Aquaculture Backgrounder
By: Inka Milewski

Finfish

Most marine finfish (e.g., salmon) and shellfish (e.g., mussels and oysters) aquaculture takes place in open net or culture systems in sheltered bays and estuaries. Wastes are discharges directly into the environment. Wastes from finfish and shellfish aquaculture operations can, under certain oceanographic condition (e.g., low bottom current velocity, water column stratification and low tidal exchange), accumulate on the seabed directly under farm sites. In the case of finfish aquaculture, waste discharges include excretory compounds, feces and uneaten food. For shellfish aquaculture, wastes discharges includes excretory compounds, feces and pseudofeces.

The amount of excretory and fecal wastes produced by fishes varies with species and type of food eaten. For example, more N is excreted when moist pellets dominate the diet and N excretion decreases when the fat content is increased and protein is decreased (Johnson et al. 1993). The major component of fish fecal waste, by weight, is suspended organic solids. Suspended solids are subject to bacteria action in the water column and when they settle on the seafloor. This biodegradation results in the release of ammonia as well as other compounds.

Fish excretory products include ammonia, urea, creatine and creatinine (Bergheim and Åsgård 1996). Ammonia, or TAN (Total Ammonia Nitrogen), is the main excretory product in bony (teleost) fishes. Ammonia and urea are excreted across the gills. N excreted via the kidneys represents a very small fraction of the total ammonia and urea produced. TAN can represent 75-90% of the total nitrogenous waste from fishes (Dosdat et al. 1996). Below is a range of estimates for total nitrogen (TN) produces by various species in a fish farm setting.

Reference	**Species**	**Total Nitrogen produced per metric tonne of fish produced** (kg N/mt)
Bergheim and Åsgård 1996.	Atlantic salmon	30
Dosdat et al. 1996	Sea bass	74
Dosdat et al. 1996	Turbot	67

Dosdat et al. 1996	Brown trout	43
Dosdat et al. 1996	Rainbow trout	72
Strain et al. 1995	Atlantic salmon	33
Sowles 2001	Atlantic salmon	40 - 60 (range based on dry *vs*. wet feed)
DFO 2003	Atlantic salmon	32
Davies and Slaski 2003	Atlantic halibut	48

References

Bergheim, A and T. Åsgård. 1996. Waste Production from Aquaculture, pp. 50-80. *In*: D.J. Baird, M.C.M. Beveridge, L.A. Kelly and J.F. Muir (eds.) Aquaculture and Water Resource Management. Blackwell Science, U.K.

Chapelle, A., Ménesguen, A., Deslou-Paoli, J.-M., Souchu, P., Mazouni, N., Vaquer, A., and B. Millet. 2000. Modelling nitrogen, primary production and oxygen in a Mediterranean lagoon. Impact of oyster farming and inputs from the watershed. Ecological Modelling 127(2-3): 161-181.

Chamberlain, J., Fernandes, T.F., Read, P., Nickell, T.D., and I.M. Davies. 2001. Impacts of biodeposits from suspended mussel (*Mytilus edulis* L.) culture on the surrounding surficial sediments. ICES Journal of Marine Science 58:411-416

Christensen, P. Bondo and Glud, R.N. Dalsgaard, T., and P. Gillespie. 2003. Impacts of longline mussel farming on oxygen and nitrogen dynamics and biological communities of coastal sediments. Aquaculture 218:567-588.

Cranford, P., Dowd, M., Grant, J., Hargrave, B., and S. McGladdery. 2003. Ecosystem level effects of marine bivalve aquaculture, pp 51-95. *In* Fisheries and Oceans Canada (ed.) A scientific review of the potential environmental effects of aquaculture in aquatic ecosystems. Volume I. Can. Tech. Rep. Fish. Aquat. Sci. 2450: ix +131p.

Dalhbäack B. And L.Å.H. Gunnarsson. 1981. Sedimentation and sulfate reduction under a mussel culture. Marine Biology 63: 269-275.

Dankers, N., and D.R. Zuidema. 1995. The role of the mussel (*Mytilus edulis* L.) and mussel culture in the Dutch Wadden Sea. Estuaries 18(1A): 71-80.

