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The aquaculture industry needs new cost-effective solutions for removing effluent nitrogen to reduce their environmental impact. Recent studies have shown that laboratory and pilot-scale woodchip bioreactors can remove nitrate from aquaculture effluent. Encouraged by these results, several Danish fish farmers recently constructed commercial scale woodchip bioreactors prior to- or integrated into existing free water surface constructed wetlands without knowing the effects of design and upscaling on removal performance. The objective of the current study was to monitor initial performance (first 28–52 weeks of operation) of three such custom-designed denitrifying woodchip bioreactors installed in full-scale (350, 650, and 1250m³ woodchips) for effluent treatment at three commercial recirculated rainbow trout (Oncorhynchus mykiss) farms.

All three woodchip bioreactors removed nitrogen (essentially nitrate-nitrogen) continuously from the start and at relatively stable rates (5.3–8.5 g N/m³/d; 4.5–7.8 g NO₃-N/m³/d) during the investigation period. Leaching of dissolved organic matter continued for up to half a year whereas there was no similar leaching of dissolved phosphorus. A net production of dissolved organic matter was observed under nitrate-limited conditions in one of the bioreactors characterized by a loading of 5.5 compared to 16.4–16.8 g NO₃-N/m³/d at the other sites, and an empty bed contact time (EBCT) of 26 h compared to 15–16 h at the other sites. An increase in water level difference between inlet and outlet indicated that accumulation of particulate organic matter and associated bacterial growth may lead to head loss potentially reducing the long-term performance of the bioreactors. In conclusion, the study confirms that woodchip bioreactors can be applied at full-scale for removing NO₃-N from fish farm effluent. Woodchip bioreactors should be designed to minimize head loss and the risk of clogging, and loading and retention time should ensure that denitrifiers do not become nitrate-limited.