was consistent fishing activity by Central Port Mouton boats in December around Charley Island, Spectacle Island, Mink Island and the western side of Port Mouton Island.(Charley Island, Spectacle Island and Mink Island occupy the western portion of the present degraded zone). Many South West Port Mouton boats were also fishing in the Port Mouton Island basin around Spectacle Island, Massacre Island and Jackie's Island in early December, and in March and April. (The location of the proposed aquaculture site is in this basin on the western side of Port Mouton Island).

There was consistent fishing activity off Port Mouton Head to Port Joli Head in March and April by South West Port Mouton boats. This location is the shoreline of the present Kejimkujik National Park Seaside Adjunct.

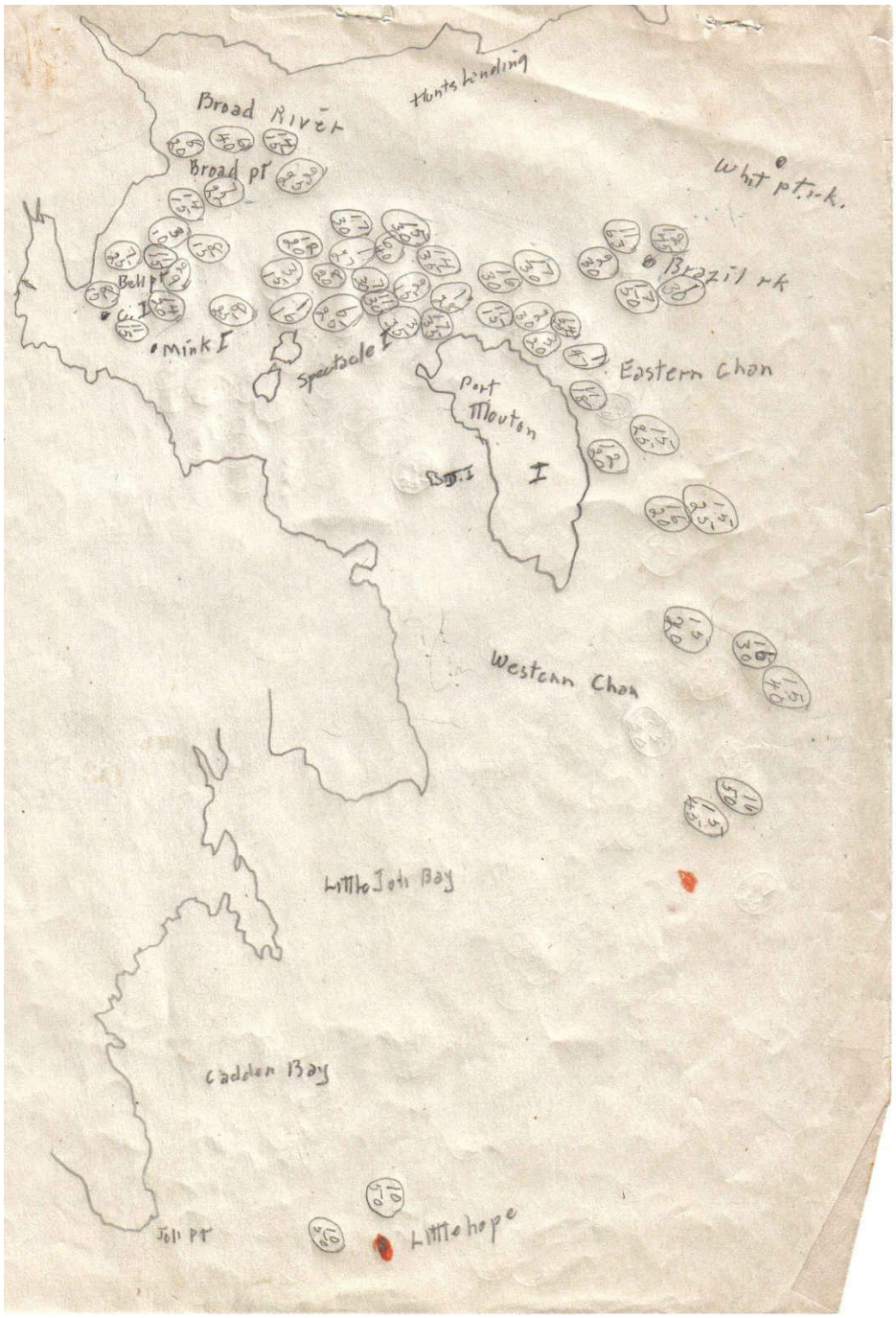


Figure 10.1 Map from Federal Department of Fisheries 1946-47 lobster study showing effort of approximately 12 boats from the (North) Port Mouton fleet.