Davies, I.M. and R.J. Slaski. 2003. Waste production by farmed Atlantic halibut (*Hippoglossus hippoglossus* L.). Aquaculture 219: 495-502.

Deslou-Paoli, J.-M., Souchu, P., Mazouni, N., Juge, C., and F. Dagault. 1998. Relationship between environment and resources: impact of shellfish farming on a Mediterranean lagoon (Thau, France). Oceanologica Acta 21(6): 831-843.

Department of Fisheries and Oceans (DFO), Science Branch, Maritimes Region. 2003. Salmon holding capacity in southwestern New Brunswick. Can. Tech. Rep. Fish. Aquat. Sci. 2489: *iv* + 60 p.

Dosdat, A., Sevais, F., Métailler, R., Huelvan, C. And E. Desbruyères. 1996. Comparison of nitrogenous losses in five teleost fish species. Aquaculture 141: 107-127.

Hatcher, A., Grant, J. And B. Schofield. 1994. Effects of suspended mussel culture (*Mytilus* spp.) on sedimentation, benthic respiration and sediment nutrient dynamics in a coastal bay. Marine Ecology Progress Series 115:219-235

Haven, D.S. and R. Morales-Alamo. 1966. Aspects of diodeposition by oysters and other invertebrates filter feeders. Limnology and Oceanography 11:487-498

Hayakawa, Y., Kobayashi, M., and M. Izawa. 2001. Sedimentation flux from mariculture of oysters (Crassostrea gigas) in Ofunato estuary, Japan. ICES Journal of Marine Science 58:435-444.

Johnsen, F., Hillestad, M., and E. Austreng. 1993. High energy diets for Atlantic salmon. Effect on pollution. pp. 51-63. *In:* C.B. Crowy and C.Y. Cho (eds.) Nutritional Strategies and Aquaculture Waste. Proceedings of the First International Symposium on Nutrition Strategies in Management of Aquaculture Waste. University of Guelph, Ontario Canada, 1990. *cited in*: Bergheim and Asgard 1996.

Kaspar, H.F., Gillespie, P.A., Boyer, , I.C. and A.L. MacKenzie. 1985. Effects of mussel aquaculture on the nitrogen cycle and benthic communities in Kenepuru Sound, Marlborough Sounds, New Zealand. Marine Biology 85:127-136.

Lavoie, R. E. 1995. Culture of the American oyster, *Crassostrea virginica*, pp. 189-224. *In* A.D. Boghen (ed.) Cold-Water Aquaculture in Atlantic Canada. Second Edition. Canadian Institute for Research and Regional Development. Moncton, New Brunswick.

Nixon, S.W. 1981. Remineralization and nutrient cycling in coastal marine ecosystems. In: Neilson, B.J. Cronin, L.E. (Eds.) Estuaries and nutrie\nts. Humana Press, Clifton, NJ. *cited in* Hatcher et al. 1994.

Pietros, J. Mugg and M.A. Rice. 2003. The impacts of aquacultured oysters, *Crassostrea virginica* (Gmelin, 1791) on water column nitrogen and sedimentation: results of mesocosm study. Aquaculture 220: 407-422.

Souchu, P., Vaquer, A., Collos, Y., Landrein, S., Deslous-Paoli, J., and B. Bibent. 2001. Influence of shellfish farming activities on the biogeochemical composition of the water column in Thau Lagoon. Marine Ecology Progress Series 218: 141-152.

Sowles, J. 2001. Nitrogen in the Gulf of Maine: Sources, susceptibility and trends. 1-13 pp. *In:* 2001: Managing nitrogen impacts in the Gulf of Maine. NOAA/UNH Cooperative Institute for Coastal and Estuarine Environmental Technology, Gulf of Maine Council on the Marine Environment, and NOAA, National Ocean Service.

Strain, P.M., D.J. Wildish, and P.A. Yeats. 1995. The Application of Nutrient Loading and Oxygen Demand to the Management of a Marine Tidal Inlet. Marine Pollution Bulletin 30(4) 253-261.