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SEDIMENTATION AND COMPOSITION OF PARTICULATE MATTER IN A MARINE FISH FARM (GULF OF TRIESTE, NORTHERN ADRIATIC); PRELIMINARY RESULTS

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ABSTRACT

Composition and sedimentation of particulate matter was determined in a fish farm of the Slovenian coastal sea. The average sedimentation rates of TPM, POC and TPN measured in the farm were higher than those on the control site due to food supply to fish and organic waste from fish farming activity. The impact of fish feeding was also evident from the isotopic ($\delta^{15}\text{N}$ values) and elemental composition (C and N) of sedimented material with higher values in the fish farm area. Changes in composition of particulate matter and sedimentation fluxes were related to feeding regime during the year and seasonal characteristics of the water column.

Key words: fish farming, elemental composition, $\delta^{15}\text{N}$, sedimentation rate, northern Adriatic

SEDIMENTAZIONE E COMPOSIZIONE DI MATERIA PARTICELLATA IN UN ALLEVAMENTO MARINO DI PESCI (GOLFO DI TRIESTE, ADRIATICO SETTENTRIONALE); RISULTATI PRELIMINARI

SINTESI

La composizione e la sedimentazione della materia particellata sono state determinate ad una profondità di otto metri in un allevamento di pesci in acque costiere della Slovenia. I tassi medi di sedimentazione di materia particellata totale (TPM), carbonio organico particellato (POC) e azoto particellato totale (TPN) sono risultati maggiori di quelli rilevati nel sito di controllo, a causa del mangime per pesci. L'impatto del nutrimento di pesci è risultato evidente anche dalla composizione isotopica (valori $\delta^{15}\text{N}$) ed elementare (C, N) del materiale sedimentato, con valori maggiori nell'area dell'allevamento ittico. Variazioni stagionali della materia particellata e flussi di sedimentazione sono stati correlati al regime alimentare durante l'anno e alle caratteristiche stagionali della colonna d'acqua.

Parole chiave: allevamento di pesci, composizione di elementi, tasso di sedimentazione, Adriatico settentrionale

INTRODUCTION

The northern Adriatic is an area under significant impact of fish farming activity, which influences the marine environment. Environmental impact is mostly caused by the supply of unconsumed food and fish feces (Hargrave *et al.*, 1993) leading to high sedimentation rates and consequently to anoxic sediments and impoverishment of benthic fauna (Duplisea & Hargrave, 1996; Mazzola *et al.*, 1999; Karakassis *et al.*, 2000). The water quality is affected both by particulate and solute waste (Pitta *et al.*, 1999), which can influence the phytoplankton growth (Frid & Mercer, 1989; Arzul *et al.*, 1996).

This work is part of a larger study (EU/BIOFAQs project) to investigate the efficiency of biofilters as reducers of negative impacts of marine cage aquaculture. Our study has been carried out in 2001 to determine the seasonal changes in sedimentation fluxes and composition of particulate matter in the fish farm area in comparison to the selected control point.

MATERIALS AND METHODS

The investigated fish farm Lera d.o.o. is one of the two Slovenian farms situated in the coastal waters of Bay of Piran – Gulf of Trieste (northern Adriatic) (Malačić & Forte, *this volume*). The fish (*European Sea-bass*) were fed commercial pelleted fish food (Marico Start Premium). The food input increased from January to spring and with minor deviation at a high level during the summer, followed by a continual decrease until the following spring.

Four arrays of bio-filters were moored along square cages at a distance of approximately 3 m, and this area was selected as a sampling site (Plate 1: Fig. 1). On the horizontal array of bio-filters, cylindrical sediment traps with diameter of 7 cm and an aspect ratio of 7 were mounted at depth of 8 m (Fig. 1) to collect sinking particles. Sediment traps were designed to collect four samples simultaneously and were deployed for 24 hours. Similarly, the sedimentation rates were also measured on control site (CL) including control arrays that were deployed approximately 150-200 m from cages in SE direction. During 2001, four samplings were carried out in July, August, September and November.