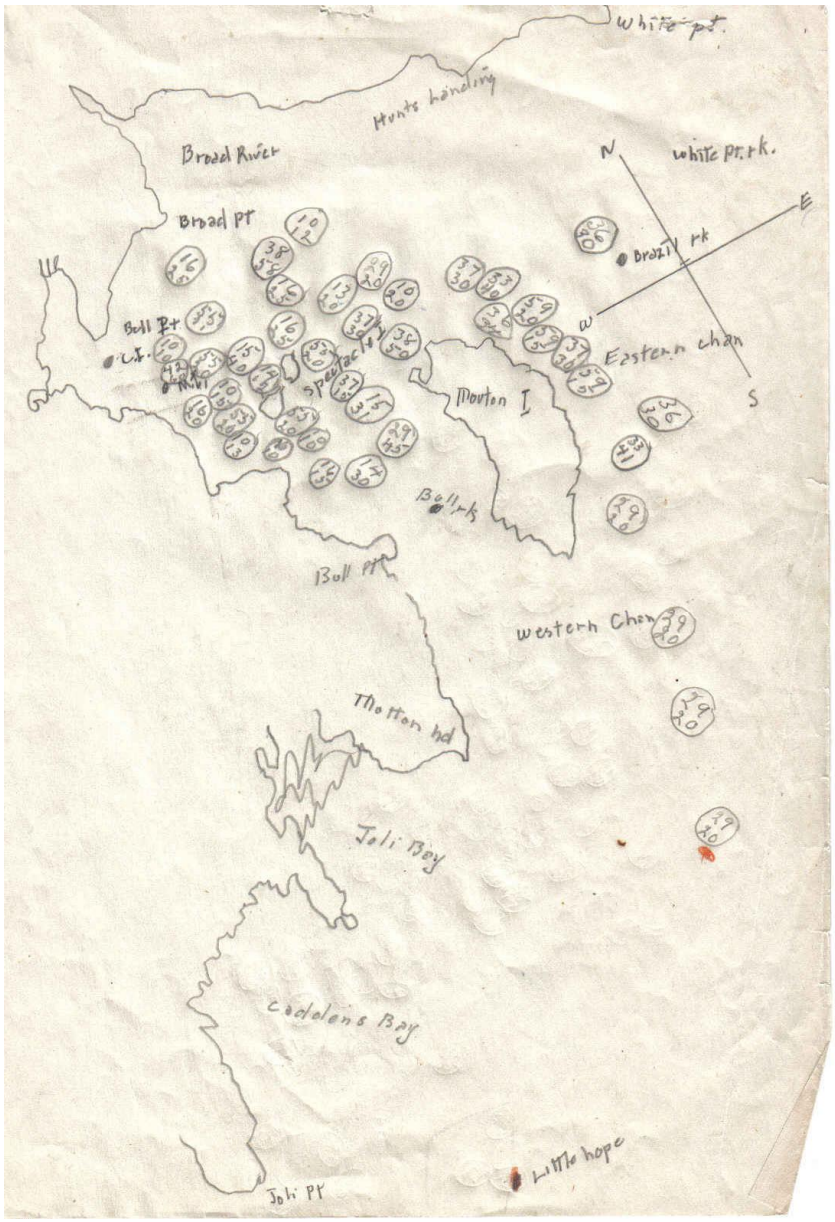


Figure 10.2 Map from Federal Department of Fisheries 1946-47 lobster study showing effort of approximately 13 boats from the Central Port Mouton fleet.

