



PORT MOUTON AQUACULTURE SITE REVIEW

Context

DFO Maritimes Science was asked by the Habitat Protection and Sustainable Development (HPSD) Division to provide information to contribute to a review of an aquaculture site proposed for Port Mouton. Specifically, DFO Maritimes Science was asked the following questions:

1. The proponent has collected sediment chemistry and oceanographic data for the proposed site in Port Mouton. Based on this information, would the proposed site be likely to contribute to organic enrichment of benthic fish habitat such that sulphide levels would exceed background levels for this area?

2. Does DFO Science have any additional oceanographic data for the Port Mouton area? If so, do the oceanographic data in conjunction with the current meter data and drogoue data indicate that there will be a cumulative interaction between an existing site and the proposed site?

3 (a). Is there, or has there been, a decrease in productive capacity around the existing site that can be attributed to salmon production at site?

3 (b). If so, and if there is likely to be a cumulative interaction between the proposed site and the existing site, is it likely that the zone of decreased productivity would expand if the proposed site were put in place? Could an estimation of the geographic boundaries of such a zone of decreased productivity be produced?

4. Can questions 3(a) and 3 (b) be answered using DEPOMOD? If so, is there any way that the Habitat Protection and Sustainable Development (HPSD) Division can assist DFO Science in running this model for the existing and proposed sites?

It was requested that this information be provided by mid-June, 2007 so that HPSD would be able to provide feedback in a timely manner to the Canadian Environmental Assessment Act process currently being led by Transport Canada. DFO Science has produced a National Science Advisory Report (SAR) on Finfish Cage Aquaculture in the Marine Environment (DFO, 2005), and DFO Science has provided information and advice on Maritimes finfish cage aquaculture in the past. This response is considered to be site-specific application of the conclusions and recommendations presented in the SAR.

Background

The HPSD Division received an application for the establishment of a 29 hectare marine finfish, aquaculture site (1251), in Port Mouton Bay, Queens County, NS. The new site (1251), once approved, will be divided into 2 smaller sites which will be operated on a rotational basis. This site, in conjunction with the existing site (0835), will operate as a 3 site crop rotation incorporating fallow into the production at all the sites. Transport Canada is currently conducting an environmental assessment of the proposed site.

According to information submitted to DFO HPSD by the Friends of Port Mouton, the biodiversity of species in inner Port Mouton Bay has progressively declined over the period of operation of site 0835 at Spectacle Island to the point where lobster, bait-fish, scallops, clams and mussels are diminished or no longer present. They also indicate that there has been a reduction in Irish moss and discoloration of rockweed over a large part of the shoreline which has resulted in a loss of production for rockweed and moss harvesters. The group also contends that green algae have appeared on shorelines and on the seabed in a 1 square mile area around the present site. This area of concern is referred to by the Friends of Port Mouton as a "Dead Zone". Additionally, the Friends of Port Mouton claim that further interactions between the proposed site 1251 and the existing site 0835 could result in significant losses to commercial fisheries in the area.

Approximately 6 years ago, the proponent, Aqua Fish Farms Ltd. submitted preliminary current meter data from a 48 hour period at the proposed site (1251) in Port Mouton. The Friends of Port Mouton reviewed the current meter data and verified this data by deploying 2 drogues in close proximity to where the current meter was deployed 6 years previously. The drogues, which were tracked for approximately 12 hours, indicated that the current speeds were larger than indicated by the current meter data collected 6 years previously. However, the concerned residents are claiming that the currents in the proposed area are considered to be weak and deposition is likely. Furthermore, they suggest that the existing site, located just northeast of Spectacle Island, approximately 2.5 km from the new site, could interact with the proposed site.

In 2007, the proponent, Aqua Fish Farms Ltd. moved the site from its originally proposed location, i.e., where the original current meter data was collected and drogue study was conducted. DFO Science recently collected 3 weeks of current meter data to assist review of this new aquaculture site (1251).