After the collection, three aliquots of homogenized suspension from two cylinders at each locations were filtered through precombusted Whatman GF/F glass micro-fibre filters. All samples were freeze-dried for 24 hours and weighed. Dried samples were used for analysis of total suspended matter (TSM), particulate organic carbon (POC), total particulate nitrogen (TPN) and isotopic composition (^{13}C and ^{15}N). Total particulate matter was determined gravimetrically. Organic carbon (POC) and total particulate nitrogen (TPN) analyses of the freeze-dried and acid-washed samples (Hedges & Stern,

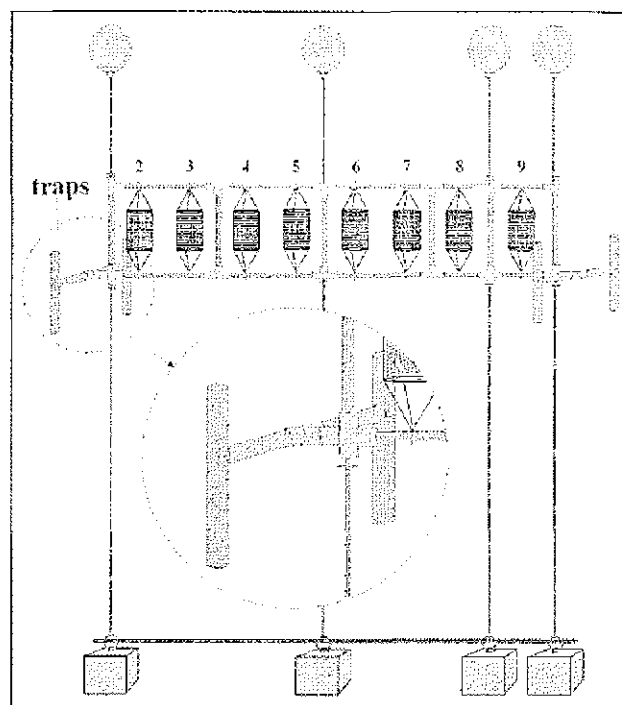


Fig. 1: Scheme of biofilters arrays showing the deployment of sediment traps.

Sl. 1: Shematska predstavitev sistema umetnih substratov (biofiltrrov) ter postavitev sedimentnih pasti.

1984) were performed with Carlo Erba elemental analyser 1108. Analyses of the ^{13}C and ^{15}N isotopic composition of the freeze-dried samples were performed with a Europa 20-20 (Europa Scientific) mass spectrometer. Stable-isotope ratios were expressed in δ notation as parts per mil (‰) according to the following relationship:

$$\delta X = [(R_{\text{sample}}/R_{\text{standard}}) - 1] \times 10^3$$

where X is ^{13}C or ^{15}N and R is the corresponding ratio $^{13}\text{C}/^{12}\text{C}$ or $^{15}\text{N}/^{14}\text{N}$. Standards for ^{13}C and ^{15}N are V-PDB and atmospheric N_2 (air), respectively.

RESULTS AND DISCUSSION

The results of elemental composition of sedimented total particulate matter (TPM) from sampling (SL) and control (CL) sites are presented in Table 1. In accordance with our expectations, the material collected in the traps deployed along the fish cages at a depth of 8 m had a higher portion of organic carbon (POC) and total particulate nitrogen (TPN) in comparison to the control site. This enrichment in organic carbon and total nitrogen of particulate matter of SL indicates a contribution of organic waste from partially degraded or uneaten fish food containing high content of organic carbon and nitrogen (Marico Start Premium: 44% C and 9% N). How-

ever, the differences between two sites were more evident during the summer samplings indicating more intense feeding regime of fish.

Tab. 1: Average $\delta^{15}\text{N}$ (‰) values and elemental composition of the sedimented particulate matter at sampling (SL) and control (CL) sites expressed as a percentage of total particulate matter (TPM).

Tab. 1: Povprečne vrednosti $\delta^{15}\text{N}$ (‰) in elementna sestava sedimentirane suspendirane snovi na vzorčišču (SL) in kontrolni postaji (CL), izražena kot odstotek celotne suspendirane snovi (TPM).

	SEDIMENT TRAP SAMPLES							
	Sampling site (SL)				Control site (CL)			
	Jul	Aug	Sep	Nov	Jul	Aug	Sep	Nov
POC (%)	5.95	11.95	2.76	3.39	2.02	8.11	2.15	2.71
TPN (%)	0.71	1.39	0.38	0.51	0.31	1.15	0.31	0.43
C/N (at.)	9.96	10.05	8.36	7.74	7.68	8.08	8.05	7.34
$\delta^{15}\text{N}_{\text{air}}$ (‰)	7.6	6.3	4.6	4.7	5.8	5.6	1.1	4.6

The average sedimentation rates of TPM, POC and TPN (Figs. 2, 3, 4) reveal higher values on station SL. The same trend, but with higher values, has already been reported for another Slovenian fish farm in the Gulf of Trieste using bottom traps (Kovač *et al.*, 2001). This is in accordance with general observation that the quantity of trapped material increases with depth (Hargrave & Taguchi, 1978). Sedimentation rates of particulate organic carbon determined in July, August, September and November in fish farm were by about 67%, 78%, 48% and 24% higher than those measured at control point. The same was observed for the sedimentation rates of TPN. However, greater differences between both sites during the summer probably result from a higher rate of food addition in this period. The $\delta^{15}\text{N}$ average values of sedimented material at SL also indicated higher supply of fish food and feces during the summer (average 7.0‰) and greater impact of the sediment in the autumn (4.7‰). Comparison of $\delta^{13}\text{C}$ of sedimented matter does not show significant differences, indicating that this parameter is not very suitable for this kind of study (Kovač *et al.*, 2001).

