Riparian Forestry Project (RipFor): the ecological part on the River Fersina (Trentino, Italy)

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SUMMARY - Riparian Forestry Project (RipFor): the ecological part on the River Fersina (Trentino, Italy) - The RipFor (Hydraulic, Sedimentological and Ecological Problems of Multifunctional Riparian Forest Management) is an European project concerned with the optimisation of riparian forest management, with special respect to hydraulic and ecological problems occurring in floodplains. Field and laboratory work was carried out in collaboration with Freie Universität Berlin, Universität Karlsruhe, Universität für Bodenkultur Wien and Università degli Studi di Trento (Dipartimento di Ingegneria Civile ed Ambientale). Each partner worked on a different aspect of the project (hydraulic, sedimentological or ecological studies). The results will be combined with existing experience to introduce innovations, improvement and optimisation. The final deliverable of the project will be guidelines to improve riparian forest management. Our ecological field studies were carried out in order to map the ecological functionality of streams in all its aspects, and for understanding more particular problems such as organic material retention and processing and as macroinvertebrate community. This work was concentrated on the Fersina stream (Trento, NE Italy).


Key words: river riparian zone, F.F.I., macrobenthos, Fersina River, Italian Alps
Parole chiave: zona fluviale riparia, I.F.F., macrobenthos, Torrente Fersina, Alpi italiane

1. INTRODUCTION

Structure and composition of lotic macroinvertebrate communities are known to depend on both biotic and abiotic characteristics of stream habitats (Resh & Rosenberg 1984). The River Continuum Concept (Cummins 1974) describes the role of allochthonous organic and nutrient input and autochthonous production to maintain the quality of running water life, and also describes the increase of structural and ecological complexity from the upper to the lower reaches. Litter is one energy source for streams providing various food sources and habitat for aquatic invertebrates (Lopez 1997), and the presence of vegetated river banks is very important to guarantee a high functional level in stream ecosystems. Litter production, decomposition and transport are the main processes in river corridors (Malanson 1993), and the composition and richness of riparian forestry are related to litter distribution in the river.

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APP A (Agenzia Provinciale per la Protezione dell’Ambiente) carried out the ecological part of the project, with the objectives to evaluate the relationship between vegetated riparian zone and ecological functionality of the running water. The work was concentrated on Fersina stream (Trentino, Italy), in a site near Canezza. It is a left tributary of the Adige River, rises at 2055 m above sea level and, after 30 km, flows into the Adige River at 191 m above sea level. The total area of the Fersina basin is 170.3 km².

This research was planned considering different study approaches, in order to describe:
- The importance of litter fall as food source for the macroinvertebrate community using the leaf pack method (Petersen & Cummins 1974);
- The capacity of a river to retain litter under large stones, cobbles, pebbles, and so to evaluate the organic matter retention capacity;
- The functional capacity of the river ecosystem using the F.F.I. method (Siligardi et al. 2000);
- The composition of the macroinvertebrate community.

The results should provide useful information to river managers and end-users for a better and integrated approach to plan river bank stabilization considering the hydraulic and ecological requirements.

2. METHODS

2.1. Detritus processing analysis and leaf-pack

In this analysis the CPOM (Course Particulate Organic Matter) demolition processing was investigated using a defined amount of natural autumnal leaves (LP). It is possible to evaluate the CPOM demolition capability of a river, observing the weight lost from a LP during a fixed time period. LPs simulate importing of leaves which may enter the river ecosystem: cellulosolitic fungi and bacteria digest foliar tissues and the leaves thus softened are colonised by macrobenthos which recycle the organic material (Petersen & Cummins 1974).

For the formation of LPs alder (Alnus glutinosa (L.) Gaertner) leaves were used because they are rapidly demolished. The leaves, after complete dehydration in oven, are made into packs weighing 5 ± 0.1 grams. The LPs were taken to the site of investigation on Fersina Torrent and softened with stream water. Subsequently LPs were fixed with plastic staples onto nylon chords that were anchored onto the bed. In total 21 LPs were positioned. In the laboratory, 5 LPs were inserted into plastic sacks filled with stream water to determine leaching effect after 48 hours.

The starting date for LP positioning was June 27, 2001. At weekly intervals 3 LPs were removed, one for each chord, for a period of 5 weeks, collecting everything with a small-meshed net (200-300 µm). Subsequently, in the laboratory leaves were washed and the benthos contained in them was collected, sorted, classified at Genus or Family level and preserved in non-denatured 70% ethanol.