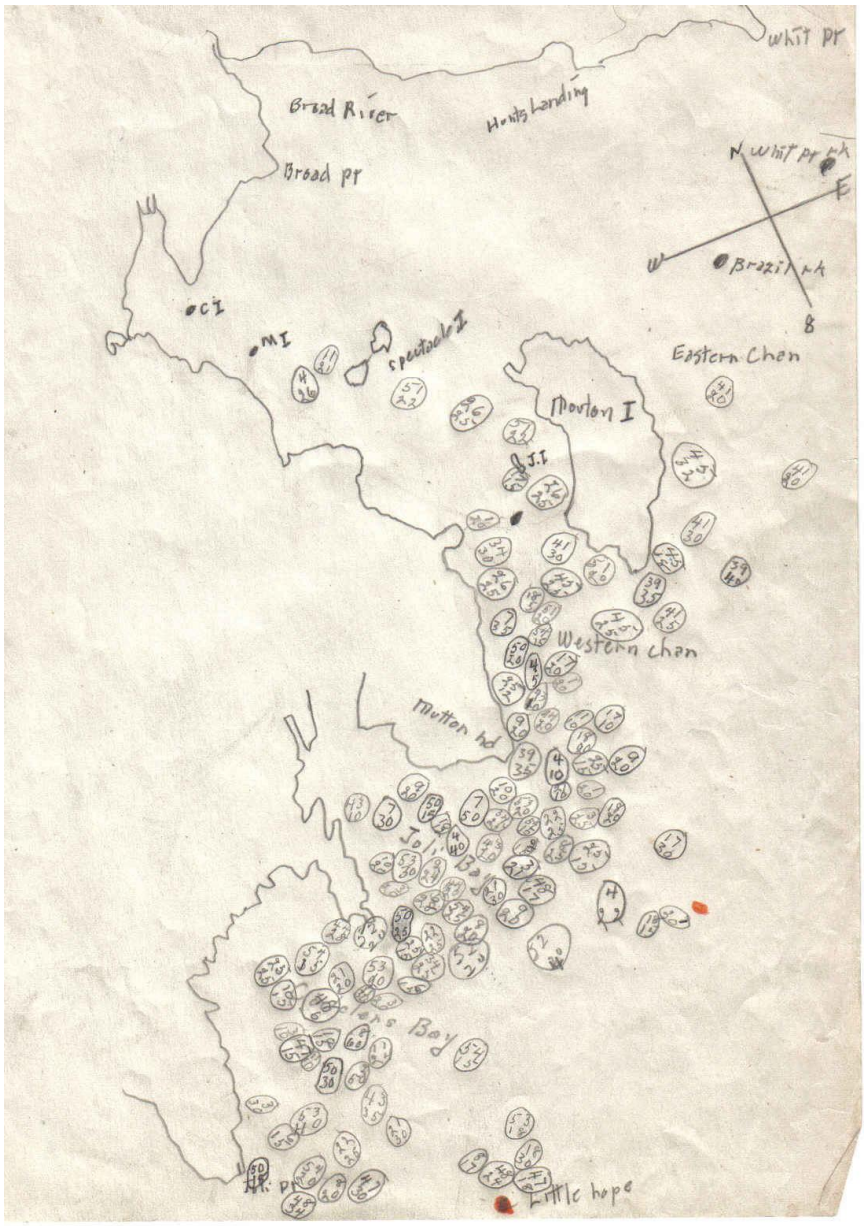


Figure 10.3 Map from Federal Department of Fisheries 1946-47 lobster study showing effort of approximately 34 boats from the South West Port Mouton fleet.

