FRAGMENTATION OF LOTIC HABITAT IN THE NATURA 2000 SITE ROSCI 0103 "LUNCA BUZAULUI"

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Habitat destruction and fragmentation are the most important factors that drive loss of species diversity. The populations restricted to lotic, freshwater habitats are very sensible to fragmentation by dams and other structure that impede their free movement through river corridors. The macroinvertebrate community and the fish community are components of the lotic system and reflect the level of environmental integrity. In this study was analysed the influence of habitat fragmentation resulting of damming and flooding area changing of Buzau river (sector within natura 2000 site "Lunca Buzaului") on the benthic macrofauna and the fish species of conservative value. All the environmental alterations reflect in modification of structural characteristics of Buzau river and determine the re-arrangements in the biological communities, resulting new assemblages of benthic macroinvertebrates and fishes.

Key words: lotic system, fragmentation quantify, habitat score, Natura 2000

Fragmentarea habitatelor lotice in perimetrul sitului Natura 2000 ROSCI 0103 Lunca Buzăului

Distrugerea/restrângerea şi fragmentarea habitatelor sunt cei mai puternici factori care duc la scăderea diversităţii speciilor. Populatiile care traiesc in apele dulci curgatoare sunt foarte sensibile fata de fragmentarea indusa de baraje si alte constructii care le limitează răspândirea în lungul râului. Comunităţile de macronevertebrate bentonice şi comunităţile de peşti sunt elemente componente ale ecosistemului lotic si starea lor reflectă integritatea mediului. In studiul de faţă a fost analizată influenţa fragmentării habitatelor indusă de construcţia de baraje şi de modificările luncii inundabile ale Buzăului (în perimetrul sitului Natura 2000) asupra faunei bentonice de macronevertebrate şi asupra speciilor de peşti cu valoare conservativă. Toate deteriorările suferite de mediul natural se reflectă în modificarea caracteristicilor structurale ale ecosistemului lotic Buzău şi determină schimbări ale comunităţilor biologice – noi asociaţii de macronevertebrate bentonice şi peşti.

Cuvinte cheie:system lotic, cuantificarea fragmentarii, scor de perturbare a habitatelor, Ntura 2000

Lotic ecosystem are central to society and environment since the modifications in time in the distribution of the taxons, including the relation between living and non-living components of the support aquatic ecosystems may pose serious threats to the overall functionality of the natural and even anthropised ecosystems and landscapes. The construction of dams has great influence in the transportation of fine particles that fill interstitial spaces, in the light penetration in water, in the productiveness of the system and in the formation of unstable substrate. Other alterations, such as destruction of riparian vegetation, result in increase of soil erosion and acummulation of sediments, in the homogenization of habitats, and in modification of trophic balance between allochthonous and autochthonous organic matter.

All these impacts reflect in modification of structural characteristics of the rivers and streams and also in areas around the hydrographical basin. These environmental alterations determine the re-arrangements in the biological communities, that results in new assemblages which characteristics may supply information about enviromental impacts.

Generally, habitat fragmentation is an ecological process in which a large patch of habitat is divided into smaller patches of habitats (Gomi et al., 2003). Usually, this process is caused by human activities (roads, agriculture). It also reduces the value of the landscape as habitat for many species (plants and animals). Fragmentation alters natural habitat in many ways, including reduction of patches' sizes, increment of distances between similar patches, and increment of edges and predation (Robinson et al. 1995).

The lotic system Buzau (within Natura 2000 site ROSCI 0103)

Despite the geographical conditions (the river flows through a region with a numerous human population) the biological state of the system is rather a satisfactory one. Up to the low sector it can be taking into account two main factors:

a) the variations of the flow, induced by the releasing of the water from the dam reservoirs

b) the missing of the protective effect of the floodplain (disappeared as a consequence of impoundment)

By faunistical analysis can be concluded that some taxons may be considered significant enough: *Baetis vernus*, *Ecdyonurus dispar*, *Ephemerella ignita*, *Oligoneuriela rhenana*, species of *Hydropsyche*. The absence of *E.insignis* larvae is some sampling areas is significant, too: slowly current and fine deposits of mud are restrictive factors for the rheophilic species; the right velocity of the current, restrictive for *Hydropsyche* larvae, too; the warming of the water and increasing of eutrophy; sandy substrata and increasing of eutrophy.