Analysis and responses

Organic Enrichment

Question: Given existing information, is the proposed site likely to contribute to organic enrichment of benthic fish habitat such that sulphide levels would be likely to exceed background levels for this area?

According to DFO's SAR on finfish aquaculture in the marine environment (DFO, 2005), elemental budgets or mass balance calculations can be used to estimate the relative magnitude of multiple processes that supply and remove nutrients or organic matter in coastal ecosystems. To estimate absolute magnitudes of these processes, it is necessary to quantify all sources and sink terms precisely. The reliability of such estimates will also depend on the quality of the model parameters and the accuracy of the description of farm operations, other nutrient sources and ecosystem processes. Complete information about all potential sources and sinks of nutrients and organic matter in the vicinity of the proposed site is not available for this analysis. However, based on the site-specific information that has been provided and based on monitoring that has been conducted at other finfish aquaculture sites in the Maritimes Region, it is expected that benthic sulphide levels in the area of the proposed fish cages will increase from present values once fish are on the site.

Current meter records and drogue tracks indicate that the proposed site is an area of fairly low current speed that is influenced by wind stress. Wave activity could have a significant impact on resuspension of farm wastes, but this has not been estimated.

Monitoring the change in the total free sulphide levels, a method supported by the SAR on finfish aquaculture (DFO, 2005), at the cage site is expected to be implemented as part of the standard operating procedures for the fish farm. Existing regulatory mechanisms are expected to help ensure that these sulphide levels are maintained within acceptable limits.

Oceanographic Data

Question: Does DFO Science have any additional oceanographic data for the Port Mouton area?

In 2001, S4 current meter data were collected over a two week period at both new and proposed site. Data may be influenced by moving the meter and the presence of the existing site. However, data can be interpreted as being from one location to develop progressive vectors plots and speed frequency distributions.

In 2006, Acoustic Doppler Current Profiler (ADCP) data were collected at the proposed site for about three weeks in December.

Question: If so, do the oceanographic data in conjunction with the current meter data and drogue data indicate that there is likely to be a cumulative interaction between an existing site and the proposed site?

The use of oceanographic data as a predictor for the environmental interactions of aquaculture was not specifically addressed within DFO's SAR on finfish aquaculture (DFO, 2005). However, the use of DEPOMOD (a computer model developed in Scotland) was reviewed. It was determined that while DEPOMOD could be a useful planning tool, model predictions did not replace field observations and monitoring data. It was also suggested that model outputs should be validated against measured flux rates in the field. This suggests that field measurements are an important component of aquaculture site evaluation.

When the S4 current meter data from 2001 are combined for each site and interpreted as one record, the frequency distribution shows that the existing site has lower current speeds than the proposed site (median velocities $\sim 2.8 \text{ cm s}^{-1}$ and $\sim 6.5 \text{ cm s}^{-1}$ respectively). This suggests that the existing site is more depositional than the proposed site, although the records are very short and results should be viewed with caution.

Examination of the 2006 ADCP data shows that wind forcing is an important component for drift at the proposed location. For about half the time, the drift at the surface is to the southeast and then it reverses and flows to the northwest. There is also a period when the surface and bottom current are in opposition, which further supports the idea that wind driven circulation is important at this site.

The physical setting of the two locations suggests that they are separate and that the particulate fraction of the wastes would be unlikely to interact. The two sites are separated by a ledge between Spectacle Island and the mainland, and the ADCP data indicate that the predominant transport direction would be towards Spectacle Ledge. Wastes from the new site should accumulate beneath the cage site, be displaced to the depositional area to the west of the cage site or be dispersed to the northeast into a region of much higher energy identified as gravel bottom.

Dissolved wastes are expected to disperse widely over the area and some interaction between sites might occur. The relative contribution of dissolved nutrients from the farm sites to the total load for this region is unknown.

Productive Capacity

Question: Is there, or has there been, a decrease in productive capacity around the existing site that can be attributed to salmon production at the site?

Baseline data would be required to verify if there has been any change in productive capacity around the existing site. It would also be important to define what species are to be considered when establishing productive capacity.