Additionally, the seasonal characteristics (physical, biological) of the water column influenced sedimentation and composition of particulate matter. The late autumn period was characterized by an increased significance of land material (fresh-water supply), resuspension and grater mixing of water body. In the summer period, the greater stability of stratified water column with an impact of sedimented phytoplankton material to sedimented matter was determined.

Compared to data from control site, where all measured values were lower, the composition and sedimentation of particulate matter from fish farm highly reflects the impact of organic material from the fish farming activity (mostly fish food and waste).

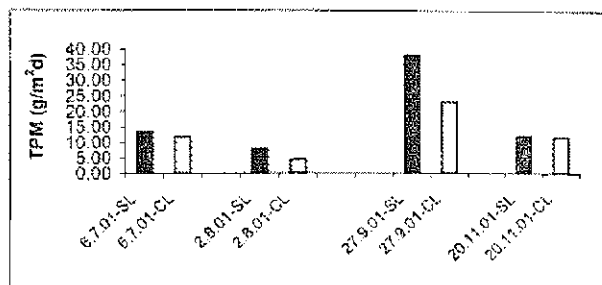


Fig. 2: Sedimentation rate of total particulate matter. Sl. 2: Hitrost sedimentacije celotne suspendirane snovi.

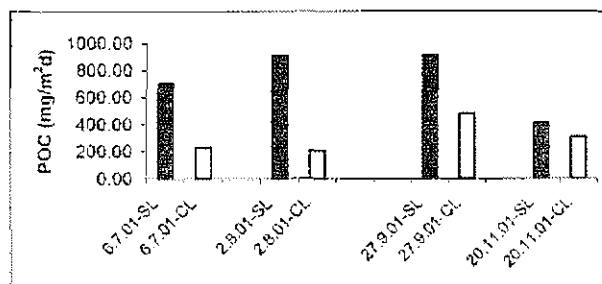


Fig. 3: Sedimentation rate of particulate organic carbon. Sl. 3: Hitrost sedimentacije suspendiranega organskega ogljika.

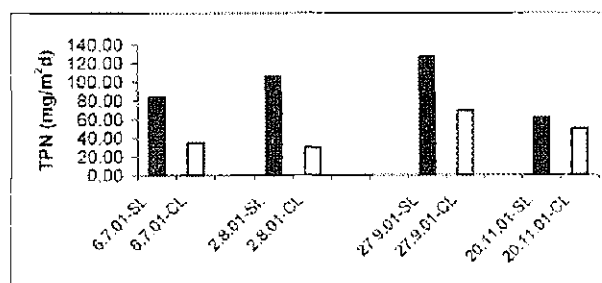


Fig. 4: Sedimentation rate of total particulate nitrogen. Sl. 4: Hitrost sedimentacije celotnega suspendiranega dušika.

SEDIMENTACIJA IN SESTAVA SUSPENDIRANE SNOVI V OBMOČJU RIBOGOJNICE
(TRŽAŠKI ZALIV, SEVERNI JADRAN); PRELIMINARNI REZULTATI

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POVZETEK

V slovenskem obalnem morju smo v območju ribogojnice ugotavljali sestavo in sedimentacijo suspendirane snovi. Izmerjene povprečne sedimentacijske hitrosti celotne suspendirane snovi, suspendiranega organskega ogljika in celotnega suspendiranega dušika so bile v območju gojišča višje od vrednosti, dobljenih za kontrolno postajo, zaradi prispevka organske snovi, povezane s samo aktivnostjo gojenja (hrana za ribe, feces rib). Velik vpliv hranjenja rib kažejo tudi rezultati izotopske (predvsem $\delta^{15}\text{N}$ vrednosti) in elementne analize (C in N) sedimentirane snovi. Spremembe pa niso odvisne le od letne sheme hranjenja rib, marveč tudi od sezonskih značilnosti vodnega stolpca.

Ključne besede: ribogojnica, elementna sestava, $\delta^{15}\text{N}$, hitrost sedimentacije, severni Jadran

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