The lotic system reacts to these factors by some strategies:

a) preponderance of the species who can use the periphyton or particulated organic matter;

b) the increasing of diversity in sectors with heterogeneous substrata;

c) the developing of the submerged madicolous fauna compartment, in order to use the exceed of mineral nutrients; in this case, the diversity of the phytophillous fauna is satisfactory, not very low as in other lotic systems.

On the other hand some sectors are more diverse and the presence of *Oligoneuriella rhenana* larvae is relevant for the quality of the water.

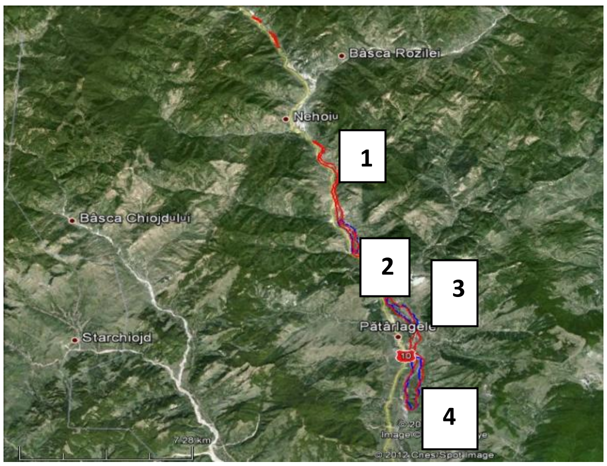


Fig. 1 Upstream sector

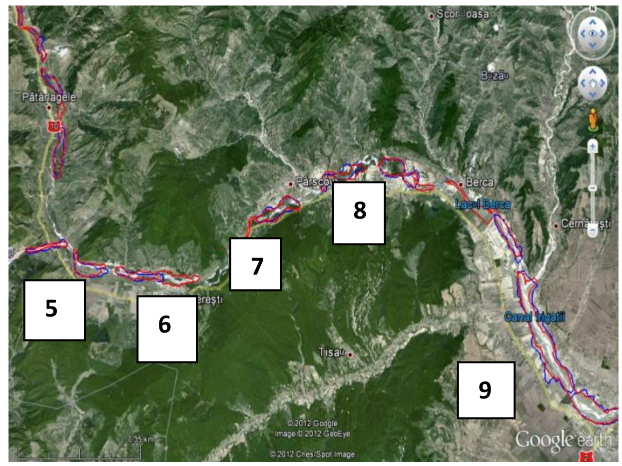


Fig. 2 Middle sector

Fig. 3 Downstream sector (1 – 15: sampling areas)

Fig. 4 Buzau river, downstream Siriu dam   Fig. 5 Paltineni sector

Downstream Siriu dam (Fig. 4) is characterized by a substratum with boulders on a fine sandy bed; among boulders, small deposits of detritus.Numerically prevalent group (the estimation of the numerical prevalence was made for the type of the studied habitat-boulders and gravel, washed in the dredge with a fine net): chironomids. Perlid plecopterans (Family Perlidae), baetidae efemeropterans and limnefilid (Limnephilidae) trichopterans are also present.

The sector of Paltineni (Fig. 5) has a stony substrata and rectangular lines of sand stones (boulders, cobble, gravel). Many baetidae, ephemeropterans form an important part of the community. *Baetis vernus* larvae is a common species in more eutropic waters (a limited eutrophic state. Other groups: *Rhithrogena* and *Ecdyonurus* species, rhyacophilidae trichopterans, chironomids, blepharocerids, hydracarians.

Fig. 6 Madicolous habitat   Fig. 7. Sibiciu-Mlajet sector

Downstream Paltineni, in the sector Sibiciu-Mlajet (Fig. 7), on the stony bottom there are filamentous algae and fine vegetal detritus (madicolous habitat, fig. 6). The ephemeropterans are the numerically prevalent group (mainly *Baetis scambus*, *Baetis fuscatus0,* From this area and up to Cislau, the *Oligoneuriella rhenana* populations are maintaining at an optimum level. They prefer flattened boulders and cobble. We observed 3 - 10 specimens on a surface of 400-500 cm^2, chiefly into a zone no more than 10 meters wide near the right bank of the river.

