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THE EVALUATION OF FISH FARMING IMPACT BY NUTRIENT CONTENT AND CHLOROPHYLL A IN MALA LAMLJANA BAY

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Abstract - This paper offers a brief review of the impacts of fish farming on the nutrient content and chlorophyll a in Mala Lamljana Bay, Croatia. Local loading of nitrogen and phosphorous compounds in fish farms can be very significant and can represent the largest source of N and P in a given area. Low N and P concentrations, low chlorophyll a concentration and a great variety of phytoplankton species were found in the bay, despite the high nutrient loading during the long history of farming in the bay. The phytoplankton community consisted mostly of diatoms and partly of dinoflagellates. *Skeletonema costatum* and *Chaetoceros compressus* were the dominant species (90%) in summer chlorophyll, which is typical for Middle Adriatic oligotrophic coastal waters. Nevertheless, further studies are required to determine changes in water column factors and planktonic communities in this area.

Keywords: Fish farm, cages, nutrients content, chlorophyll a, phytoplankton species

INTRODUCTION

Intensive fish farming produces considerable amounts of nutrient waste in a dissolved form (Bergheim and Asgard, 1996). Anthropogenic nitrogen loading in marine waters is acknowledged as the principal cause of degradation and alteration to coastal ecosystems worldwide (Seitzinger and Sanders, 1999; Wu, 1999). In good water conditions, a high content of nutrients, especially phosphorus and nitrogen compounds, will stimulate primary production and can lead to phytoplankton blooming especially during the summer, when the temperature rises (Enell and Lof 1989). Some authors (Lee and Jones, 1979; Schindler, 1979) were not able to confirm such a clear relationship between nutrient levels and primary production, while others (Gowen and Ezzi, 1992) found that nutrient enrichment stimulated phytoplankton growth when a particular nutrient was the limiting factor of phytoplankton growth. Nutrient discharges from fish farms can be determined retrospectively, simply and with a high degree of accuracy from records of fish production and feed conversion ratios and food composition. Prospective prediction of the inputs on a daily basis and over a longer period would represent a valuable management tool for farmers, as well as for regulatory and planning authorities (Einen et al., 1995).

The aim of this paper is to give a brief review of the impacts of fish farming on nutrient content and chlorophyll a in Mala Lamljana Bay, Croatia.

MATERIALS AND METHODS

The fish farm is located in the Mala Lamljana Bay on the island of Ugljan, Croatia. It is a relatively sheltered (1,800 m long and 714 m wide) and shallow (37 m deep) bay. Currents are predominantly tidally driven to the NW, and the bay is well protected from the predominant NE and SW winds. Sediments are predominantly sandy, with some isolated muddy

Table 1. The temperature, total fish biomass and total food added in the fish farm.

	Total fish biomass (t)	Total food (t)	Temperature (°C)
January	93	25	12.7
February	102	22	11.5
March	107	12	10.8
April	111	13	13.0
May	117	27	16.3
June	127	27	19.7
July	145	51	21.8
August	167	53	23.0
September	190	60	[illegible]
October	207	39	19.6
November	222	29	17.5
December	231	19	15.2

Table 2. The concentrations of phosphates (mg/l) and nitrates (mg/l) in water samples taken from sites S1 and S3 at 3 m and 10 m depths.

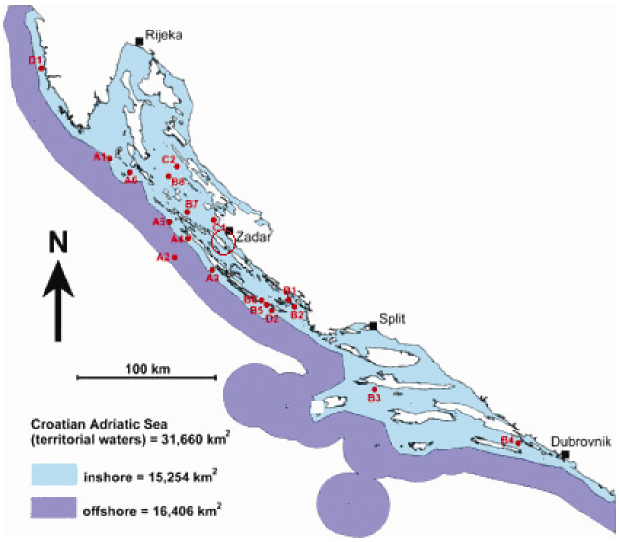
DATE	PHOSPHATES (mg/l)				NITRATES (mg/l)			
	S1		S3		S1		S3	
	3m	10m	3m	10m	3m	10m	3m	10m
24/02	0.012	0.010	0.010	0.008	[illegible]	0.009	0.011	0.011
05/04	0.010	0.014	0.014	0.012	[illegible]	0.024	0.024	0.022
29/04	0.011	0.018	0.013	0.013	0.011	0.010	0.012	0.012
02/06	0.014	0.014	0.024	[illegible]	0.014	0.013	0.013	0.011
30/06	0.015	0.017	[illegible]	0.017	0.013	0.012	0.012	0.013
29/07	0.020	0.026	0.024	0.028	0.010	0.012	0.010	0.015
26/08	0.011	0.029	[illegible]	0.011	0.011	0.091	0.010	0.010
29/09	0.013	[illegible]	0.016	0.015	0.022	0.017	0.010	0.012
27/10	0.014	[illegible]	-	-	0.021	0.014	-	-
17/11	0.020	0.016	-	-	0.013	0.027	-	-
14/12	0.015	0.020	-	-	0.019	0.020	-	-

