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Comparing natural and mussel farm-derived fluxes of carbon and nitrogen in the Firth of Thames, New Zealand

John Zeldis

National Institute of Water and Atmospheric Sciences (NIWA), Christchurch, New Zealand (j.zeldis@niwa.co.nz / Fax: +63 03 348 5548 / Phone: +63 03 348 8987)

The Firth of Thames, a large embayment of the Hauraki Gulf in northeastern New Zealand, currently supports the largest block of mussel aquaculture farms in the country. Additional developments proposed for the Firth would increase current activity 7-fold, with potential total harvest >60 000 t green weight $y^{-1}$and farms occupying 3.3 % of Firth surface area. The sizes of these developments make it important to predict their environmental impacts at the Firth-wide scale. This study used water, salt and nutrient mass-balance modelling and primary production estimates to evaluate Firth system carbon (C) and nitrogen (N) gains and losses through fixation, respiration, denitrification, and export. These results were compared with mussel biomass, C and N composition, and weight-specific respiration, to evaluate the importance of mussel aquaculture within the Firth ecosystem. Firth primary production was ∼180 000 t C y^{-1} and respiration was ∼240 000 t C y^{-1}. Denitrification was ∼11 000 t N y^{-1}. Current mussel harvest removes 0.2% of Firth C primary production y^{-1}, increasing to 1.6% y^{-1} at projected maximum farm development. Mussel C respiration accounted for 0.3 and 1.8% of Firth respiration, under these respective scenarios. At maximum development, ∼1.4% of Firth fixed N would be removed by the harvest. This was about 2.8% of the size of the denitrification sink. At maximum development, phytoplankton biomass would be reduced by 16% over 10% of the Firth, which approaches a currently applied regulatory criterion that phytoplankton depletion by Firth mussel farms should not exceed 20%, over 10% of the Firth. This finding was consistent with other dynamical modelling of phytoplankton depletion around these farms.