Fig. 8. The fragmenting factor: Berca dam Fig. 9. Bryozoa, downstream the dam

Up to Cislau the river is almost in good biological conditions. The main fragmenting factor is the dam Berca; downstream, the rivers is impacted by the quarries (more than 80 historical exploitation).

Fig. 10. River at Sageata Fig. 11. River bed at Bentu

Fig. 12. Maracineni: abrupt discharge Fig. 13 Sandy sector near Jirlau

Downstream Buzau City the river bed is mainly a sandy one; the banks are clayly with zones with boulders from the impoundments. Artificially created rocky habitats are added to areas with low water velocity. The increased roughness allows sedimentation (FPOM). This new condition favourize the rheophilic species like *Heptagenia* ones. The deposits of mud are rich in oligochaetes and chironomids.

The second barrier fragmenting lotic habitat is the abrupt discharge from Maracineni (fig. 12).

In the last sector of the river within the Natura 2000 site the sandy substratum is prevalent. In the area Cislau-Gavanesti there are some braided sections which permitt the deposition of fine, muddy sediments, inducing the dominance of oligochaets (*Limnodrilus*). On the other hand, in the sections with a high velocity of the water there are numerous populations of trichoptera hydropsychidae. The riverine vegetation is a main factor for the functionality of the ecosystem and influences the carrying capacity in two ways:

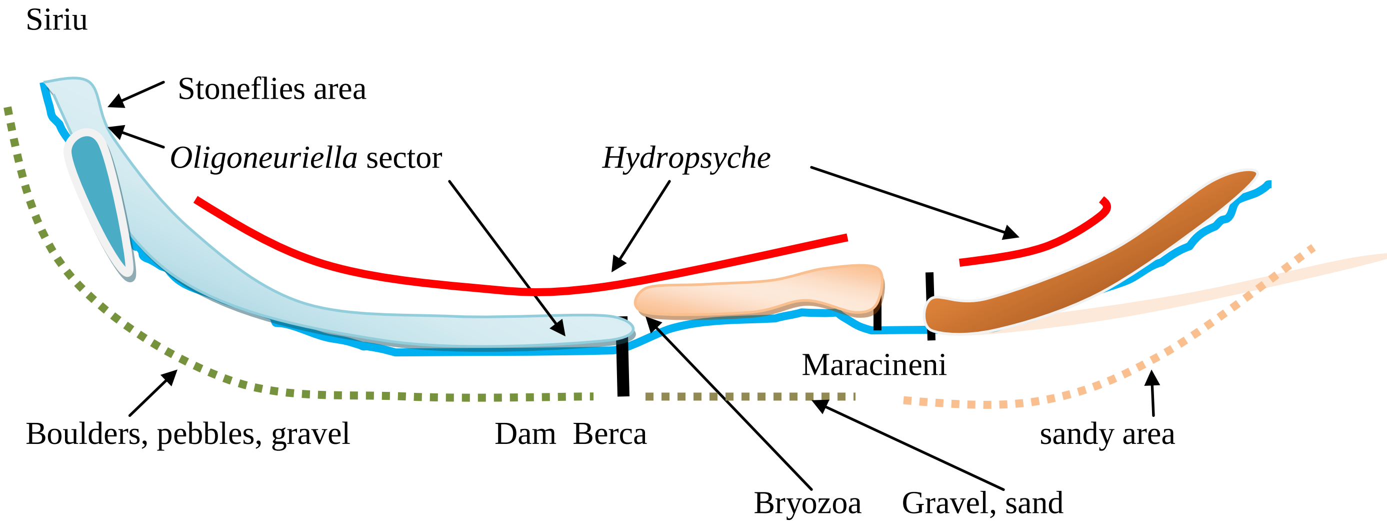
a. directly, as a sourse of organic fresh material available for macrodecomposers (shredders – crustacea amphipoda and some trichoptera) and microdecomposers
b. indirectly, by the shading effect which favors the low temperatures of the water.

The riverine herbaceous vegetation rinsed by the water flow is a shelter for many species mostly in the flooding periods.

