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Near-Field Depositional Model for Salmon Aquaculture Waste

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Abstract An analytical near-field depositional model for solids wastes (organic matter from waste feed and faeces) from open net pen culture of finfish is presented. The model is based on the premise that the statistics of the depth-averaged currents, which are assumed to be normally distributed, determine the distribution of wastes on the ocean bottom. Using a farm configuration consisting of a single net pen, the model is used in a diagnostic mode to quantitatively examine the effects on the waste depositional field or footprint of the farm that result from changing the depth under the net pens and changing the statistics (standard deviations) of the depth-averaged velocity. The model is also used to examine the changes to the farm footprint that result from orientating a two by four linear grouping of net pens perpendicular to and parallel to the principle current direction. The model was tested on an operating Atlantic salmon farm by comparing the predicted organic matter fluxes from the farm with the vertical fluxes of organic matter measured by sediment traps. Based on a rather limited data set, predicted organic

matter fluxes were found to be about four to five times higher than observed sedimentation rates. Further, the model predictions were sensitive to the value used for feed waste. The limitations and uncertainties in the model assumptions, parameterizations and in the methodologies used to validate the model are discussed and recommendations for future research are provided.

Keywords Aquaculture · Model · Solid wastes · Sedimentation

1 Introduction

There exists a range of environmental impacts resulting from the culture of salmon in open net cages in the marine environment. The impacts occur over a range of space and time scales and include alterations to ecosystems caused by the enhanced release of nutrients and carbon to the water column, organic wastes to the sediments, discharge of contaminants, theraputants and cross-transmission of pathogens and parasites [1]. One of the most conspicuous impacts of open net cage fish farms is on the sediment geochemistry and benthic fauna underneath and in the immediate vicinity of net cages – the near-field environment [2, 3]. Benthic impact typically results from the enhanced sedimentation of organic-rich wastes (faeces and waste feed) from the farm. The degree of impact to the benthic community and habitat is influenced by a combination of factors such as production levels, feed characteristics (including ingredient composition and digestibility as well as physical characteristics such as pellet length and diameter, etc.), feeding efficiency, bathymetry, circulation, and the assimilative capacity of the benthic environment.

Mathematical or numerical models describing the distribution and impact of solid wastes from marine salmon farms can be useful tools for the management, monitoring and study of the aquaculture industry and its impacts. Firstly, the models can aid in the selection of suitable locations, in the configuration of the net pen structures, or in setting site-specific production limits. Secondly, because the models map both the shape and size of the depositional field of the farm wastes or footprint of the farm at any stage of the production cycle, they can assist in the design of monitoring schedules and selection of monitoring sites. Since high-resolution spatial grid sampling is technically difficult and expensive to accomplish, model footprints can aid in targeting transects of organic enrichment gradients. Finally, the models can be used as research tools by helping to identify and understand the key processes responsible for a wide range of impacts associated with the open pen culture of salmon.

Modelling the changes in sediment chemistry and benthic impact caused by the organic-rich waste solids from marine salmon farms is complex and