SABLEFIN HATCHERIES LTD: POTENTIAL IMPACTS OF HATCHERY EFFLUENT ON EELGRASS BED.

REVIEW OF PROVIDED MATERIAL AND PERTINENT INFORMATION

Prepared for
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General introduction and background

Eelgrass beds are of considerable ecological importance to coastal and marine ecosystems, as they play a significant role in the processes and resources of nearshore coastal systems. The ecological value of eelgrass beds include a) the absorption of nutrients and hence the provision of large quantities of fixed carbon to coastal systems (Larkum et al. 1989); b) the stabilisation of bottom sediment (Fonseca and Kenworthy 1987) as they reduce current speed and facilitate sedimentation of particulate matter; c) the supply of shelter, breeding, and nursery grounds for adult and juvenile important commercial and recreational fisheries species (e.g. lingcod), as well as substrate for encrusting animals and plants; d) the provision of an essential food source to a number of herbivores; and e) the increase of biological and habitat diversity.

The distribution and growth of eelgrass is regulated by a number of key environmental factors such as temperature, salinity, nutrient availability, substratum characteristics, turbidity, and irradiance (Abal and Dennison 1996). Nutrient availability affects the growth, distribution, morphology and seasonal cycling of seagrass communities. In addition, eelgrass depends on an adequate degree of water clarity to sustain productivity (Short and WyllieEcheverria 1996). Increased turbidity and sedimentation reduce water clarity, which can affect the health and productivity of eelgrass communities (Abal and Dennison 1996).

Nutrient loading is the primary factor responsible for both a reduction in water quality and the stimulation of algal growth in coastal waters (Short and WyllieEcheverria 1996). As such, eutrophication – the result of nutrient addition to aquatic systems - has often been cited as a major cause for the decline of, or lack of recovery of, *Zostera* beds (Borum 1985; Wetzel and Neckles 1986; Shepherd et al. 1989; Short et al. 1995). In particular, high nitrate concentrations have been implicated in the loss of, and at times death of, mature *Z. marina* beds (Burkholder et al. 1992). Large increases in nitrate (N) availability are deleterious to eelgrass (Burkholder et al. 1992) primarily as the excess nutrients (often in the form of nitrate and/or ammonium) promote the proliferation of fast-growing, nitrogen-limited, opportunistic algal producers, including phytoplankton, epiphytes (Lapointe et al. 1994) and filamentous macroalgae (Duarte 1995; Short et al. 1995); species that compete with seagrass for light and can cause mostality by shading (Borum 1985; Wetzel and Neckles 1986; Shepherd et al. 1989; Burkholder et al. 1992; Short et al. 1995; Hauxwell et al. 2003). Such algal mats do not provide support to fish and other associated biota, equivalent to that of eelgrass ecosystems (Deegan et al. 2002).
Moreover, under conditions of high N availability, especially when ammonium is present, plant growth and survival can be curtailed as the plant is unable to down-regulate N uptake. This is due to direct ammonium toxicity (vanKatwijk et al. 1997), to the internal demand of energy needed for ammonium assimilation (Burkholder et al. 1992), which is diverted from growth and metabolism maintenance, as well as, probably in part, to a lack of inhibitory feedback mechanisms (Touchette and Burkholder 2000). With decreasing carbohydrate reserves, crucial for survival during periods of low light availability (Burke et al. 1996), the structural integrity of eelgrass deteriorates until it dies.
Under conditions of nutrient enrichment, levels of phenolic compounds are also often lowered, again possibly due to a reduction in available carbon within the plant (Buchsbaum et al. 1990). These compounds play an important role in providing *Zostera* with defences against infection, including wasting disease. Ultimately, loss of eelgrass habitat results in loss of productivity and species diversity.

Since seagrass restoration is difficult (Davis and Short 1997), simple but accurate indicators of incipient eelgrass decline due to nitrogen loading are needed. Routine monitoring of shoot density within meadows and, if possible, eelgrass bed area are recommended as depressed shoot recruitment and increased mortality seem to be important processes in eelgrass decline (Hauxwell et al. 2003).

Recommendations and clarifications

Page 2 of No. 2003-WAS-021(a): *"In its application for the Approval, Sablefin states that the characteristics of the effluent shall be equivalent to, or better than: 20 milligrams per*

litre of total suspended solids (TSS), temperature of 8 to 12 degrees Celsius, pH of 7.5 to 7.9, and a fecal colliform content of zero."
Due to the potential impacts of increased nitrate load on eelgrass habitat a range of "acceptable" nitrate concentration (as well as ammonium) should be included in the characteristics of the effluent. Moreover, the authorized TSS concentration highlighted in the text is misleading. Although on page 2 the text seem to indicate that TSS content is to be equivalent or better than 20 mg/L, text on page 3 states that the "*discharge is not to exceed 10mg/L above the TSS content in the source water supply*." Clarification is required whether the two requirements apply i.e. 10mg/L above source levels as well as a maximum of 20mg/L, or whether one supersedes the other. Should the latter be the case, clarification is required as to which one.