Habitat type	**Temporal scale of disturbing**	**Temporal scale of disturbing**
Microhabitat	Days	Element boundaries: boulders, rocks, gravel, logs; substratum preference, feeding habitats
Functional habitat	1 month – 1 year	System components: pools, riffles, bars, natural levees, islands
Lotic ecosystem within fluvial corridor	1 – 100 years	Channel, flooding area, vegetation; coarse scale geomorphological features
Lotic corridor	hundred – thousands years	Integrated fluvial corridor interacting with catchement area

The fragmentation of lotic habitat an carrying capacity of the river

The lotic system Buzau has a satisfactory carrying capacity. There is a pattern strategy as a response to stress factors and for maintaining an optimum number of species. Is evident the tendency of simplifying the structure of lotic biocenosis. This phenomenon is common for many Romanian rivers.



The species of *Ecdyonurus* (especially *insignis* and *dispar*) have a special significance: their missing in some sampling points is the result of the very strong current of the water, here they being replaced by *Rhithrogena*.. In another sampling points, their missing is the result of the eutrophication which leads to the decreasing of the water quality. Consequently the effect of the biological filter the *Ecdyonurus submontanus* appears.

Prevalent group from benthos is that of the mayflies, most of the species belonging to the families Baetidae and Heptageniidae. Caenidae and Ephemerellidae species have small populations or are missing, being insignificant in comparison with the other ephemeropterans. This is the result of the habitat fragmentation and disturbance of flow regime downstream Buzau city.

The lower limit of carrying capacity is induced by the wastes loading of the water and is sustained by the populations of Diptera Chironomidae, Oligochaeta, Bryozoa colonies and Trichoptera Hydropsychidae. The decreasing bellow this limit can produce a drastically change of the system and just the human intervention is necessary to sustain the biological recovering.

The populations of *Hydropsyche sp.*(Trichoptera Hydropsychidae) , *Plumatella repens* (Bryozoa) determine the filterig capacity of the benthic communities and ensure specific conditions for installing of other benthic groups. So, the aggregation of Hydropsychidae larvae on boulders or argilla permitt the forming of an association with Ephemeroptera larvae, many Chironomidae. Must be mentioned that the Hydropsychidae larvae are dominant in the upper sections of the river also, being sustained by the loading particles. This situation determines some effects as:

- the covering of the boulders and other surfaces with a fine layer of algae, bacteria and moss
- the accumulation of a fine sediment between the elements of gravel
- the tendency of decreasing for rheofilic populations
- the dominance of filtering collectors
- the consolidation of the association

The maximum lower limit is demonstrated by the dominance of Oligochaeta and Chironomidae populations which can use the deposits organic matter.

Important for lotic habitats is the maintaining of longitudinal connectivity. At low connectivity, species diversity should be reduced by the absence of the fluvial dynamics that sustains a diversity of successional stages within the river corridor, whereas excessive connectivity will keep all communities in pioneer stages.

Methodology to quantify fragmentation

Index	Diversity of benthic species (EPT)	Artificial elements	Physical alterations	Extraction of raw materials	Level of fragmentation	River dynamics
10	EPT – *Oligoneuriella*, riacofilide, perlide	None	None	None	0	Natural
9	EPT – *Oligoneuriella*, riacofilidae, perlidae	Punctual, irrelevant	Irrelevant	Irrelevant	insignificant	Natural
8	EPT – *Oligoneuriella*, riacofilidae, nemouridae	Occasional, some roads	Irrelevant	occasional	Insignificant	Natural, irrelevant use
7	ET – heptageniidae, *Hydropsyche*	Occasional, some roads	Occasional	Low, no qualitative effects	None or scarce	Little alteration
6	ET – baetidae, *Hydropsyche*	Little, some local roads	None or minor (stone-walls)	Limited	Low, no qualitative effects	Little management
5	E – baetidae, caenide	Conspicuous, but not dominant	Moderate	Sustainable	Patchwork	Forced by man
4	E – baetidae	Important presence	Important	Intense	Moderate, with or without corridors	Important management
3	Chironomidae,	Abundance	Important	Regular, more intense	Intense, extended	Intensive management
2	Oligochete, chironomide	Abundance	Extended (excavations)	Very intense	Intense, very extended	Intensive management
1	Oligochete	Clear dominance (quarries)	Extended (excavations)	Very intense	Maximal	Intensive management
0	Oligochets, bryozoa	Clear dominance (quarries)	Full modification	Uncontrolled	Maximal	Full control