The washed leaves were then dehydrated in oven at 40 °C for 24 hours. The weight of each dried LP was measured with a precision of ± 0.1 grams.

The LP weight data was worked out as indicated in literature (Petersen & Cummins 1974), using the following calculation:

\[ W_t = W_0 \times e^{-kt} \]

where \( W_0 \) = initial weight (grams), \( t \) = time (days), \( k \) = leaf demolition constant.

2.2. Organic matter retention measurement

The process of river retention is based on the immediate trapping of coarse organic matter, e.g. leaves fallen in the river and successive storage of this material for a long term (Vought et al. 1991).

Retention can be measured as the quantity of material transported in a range of stream compared to the initial quantity of the material released in the stream (Vought et al., loc. cit.). Retention mechanisms of CPOM in the system are very important, because they allow it to be processed rather than transported downstream in a coarse particulate form (Speaker et al. 1984).

For this study we used leaves of Gingko biloba (L.), because such leaves have a particular shape and maintain the yellow colour for a long time: for this reason these exotic leaves cannot be confused with the autochthonous ones. Leaves were soaked before being used because dry leaves float on the surface of running water and cannot be trapped by the streambed under cobbles, boulder and bedrock. On Fersina stream we released one thousand leaves at the top of a stretch of 100 meters located near the site where LPs were placed, and we counted the leaves that arrived at the transverse end line of the stretch after 1, 2, 3, 4, 7, 10, 15, 20, 40 and 60 minutes after release.

Four monitoring campaign were carried out in July 2000, November 2000, February 2001 and June 2001.

2.3. F.F.I. (Fluvial Functioning Index) method

F.F.I. method (Siligardi et al. 2000) is a development of the R.C.E.-2, the first draft of which was drawn up by Siligardi & Maiolini (1993), which in its turn derives from the Riparian Channel and Environmental Inventory (R.C.E.-I) drawn up by Petersen from the Institute of Limnology of Lund.
University (Petersen 1992). The method allows the collection of information about the main ecological characteristics of a watercourse and shows eco-functional aspects and interrelations between ecosystem units within an eco-mosaic. Through the description of morphologic, structural and biotic parameters of the fluvial ecosystem, the stream functionality is evaluated. The method gives different information in comparison with other methodologies that are applied using other indicators or indices (i.e. biotic indices, chemical and microbiological analysis etc.). It is based on a check list that evaluates ecological features and functioning processes of stream environment through 14 questions (Fig. 2).

It permits to detect where a river needs to be restored and gives precise indications to orient restoration projects.

In this study the entire Fersina stream channel was investigated for a total of 17 km; according to its variability, 37 records were filled, distinguishing between left and right bank where necessary. The compilation of each record terminated with the calculation of the sum of the different weight given to the answers identified and hence with the definition of the score which may go from a minimum of 14 to a maximum of 300 and which has been translated into 5 quality classes, giving each a rating and a colour. The results were reproduced on a map with the scope of making interpretation easier.

2.4. Benthos quantitative sampling

Reliability of mean density estimates depends on a great number of variables, such as number and size of samples, substratum typology or macrobenthos distribution on the substratum. Choice of sampling sites is made in areas where substratum is homogeneous.

Macroinvertebrate quantitative collection consists of jabbing the Surber sampler in the riverbed.

In this work three samplings were made, in July 2000, in February 2001 and in June 2001, in the same site where LP were positioned. Three replicates were made for each sampling.

Surber was thrust into the target habitat and cobbles present in the sampler were swept and cleaned for a fixed period (5 minutes). Collected organisms were preserved in 70% ethanol. For each sample individuals were sorted, classified using taxonomic keys and counted.
3. RESULTS AND DISCUSSION

3.1. Leaf-pack analysis

The log regression of leaf degradation is shown in figure 3, where time is in abscissa and ln of remaining leaves weight in ordinate. The coefficient $k$ represents the slope of the regression straight line. The linear correlation between remaining weight of LPs has a very high significance with a correlation coefficient $r^2 = 0.961$.

The results for Fersina site are:
- 2000, July: $f(x) = 76.2x / (1 + 0.19x)$
- 2000, November: $f(x) = 283.7x / (1 + 0.35x)$
- 2001, February: $f(x) = 76.4x / (1 + 0.15x)$
- 2001, June: $f(x) = 128.4x / (1 + 0.17x)$

Short term retention of organic matter is related to the hydrology and the substrate typology. The stretch where experiment was done showed different retention capability in different periods: in July 62.8% of the leaves released were retained; in November only 22.7%, while in February 54%; in June 33.4%.