Page 7 "*…while the injection wells range in depth from 35 to 40 feet below the ground surface…"*
By injecting fish farm effluent into the ground via injection wells, a portion of the plume might be anaerobic due to dissolved organic carbon loading and its degradation by bacteria. This may have several impacts: 1) there is a risk of groundwater contamination, 2) due to potential anaerobic sediment conditions meio- and macrofauna might die, resulting in benthic species loss and sustained anoxic conditions, and 3) phosphorus may be released and move downstream as a result of anaerobic sediments (Krom and Berner 1980).
Unlike in the open water of Trincomali Channel, where upon impact the effluent will be diluted, nitrate levels in the sediment itself are likely to increase and anaerobic conditions may set in. These potential threats need to be addressed appropriately.

On October 12, 2004, in a letter to Rory Lambert, Sablefin Hatcheries Ltd. indicated that "*water leaving the injection wells towards the ocean travels for 100 meters through the subsurface zone."*
Is this travelling distance estimated? If so what are the assumptions that have led Sablefin Hatcheries Ltd. to reach this conclusion? In which direction are these 100 m 'being travelled', and are they likely to change as a result of changing tides, and/or seasons?

In this same letter, Sablefin Hatcheries Ltd. also point out that the total nitrogen output from the hatchery in four years time (i.e. at maximum output) will be equivalent to the waste produced by 10 cows (page 2). However, this estimate is to be **added** to the 8-10 cows that are currently grazing on Walker Hook – Hubbard in his Ecosystem Inventory of Polygon T0454 reports having seen 14. Thus total nitrogen loading will be equivalent to 20-24 cows.

It is further misleading to compare effluent values to influent values (see page 2 of the letter, 3rd paragraph). Total concentration in the water column is the value upon which impacts on surrounding biota are to be measured, with critical threshold values indicative of eelgrass preservation versus substantial decline, for example, often in the order of a few mg/L. Hence no matter how narrow the margin of additional input is, if the values are at, or above the indicated threshold, deleterious impacts on and/or loss of fauna and/or fauna are likely. It is important to highlight the fact that N load per se is of relatively little use on its own; ultimately it is the overall N loading, a measure of daily effluent rate and no. of days per year of operation, that are critical in assessing potential impact of the hatchery on the surrounding environment.

Beyond the scope of the potential impacts of the hatchery effluent on the eelgrass bed, possible adverse effects of both water intake from the aquifer as well as water discharge via the injection wells on the large tidal flat and associated salt marsh need to be considered. This is particularly important for two reasons: 1) the salt marsh/tidal flat is considered to be critical habitat for both shellfish and waterfowl. Any alterations to the present structure and fragile balance of this system may lead to a reduction in shellfish abundance and potential concurrent decline in waterfowl diversity; 2) recognising the significant bird and shellfish values, and the relatively little disturbed nature of the area to date, the entire spit/island/tidal flat complex was designated as a site of significance under the Canada/US Georgia Basin Ecosystem Initiative.

It is further recommended that baseline and monitoring studies be undertaken for the tombolo as well as for the surrounding marine habitats, in order to ensure that the areas are not impacted in the long term.

Additional information requirements

In order to adequately determine potential impacts to the eelgrass bed off Walker Hook the following information is required:

1. Estimate of seagrass bed surface area
2. Estimated nitrogen load to Trincomali Channel as a result of Sablefin activities in kg N ha^{-1} yr^{-1}; estimated total nitrogen load in same units to Trincomali Channel (i.e. including Maliview[1]. A review of the literature seems to indicate that nitrogen loads of <28 to 63 kg N ha^{-1} yr^{-1} allow for seagrass survival, whereas loads of 50 to 100 kg N ha^{-1} yr^{-1} lead to substantial losses (i.e. >50%) of seagrass.
   These estimates are required for **maximum predicted output** of the hatchery, which was found to vary between 2 million and 10 million fish.
3. Similarly estimates of total TSS are needed, again for **maximum predicted output** of the hatchery. When effluent with a high amount of TSS is released into the marine environment, high levels of ammonia are generated as a result of bacterial action on the solid organic material. A common technique to reduce the organic load of fish effluent is to add a coagulating or flocculating agent to the effluent which will cause the organic material to form a sludge, or flocculent, that can be collected and processed separately.
4. Is there any backup system to the 37 micron filter?
5. Direction of the effluent once it leaves the subsurface environment and enters the water column. Is it, and if so how, impacted by tides and seasons (i.e. current velocity, tidal exchange, water column stratification)?
6. What are the likely impacts of the effluent on sediment habitat benthic community?
7. What are the chemicals likely to be used in the hatchery?
8. What feeds will be used in the hatchery?
9. A copy of the "Lowen report"

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[1] Alternatively an indication of flow rate, nitrogen load *and no. of days per year of operation*. Here again the estimates for daily flow rates and concentration of N are needed for maximum predicted output of fish (Appeal No. 2003-WAS-021(a) states 619 m^3 – is this correct?).

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