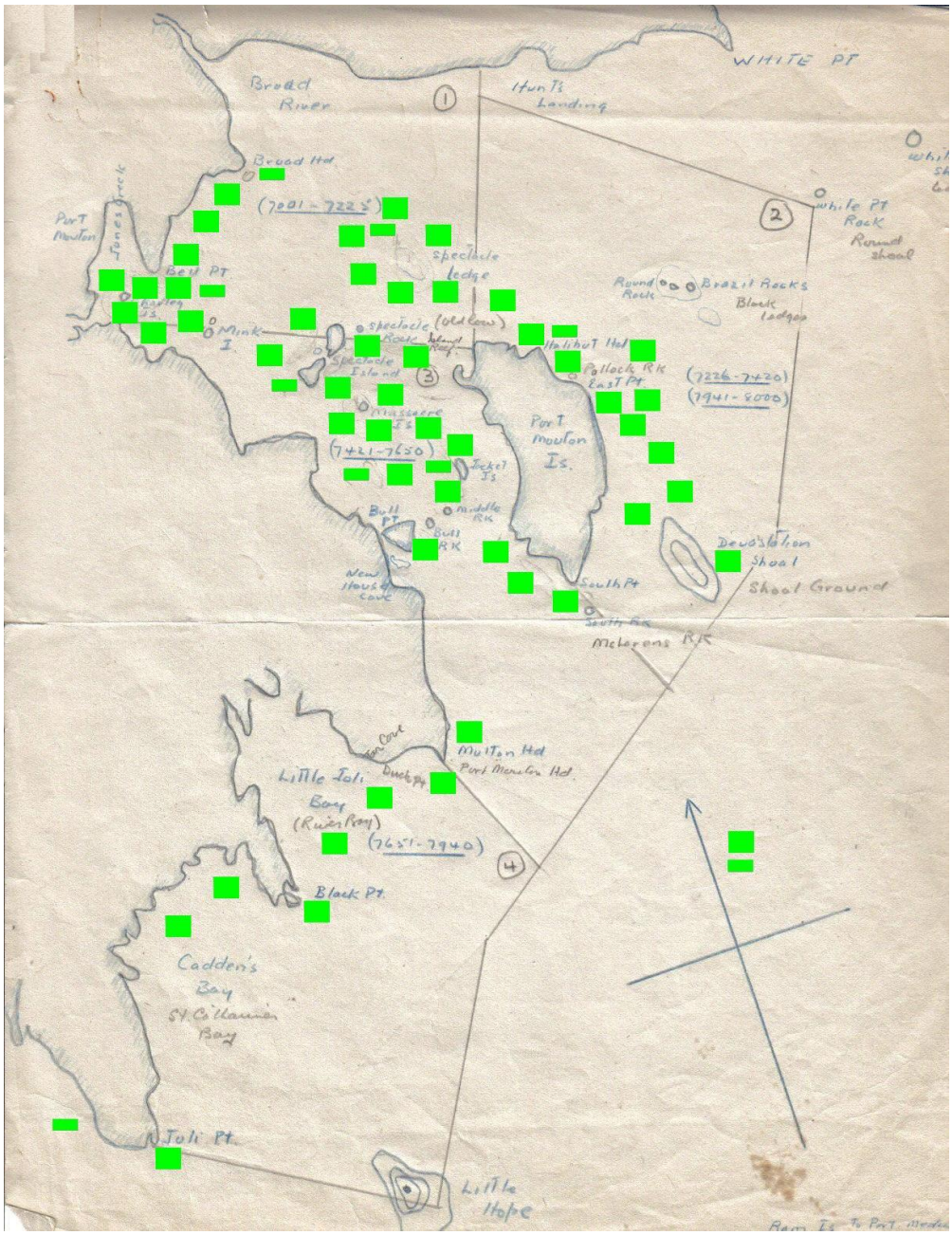


Figure 10.4 Map from Department of Fisheries Lobster Tagging Study of 1946-47 at Port Mouton with general locations and numbers of recovered tagged lobsters by 71 boats superimposed. Each square is equivalent to 10 (rounded) recovered tags.

These data from Port Mouton Bay provide an important reference point to the historical access to the lobster fishery and correspond to lobster fishing patterns in

the recent years before the aquaculture site at Spectacle Island. The present degraded zone in the inner harbour of Port Mouton Bay and the basin area at Port Mouton Island comprise traditional lobster fishing areas of significant proportion.

A case in point is the decision by the State of Maine Department of Marine Resources in 2005 to deny an application for a 10 year, 2 acre mussel aquaculture lease by Aqua Farms LLC because the aquaculture activities proposed would unreasonably interfere with lobster fishing in the area. Maine fishermen testified to the historical and current use of the area for lobster fishing.
http://www.maine.gov:8080/dmr/aquaculture/documents/AquaFarmsLLCHopeIs.pdf

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Appendix

Modelling Discharges, Flushing and Dilution for the Salmon Aquaculture Site Proposed for Port Mouton Island

A.1 Introduction

Some insights can be gained for anticipating the magnitude and effect of discharges from a salmon farm by applying mass balance modeling. There is the water sector (Figure A.1) which simulates the mass of water moving with the tide in and out of the Port Mouton Island basin, or in and out of the farm itself. Coupled with this is the tracer sector to account for the source strength or mass of tracer (wastes) discharged and also the flushing rate. The outputs of this modeling are the rates of various discharges and levels of concentration build-up. We begin with the salmon feces particles, followed by the nutrient, dissolved nitrogen4 (which is usually the limiting nutrient for coastal algae) and dissolved oxygen.