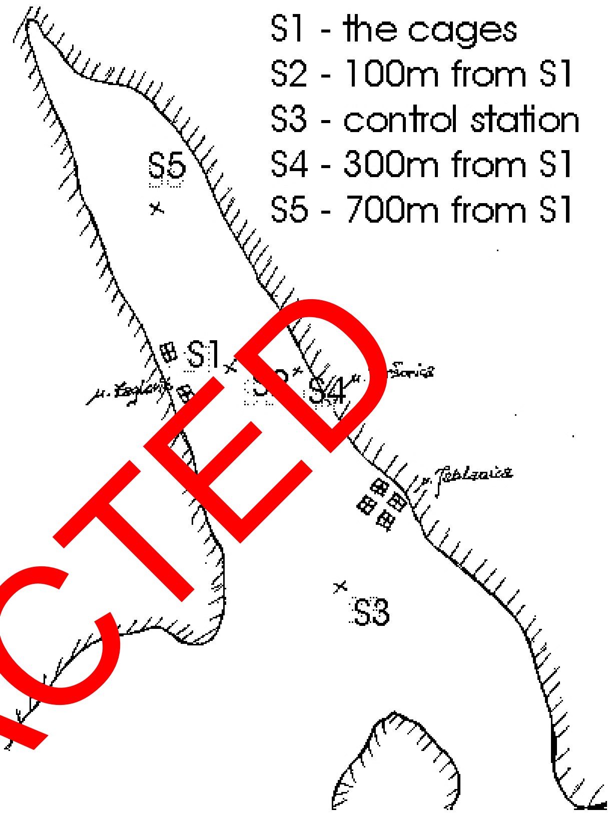
Table 3. Chlorophyll a at S1.

CHLOROPHYLL A (mg/m^3)			
Depth	May	June	July
0 m	0.30	0.59	0.95
5 m	0.28	0.42	0.76
10 m	0.24	0.37	0.59
Bottom	-	0.25	0.40

Table 4. Chlorophyll a (mg/m^3) at three different sampling sites and at three different depths on June 6th.

CHLOROPHYLL A CONTENT (mg/m^3)			
Depth	S2	S3	S5
0 m	0.59	0.28	0.66
5 m	0.42	0.39	0.48
10 m	0.37	0.34	0.51
Bottom	0.25	0.14	-





zones (below the cages). Pilot scale production started in 1981. The main farmed species is sea bass (*Dicentrarchus labrax* L.), which represents 90% of the produced population. Average fish production is 2[illegible] tons per year and average food consumption is 52 tons per year. It was estimated that 3.8 t of phosphorus and 29.3 t of nitrogen were added to the water in one year. The fish were reared in rectangular cages (10m x 10m x 5m). The depth below the cages varied from 15 m to 30 m. Fish density in the cages was 12 kg/m³. Standard oceanographic methods for N and P analyses were used (Grasshoff, 1976). Water samples were taken at two sites (S1 – in the cages and S3 – a control site at the entrance of the bay), and at two depths (3 m and 10 m). The standard fluorescence method was used to estimate the concentration of chlorophyll a (Holm-Hansen, Lorenzen, Holmes and Strickland, 1965). Water samples were taken in four different sampling sites (S1 – in the cages; S2 – 100 m from the cages; S3 – control site; S5 – 700 m from the cages) and at five different depths (0m, 3m, 5m, 10m and the bottom).

RESULTS AND DISCUSSION

Table 1 gives the temperature, total fish biomass and total food added in the fish farm in one year. Table 2 provides the nutrient content in the water. The contents of nutrients were relatively low. The maximum 0.029 mg/l was found in S1 on 26th of August and 0.128 mg/l in S3 on 29th of July. Nitrate concentrations were also constantly lower than 1 mg/l for both depths and for both sites. Table 3 gives the results of chlorophyll a content (mg/m³) in water samples taken from May to July at sampling station S1 (the cages) at four different depths (0m, 5m, 10m, the bottom). The phytoplankton biomass slightly increased from May to July, but it was lower than 1 mg/m³.

The results of chlorophyll a in water samples taken from three different sampling sites (S2 – 100 m from the cages; S3 – control site; S5 – 700 m from the cages), and at four different depths (0 m, 5 m, 10 m, the bottom) are given in Table 4. The samples were taken at 13.00 h on June 6th. The phytoplankton biomass was low in all samples. The phytoplankton community consisted mostly of diatom and partly of dinoflagellates. *Skeletonema costatum* and *Chaetoceros compressus* were the dominant species (90 %) in summer chlorophyll. This is a typical phytoplankton community for Middle Adriatic oligotrophic coastal waters (Marasovic and Pucher Petkovic, 1991).

According to the obtained results (low nutrient content in the water, low chlorophyll a and phytoplankton community composition), it can be concluded that the water in the bay did not show any signs of eutrophication, despite high nutrient loading during a long history of farming in the bay. The degree of nutrient enrichment is influenced by the scale of aquaculture, local hydrographic characteristics, the magnitude of other sources relative to aquaculture and internal processes, such as uptake by phytoplankton, algae, internal recycling, resuspension of fine material, and uptake by biofouling communities that colonize net pens (Hargrave, 2001). The effects of eutrophication may extend into shallow-water littoral and intertidal zones. Intertidal areas, subject to daily movements of water and sediment, are locations influenced by broad-scale processes affecting chemical fluxes of mass and dissolved material throughout an inlet system (Hargrave, 2001).

Further studies are required to determine changes in water column factors and planktonic communities in this area. In comparison to benthic studies, there have been very few investigations of changes in planktonic communities in the bay.

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