Question: If yes, is it likely that the "dead zone" will expand? If so, can estimation be provided for what the geographic boundaries of the dead zone would be?

To determine if the area will expand, data would have to be collected to define what constitutes the dead zone and its areal extent. Areas of natural deposition, e.g., mud bottom, exist in close proximity to both farm sites, and wastes from the farms could be expected to contribute to the accumulation of carbon at these locations. With sufficient data, it could be possible to estimate the flux of particulate wastes to these depositional zones.

According to DFO's SAR on finfish aquaculture (DFO, 2005), sites where fine particulates accumulate may be regions where ecological effects from nutrient and organic matter enrichment from all sources may be observed. Intertidal zones (and their algal communities) and deep water sinks may be such areas. The SAR also indicated that there may be far-field (>500 meters to local bay-scale) cumulative effects, such as increased dissolved nutrients, possible changes in macroalgal communities and increased sedimentation in areas where there are high densities of aquaculture operations.

Given these findings and the characteristics of the proposed site, it is considered likely that dissolved wastes will contribute to the total nutrient loading of the area and that an evolution of the macrophyte population could occur in areas adjacent to the farm sites. It is difficult to quantify the release of nutrients from fish farms as they are utilized very rapidly. Attempts to measure an increase in nutrients near farm sites in general have failed to show any elevation above background. Changes to the macrophyte species composition and abundance in other areas of intense aquaculture suggest that nutrient levels are increasing and being exploited by new species, but a direct causal link has not been established.

DEPOMOD

Question: Could DEPOMOD be used to answer the preceding questions?

As mentioned previously, DFO's SAR on finfish aquaculture reviewed the use of DEPOMOD to predict patterns of aquaculture waste sedimentation around finfish aquaculture sites (DFO, 2005). It was agreed that DEPOMOD could be a useful planning tool but that it should not be used in isolation. It was recommended that DEPOMOD be tested at additional sites that reflect the different environmental conditions in Canada. Such tests are currently being conducted in the Maritimes Region.

Using West Coast protocols, a carbon flux to the bottom could be determined using DEPOMOD or a similar model. At this time, these models address the initial deposition of feed and feces but do not address the resuspension and transport of wastes that could be a contributing factor to carbon loading in depositional zones. DEPOMOD is used to predict near-field settling of organic particles; nutrients leached from these particles are not considered. Nutrients released directly from fish effectively do not sink and DEPOMOD is not appropriate for far-field transport and dispersal issues in the near-shore where spatial gradients in currents can be significant.

Conclusions

Based on data supplied by the proponent, information provided by the Friends of Port Mouton, and data collected by DFO, it is expected that particulate material from the proposed site will have limited interaction with that produced by the existing farm. The presence of sills, the physical separation of the sites and the highly variable wind-driven currents make direct and consistent interaction between the sites unlikely. Resuspension of wastes initially deposited beneath the cages will likely depend on wave/current interaction to increase bottom stress to levels that can erode this material. No data has been provided to support this assumption, but the sediment data seems to suggest that the bottom at the proposed new farm is subject to reworking. Provided that the proposed operation adheres to all industry guidelines and departmental regulations, the accumulation of wastes below the farm site should remain within acceptable limits.

Dissolved wastes will be dispersed from both sites and will contribute to the total nutrient loading of the area. Although direct causal links have not been established, it is likely that the additional nutrients will be utilized by the macrophyte assemblage and could result in a change to the abundance or diversity of species present.

DEPOMOD or other similar models can be used to predict the initial deposition of fish farm wastes, but understanding of the processes that govern the resuspension of particulate wastes is lacking. Predicting the far field effects of aquaculture is an area that requires additional research.

More detailed analysis and/or comparison with analysis conducted by the Friends of Port Mouton would require conduct of a regional open peer review meeting.

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Sources of information

DFO, 2005. Assessment of Finfish Cage Aquaculture in the Marine Environment. Canadian Science Advisory Secretariat Science Advisory Report 2005/034.

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