Figure 4 represent the data of leaf captures in the four monitoring campaigns. Lines with the label “-m” indicate the values observed on site (real data) and lines with the label “-c” are the calculated data using the above formula. The formula coefficients were worked out using the minimum squares method. From a statistical point of view, the correlation between observed and calculated data is quite high for $P < 0.005$.

The asymptote of each curve may indicate the maximum retention capability for each period, characterised by different hydrological regimes. The highest asymptote is peculiar for the low retention because many leaves released were not trapped under the stones or other CPOM traps.

3.2. Organic matter retention

Mathematical elaboration of retention data permitted to define the equation of each campaign curve (Fig. 4), based on the following relation:

$$f(x) = \frac{ax}{1+bx}$$

where: $x$ = time (minutes) and $f(x)$ = cumulative number of leaves arrived (Tab. 1).

3.3. FFI. (Fluvial Functioning Index) method

On both river banks there is a predominance of I and III functionality level (33% - 5.458 m and 35% - 5.890 m length for right bank and 37% - 6.120 m and 35% - 5.780 m length for left bank respectively). A relevant percentage of I level stretches is located mainly in the upper part of Fersina stream basin.

The check-list questions were associated in groups that represent a functional characteristic:
- questions 1-4: vegetation conditions and land use along river course;
- questions 5-6: wet river channel width and physical and morphological structure of river bank;
- questions 7-11: river channel structure;
- questions 12-14: biological characteristics.

Questions 1-4 (Fig. 5): there is a general worsening of the right river bank comparing with the left bank, in the upper part of the river basin there is a relevant variability of conditions for both banks: the worst stretches are those where there is a noticeable presence of weirs and longitudinal infrastructures (flood defences, stone and concrete walls), with a small and discontinuous riparian strip. The F.F.I. score decreases going downstream according to the land use and the artificiality of river bed with the formation of secondary riparian vegetation.

Questions 5-6 (Fig. 6): in the upper part of the right river basin there is a certain morphological variability due to the presence of stretches with artificial infrastructure. The analysis of this question group allows to suppose that there is a variation of hydraulic regime which can compromise the river bank stability in few critical points.

Questions 7-11 (Fig. 7): the score for both banks is
quite high for the upper part of the Fersina catchment which reflects a good depuration capacity. In lower part of basin, stream Fersina functionality is strongly influenced by canalisation and straightening of the river bed.

Questions 12-14 (Fig. 8): the biological characteristics are fairly good especially in the upper stretches. In the lower part the artificial infrastructure do not guarantee the presence of a stable macrobenthonic community.

3.4. Benthos quantitative sampling

In July, 2000 benthic community in Fersina River had a density of 12,000 organisms m$^{-2}$. Plecoptera were the dominant group (42%), Diptera were also quite numerous (32%), Ephemeroptera were less frequent along with Trichoptera, Oligocheta, Coleoptera and Irudinea. In February, 2001 benthic community had a density of 14,000 organisms m$^{-2}$. In June, 2001 33,000 organisms m$^{-2}$ were found. In February and June community composition was quite similar: Diptera group was very abundant (56% e 66% respectively). The other taxa were present but not abundant. Community showed a clear dominance of detritivore organisms in all periods (91%, 75% and 68% respectively). Considering macrobenthic community by trophic roles, collectors were always dominant, with 54%, 69% and 43% respectively. In July the second abundance was represented by shredders, in February by scrapers and in June by filterers.

4. CONCLUSIONS

Ecological studies are very important to evaluate environmental quality and integrity, in addition to plane the management of riparian and perifluvial areas. In this project we applied four methodologies to study the ecological and biological situation on project site on Fersina stream, exactly:

- FF.I. index evaluated the general functioning of river-bed, riparian areas and nearly territory;
- Organic matter retention analysis allowed to relate riverbed morphology and organic matter retention and depuration capacity of the river;
- Leaf-packs analysed organic matter demolition and depuration capacity;
- Benthos quantitative sampling allowed to analyze macrobenthic community composition and dynamics connected to water quality and river functionality.

The main objective of this work was to provide information for end-user and river manager, public or private, about the management of riparian vegetation respecting the requirement of river biota. Results will contribute to the development of the guidelines, in which the importance of the real functions of riparian ecosystems should be relevant and in linkage with sedimentological, hydraulic and safety aspects. In this project IFF methodology was the most informative and the most correlated with the other aspects studied.

The urban planning should consider riparian forest ecosystem with management strategies developed as an
integral part of the community plan. In order to create some effective buffers strips in developing urban areas, planners must understand within their watersheds.

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