A.2 Discharge of Fish Feces

A.2.1 Approach

The model developed for fish feces (Stella systems modeling platform, ISEE Systems) includes water and tracer sectors (Figure A.1). The water sector simulates the tide currents flowing into and out of Port Mouton Island Basin with a period of 12.5 hours, continuing for ten days.

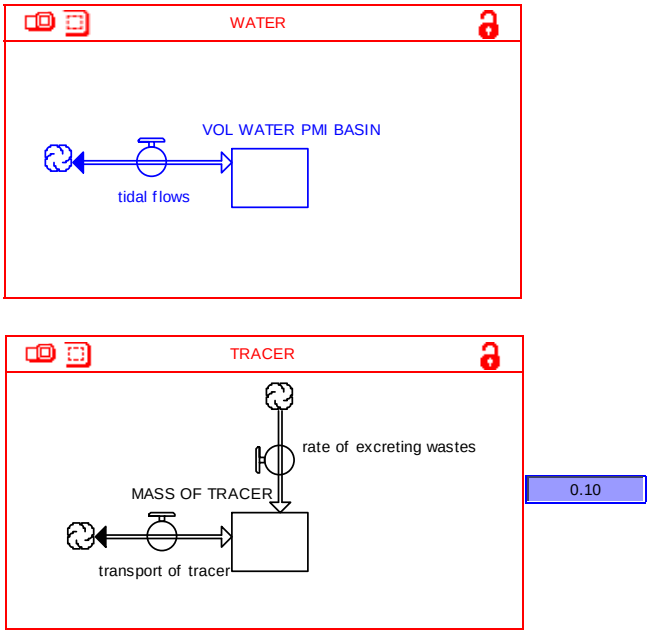

Figure A.1 Schematic of the Port Mouton Bay water sector with tidal flows and the tracer sector with discharge into the Bay and tidal transport of wastes.

The tracer sector shows the discharge of the wastes into the basin (MASS OF TRACER). The rate of discharge for the 300,000 fish is taken to be an average of 0.75 g carbon per fish per day (Strain and Hargrave, 2005).

The second feature of the Tracer section is the flushing rate (Figure A.2). The fish feces tracer is transported away from the basin at three different flushing rates in this model - high, medium and low. The high rate, 63% of the tracer permanently exported in 23 hours, is the theoretical rate for Pubnico (Gregory et al, 1993). The medium rate, 63% of the tracer permanently exported in 114 hours, is the theoretical rate for Port Mouton Bay. The low rate, 63% of the tracer permanently exported in 230 hours, is half the medium rate, and is based on the Port Mouton Island Basin drogues (March, 2007) and current meter (in December (2006), January (2002, 2007), February(2002, 2007)) trajectories which exhibited re-circulation with light winds (§3).

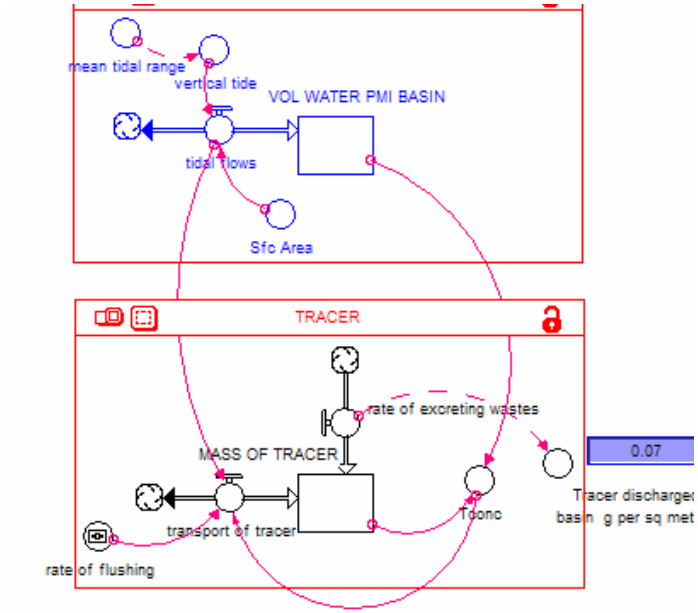

Figure A.2 The water and tracer sectors showing linkages.

