EVALUATION OF FLOATING VEGETATED SYSTEMS TO REDUCE THE EFFLUENT LOADS FROM CHANNEL RAINBOW TROUT (*Oncorhynchus mykiss*) FARMS.

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ABSTRACT

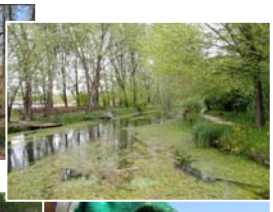
Aquaculture farms are a diffuse and important economic activities in Veneto Region (North East of Italy). Here the water effluents, characterized by low nutrients concentration, are discharged directly in the rivers without any treatment. If the water flow is considered, great nutrient loads are daily generated by the farm activity.

The aims of the research are to build up and asses different solutions in the field of constructed wetland to treat the water flow from two different farms inside the Sile River Natural Park. With these scope two innovative floating vegetated systems were set up in April 2005. These were vegetated with water jacinth (*Heichornia crassipes*) and vetiver (*Vetiveria zizanioides*). Water sample before and after the floating structures were monthly collected.

Both the systems performed well in loads reduction. Differences were registered for BOD5, COD, total nitrogen, nitric nitrogen and total phosphorus, with treatment efficiency ranging from 22 to 77%.

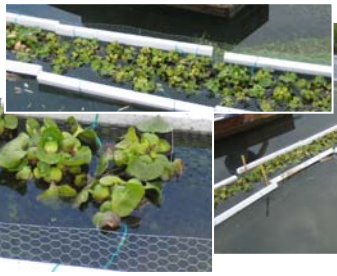
No energy input was necessary to build up the floating structure and to manage them during the research period, showing a low environmental impact and pollution emission.

The results obtained are encouraging to develop and promote these systems in the aquaculture farms, where is not realistic the building of sedimentation basins or where the receiving water bodies must to be protected from outside pollution.



Images of Sile River Natural Park




The plants used: vetiver (left) and water jacinth (right).



The basket-line build up in Az.1 and plants of water jacinth after 1 week of system set up (8 June 2006).

The floating system build up in Az.2, and particular of plants and root growing during the studying period.

INTRODUCTION

Many of the Italian fish farms are located along or near natural rivers, where they discharge the effluents. The aquaculture effluents are characterized by low pollutant concentrations but high water flow, producing high loads of nitrogen, phosphorus, and organic matters.

Several researches were conducted worldwide to test natural treatment systems to reduce the pollution of effluents (Kadlec, 1996; Summerfelt, 1998; Ying Feng, 2002; Schulz C., 2003; Borin, 2003), facing the problem that the high water flow needs large sedimentation ponds or basins. A possible solution of the problem could be to treat the effluent directly inside the farm channels with natural filter systems as a results of root systems development. With the Aquaculture funding program of Veneto Region (D.G.R. Veneto n. 3974 10-12-2004), SFOP-Innovation Action Measures, Reg. CE 2792/99 , two pilot "**floating vegetated systems**" were set up in trout farms to investigate their performance in controlling the effluent loadings.

MATERIALS AND METHODS

Two different floating systems were set up because of the different hydraulic plan in the farms and to study different technical solutions. These were located outside the trout channels, but close to the output point. The first (named Az.1) consist of two parallel basket-line systems, set up with an aluminum net and make floating within polystirene pieces. Plants of water jacinth (*Heichornia crassipes*) were placed inside the basket, two hundred each basket-line. The floating lines were 8 m x 0,6 m each one. To protect the plants (leaves and roots) from fishes and water birds a nylon net (1 cm x 1 cm) was put upon and below the floating systems.

The second (named Az.2) consist of a floating island set up with plastic square pieces. These, holed in their structure, were vegetated with vetiver (*Vetiveria zizanioides*), three plants each element. The single elements were joined each others (with iron wire rings) to form a vegetated line between the channel banks. The final structure was 8 m x 1,8 m. No protection net was been necessary in this farm.

Both the systems were established in April 2005. To evaluate the treatment performance water samples were collected before and after the floating systems to analyze: total nitrogen, nitric nitrogen, total phosphorus, soluble phosphorus, BOD5, COD, total suspended solids, conductivity, dissolved oxygen, pH. In Az.2 the floating systems catch also the daily discharge of the farm's slaughter, previous traditional biological treatment, and the samples were collected to consider also this load.