Strong winds could produce exchange of waters and dispersion of wastes with a relatively high flushing rate. Light winds are associated with low flushing rates. There is a strong seasonal variation in wind speed (Table 3.1, §3). Figure A.3 shows August 2007 wind speeds for comparison with Figure A.4 showing nine days of January 2007 winds. These wind speeds were recorded at Western Head, within sight of Port Mouton Island.

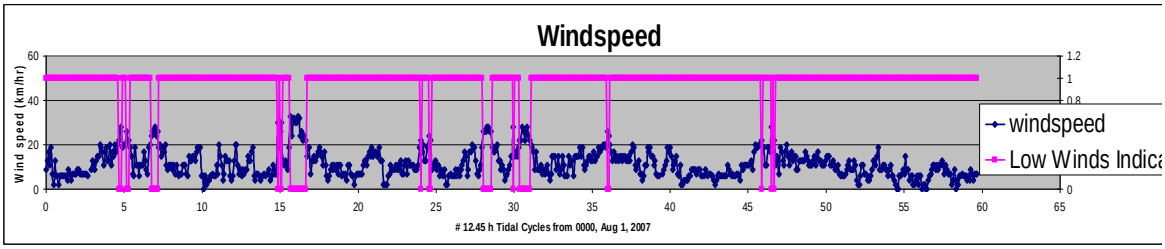

Figure A.3 August, 2007, wind speeds at Western Head, near Port Mouton Bay versus tide cycle number. Speeds less than 20 km/h are flagged with the purple line at its upper limit.

The August data show prolonged periods when winds rarely rose above 20 km/hour for many tide cycles. For example between tide cycles #32 and #60, winds were light except for brief interruptions of slightly higher winds occurring around tide cycle #46. By way of contrast, the first 9 days of January, 2007, show wind speeds rarely below 20 km/hour for as long as one tidal cycle (12.5 hours). The current meter data available for the proposed Port Mouton Island site is for the period December 18, 2006, to January 9, 2007. Current meter data does exist in DFO archives for August, 2001 – the only summer data we have been able to identify. This data is presently being reviewed by DFO at St. Andrews.

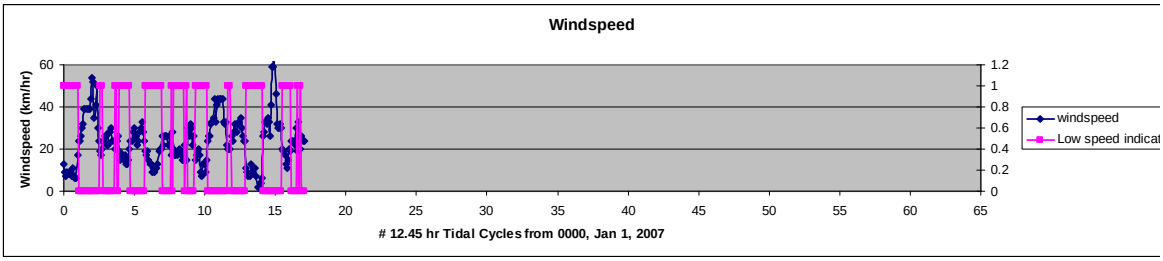

Figure A.4 January 1 to 9, 2007, wind speeds at Western Head, near Port Mouton Bay. Speeds less than 20 km/h are flagged with the purple line at its upper limit. Note that speeds are higher and interludes of light winds shorter in January compared to August.

A.2.2 Results for Fish Feces

Source strength

With a source strength from 300,000 fish of 225 kg feces per day[2] potentially impinging on the farm area of approximately 300 metres x 500 metres, this discharge is 1.5 g per square metre per day – a discharge which, except when the flushing rate is high, will likely lead to oxygen depletion and formation of sulphides. (Typically a supply of 1 to 5 g feces per square metre per day leads to formation of sulphides.) The experience at #835, Spectacle Island is that, with Port Mouton Bay's low flushing rates, the sulphides are very high at the farm site

[2] Based on 300,000 fish during year 2 and averaging 50% of the maximum discharge of carbon during decomposition of wastes (Strain & Hargrave, 2005)

(Fig.A.5), and though sulphides are not expected nor found in the far-field, effects there other than sulphides are significant for macrofauna. The absence of evidence (of sulphides) does not imply evidence of absence (of effects).

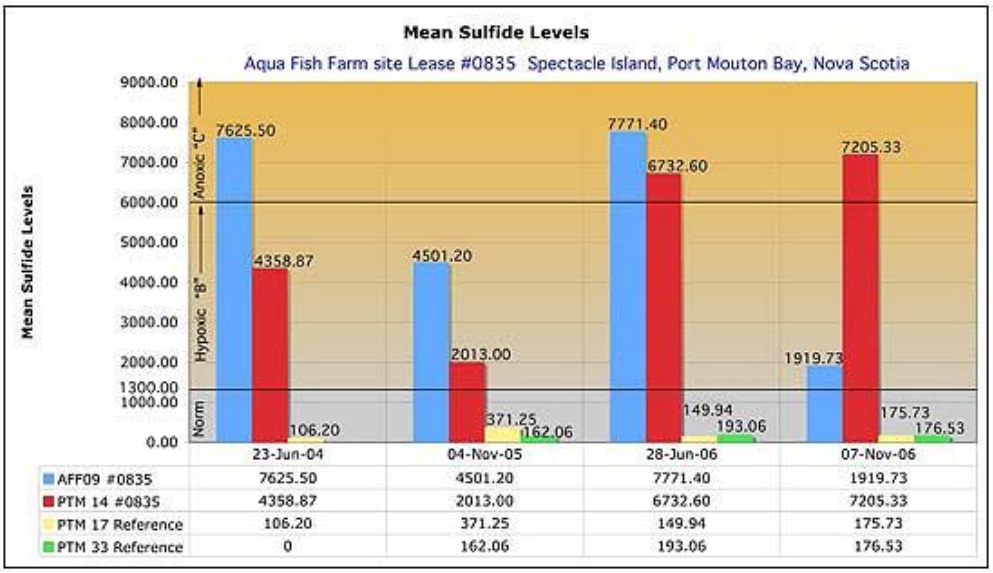

Figure A.5 Mean sulphide levels at Spectacle Island aquaculture site, 2004-2006: on-site stations AFF09 and PTM14 and off-site reference stations PTM 17 and PTM 33.

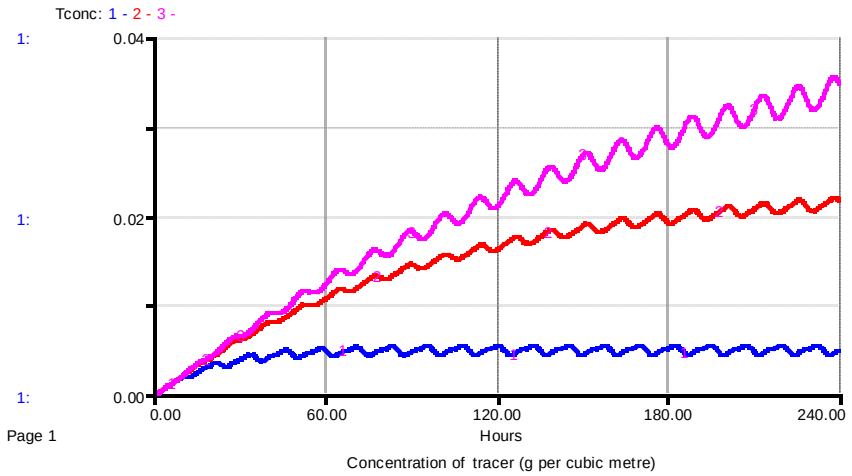

Figure A.6 At the high flushing rate (blue curve) and assuming the wastes were mixed throughout the basin and suspended rather than settled, concentrations quickly equilibrate at <0.01 g / m^3. The point is that at the medium and low

flushing rates (red and purple curves), waste concentrations would quickly build to levels many times higher.