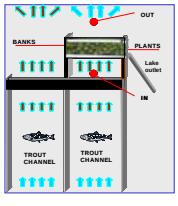
RESULTS AND DISCUSSION

In Az.1, due to unfavorable site and weather conditions in summer 2005, the test lasted six months. The plants grew well from May 2005 to mid August 2005 with a colonization of the 80% of the total area in the basket-line. The root length measured in June was 37 cm, showing good feeling with the site environment. After that, because off small shellfish of the genus *Gammarius* L. which eat the roots, and episodes of damage by swans which tear the leaves and ruin the floating lines, the test was interrupted (the plants were leave in the basket until September). The abatement of pollutants concentration was satisfactory, but, due to the low number of data collected, the Kruskall-Wallis test (5%) give significance only for BOD5.

In Az.2 the plants of vetiver suffered few weeks after the start up of the system, but later their roots growth begun. Given the slow establishment of vetiver, it was decided to transplant other wetland plants (*Typha latifolia* L., *Sparganium erectum* L.) in the floating elements, to improve the efficiency. During Summer other plants colonized the elements: *Nasturtium sp*. L., *Ortica sp.* L. and some species of *Poaceae* Family. No unfavorable conditions occur during the test time (until March 2006) and the roots grew well in water flow also in the winter months. Vetiver root was 56 cm long in December 2005 and some of the other plant's root system reach 115 cm of length (measured in March 2006). The treatment performance was good showing statistical differences (Kruskall-Wallis test, 5%) in BOD5, COD, total nitrogen, total phosphorus, and total suspended solids.

The management in Az.1 was been weekly to control and rearrange the floating lines and to clean up the jacinth foliage because off the accumulation of organic matter that reduced the physiological activity of the plants. In Az.2 the control were necessary only to keep in order the wire rings between the elements.

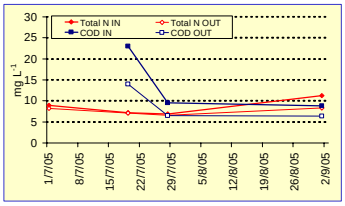
The results are very encouraging considering the continuous effluent flow, at least 100 l s-1, the partial time functioning in Az.1, and the delay start up in Az.2.



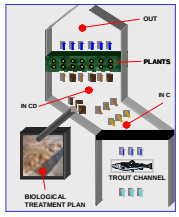
Plan of the Az.1 site

Parameter		IN	OUT	Efficiency
COD	mg L^{-1}	13,78	8,50	35%
BOD_5	mg L^{-1}	2,85	1,83	36% *
Suspended solids	mg L^{-1}	312,66	297,33	5%
Conductibility	µS	626,00	621,33	1%
Total Nitrogen	mg L^{-1}	8,55	7,57	11%
Total phosphorus	mg L^{-1}	0,32	0,44	-
Phosphorus soluble	mg L^{-1}	0,01	0,002	77%

Average treatment performance in Az. 1, (* = differences between IN and OUT)



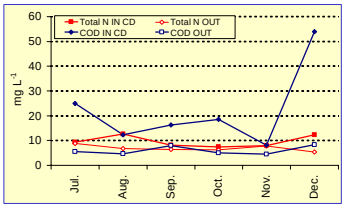
Nitrogen and COD input and output in Az. 1 during the studying period



Plan of the Az. 2 site

Parameter		IN	IN CD	OUT	Efficiency
COD	mg L^{-1}	8,97	22,37	6,01	69 *
BOD_5	mg L^{-1}	2,49	4,12	1,92	49 *
Suspended solids	mg L^{-1}	346,50	384,42	341,61	9 *
Conductibility	µS	680,17	741,94	663,11	9 *
Total Nitrogen	mg L^{-1}	7,74	9,66	6,85	22 *
Total phosphorus	mg L^{-1}	0,31	0,53	0,12	64 *
Phosphorus soluble	mg L^{-1}	0,02	0,03	0,05	-

Average treatment performance in Az. 2 (IN CD= trout outlet+ slaughter effluents) (* = differences between IN and OUT)



Nitrogen and COD input and output in Az. 2 during the studying period

CONCLUSION

The natural treatment systems tested show that there is the possibility to treat the aquaculture discharge on site, close to the trout channels and without great surface utilization. Both the tested systems performed well in removing loads from the effluents, without energy inputs and expensive management costs.

The floating system build in Az.2 showed better skills in the hydrologic environment of the test site, allowing to reduce the main pollutants from 22 to 69 %.

Further studies will be done to investigate the bacterial families developed in the rhizosphere, and their role in the pollution control.

Constructed floating wetland is therefore a good choice for the farmers and, at least the only one allowed, if compared to the traditional biological treatment or large sedimentation basins.

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