A.2.3 Interpretation

We expect accumulations under the cage to be a small fraction of the total discharge and most of the material to be carried beyond the farm to the far-field, with adverse effects.

If the low-flushing-rates prevail frequently in summer, as we anticipate, the accumulation of wastes after ten days could be many times the accumulation expected in a ten-day period at a time of high winds and high-flushing-rate.

These accumulations are of concern because they can smother benthic plants and animals, and irritate the gills of invertebrates, causing then to move elsewhere; the ecosystem is disturbed.

A.3 Nutrients Discharged

A.3.1 Approach

For nutrients we use the discharge rate given in Strain and Hargrave (2005), 100 kg N per day for the farm with 300,000 fish[2]. . This can be compared to a discharge of ~14 g N per day from a human (http://www.che.iitb.ac.in/faculty/gks/studproj/cfa_2002/anand_gautam.PDF).

A.3.2 Results

Figure A.6 serves qualitatively for nitrogen discharges. Again resulting concentrations depend strongly on flushing rate. At the *low* flushing rate (purple) anticipated in summer at Port Mouton Island Basin, the equilibrium concentration of nitrogen (or algae enabled to grow by this nitrogen) will be much higher than if the flushing rate were consistently at the *high* value shown (blue).

A.3.3 Interpretation

Nitrogen will be mostly in dissolved form and is typically the limiting nutrient for algae in these coastal waters, and background concentrations are usually practically zero in summer because of rapid uptake. The additional introduced nitrogen discharge here is large, equivalent to the nitrogen excreted by 10,000 humans. The nitrogen can be expected to be taken up by algae - and potentially produce a large mass of algae in the Basin.

Dissolved phosphorus is also an important nutrient for algae and would be discharged at a rate similar to nitrogen in human equivalents, and its concentrations would increase as flushing rates decrease.

A.4. Dissolved Oxygen Demand Discharged

A.4.1 Approach

Our approach is patterned after Appendix C. Fish-farm induced dissolved oxygen depletion (F.H. Page, DFO, 2003).

Oxygen is required for respiration by the 300,000 caged fish at an average year 2 rate[2] of 1200 kg DO per day (Strain & Hargrave, 2005). Oxygen consumption through decomposition of wastes would be additional. Consider a buffer amount of dissolved oxygen of 1 to 3 g DO/m^3 above the 6 g/ m^3 concentration considered to be the minimum required.

Residence time of water on the Port Mouton Island fish farm could be up to 5 hours, as judged from the March 2007 drogues - the time to exchange 63% of the water (setting aside the fact that these waters may have passed through the farm on previous tidal cycles). For 95% exchange, consider 15 hours residence time (following DFO 2003, above).

A.4.2 Results

The farm contains approximately 300 x 500 x 8 = 1,200,000 cubic metres of water. If there were a 1 g DO/ m^3 buffer, 300,000 fish respiring at an *average* rate of 1200 kg DO per day would consume this in 1 day. Accepting that most of the water exchanges in 15 h or 0.6 days, consumption of DO would not quite exhaust the reserves before they could be re-supplied. Nevertheless this signals potential difficulties for meeting the needs of the fish near the time of year when demand is maximum – 2400 kg DO per day.

A.4.3 Interpretation

If long periods of light winds occur in summer so that the flushing rate depends on the tide alone, and accepting that the tidal flushing rate is as low as the drogues indicated, then the expanded farm would be susceptible to depleted oxygen events.

A.5 Conclusions

The discharge rates for the proposed Port Mouton Island farm are large. The feces particles from the proposed Port Mouton Island farm could accumulate at a rate which produces sulphides under the cages and smothers benthic organisms in the far-field. The nitrogen discharge is a large injection which could significantly disturb the ecosystem with excessive algae. The oxygen demand could exhaust the supply during periods of low flushing rates and maximum demand.

Sensitivity to flushing rate has been demonstrated. The concentrations of feces particles, nitrogen and oxygen demand during periods of low flushing rates could build up to as much as six times the concentrations at high flushing rates as defined above.