1. Substrate stability. This includes the degree of cover provided by natural structures in each stream, such as cobble (in riffles), large rocks, fallen trees, logs and branches that are available as shelter, feeding, or spawning and nursery sites. Decreases in the variety and abundance of such structures render the habitat more homogeneous, thereby decreasing habitat diversity and recovery potential.
2. Velocity and depth variability. The different combinations of velocity and depth represent another component of habitat diversity. High gradient streams often show four patterns of flow: slow/deep, slow/shallow, fast/deep, fast/shallow.
3. Flow stability. This represents the occurrence of natural and continuous flows versus flashy or ephemeral flow;

4. Bottom deposition. Fine sediments accumulate mainly in pools, but may also embed in riffles, or create islands, point bars, or embayments. Depending on the channel slope, an increase in fine sediment indicates a less suitable environment for aquatic biota; however, islands, point bars, and embayments increase channel complexity;
5. This describes the variety of macrohabitats present; *i.e.* the combinations between pools, riffles, runs, and small marginal pools, against the predominance of channelized reaches;
6. Channel alteration. Measures large-scale changes in the shape of the stream channel such as artificial embankments, artificial bank stabilization, channelization, and dredging;
7. Streamside cover. Riparian zones are areas along water bodies, often with flood tolerant plants. When these zones support complex woody vegetation, they play a vital role in the structure and maintenance of physical habitat, energy flow, and aquatic assemblage composition;
8. Bank vegetative stability. Measures the extent of the streambank surface covered with vegetation or rubble, both of which provide protection from erosion;
9. Bank stability. This metric verifies whether stream banks are eroded, thereby including their potential for erosion.

DESCRIPTORS	CONTENT
Substrate stability	Habitat heterogenity – boulders, gravel, branches, logs Habitat omogenity
Velocity and depth variability	Four patterns of flow: slow/deep, slow/shallow, fast/deep, fast/shallow
Flow stability	Natural and continuous flows versus flashy or ephemeral flow
Bottom deposition	Fine sediments accumulate mainly in pools, but may also embed in riffles, or create islands, point bar. An increase in fine sediment indicates a less suitable environment for aquatic biota; however, islands, point bars increase channel complexity
Variety of macrohabitats	Combinations between pools, riffles, runs, and small marginal pools
Channel alteration	Artificial embankments, artificial bank stabilization, channelization, and dredging
Streamside cover	Complex woody vegetation; the absence of larger trees indicate a decline of integrity
Bank vegetation stability	The extent of the streambank surface covered with vegetation
Bank stability	Potential for erosion: crumbling, unforested banks, exposed roots and exposed soil

Habitat score

Sector of river	Score
Aval baraj Siriu – Lunca Priporului	**7**
Paltineni - Maruntisu	**8,50**
Cislau - Viperesti	**6,50**
Badila - Berca	**6**
Berca - Maracineni	**3,50**
Maracineni - Dambroca	**2,50**
Bentu - Visani	**5,50**

Conclusions

Modern land-use practices may have caused various degrees of habitat fragmentation that affect streams. When habitats are fragmented, or destroyed, species come to exist in discrete habitat patches that may only be suitable for a limited range of species or may limit population sizes. Hence current and future distribution of a species may reflect past and present land use. Habitat fragmentation is a scale-dependent process (Poole, 2002).

As the density of habitat fragments decrease, the isolation of patches increase geometrically. Also, with decreasing patch size, the proportion of edge habitat increases geometrically. This may be of particular importance to riverine fish that are constrained to stream corridors, where the fragmentation in the terrestrial landscape may actually have a disproportionate effect on stream inhabitants.

Much of the current knowledge of the ecology of rivers and streams is based on surveys, observations and experiments on organisms and habitats at small spatial scales. Such small-scale investigations can limit the ecological understanding needed to underpin conservation efforts for stream fish (Fausch *et al.* 2002). Moreover, riverine ecosystems have frequently been degraded by ecosystem- wide activities in the terrestrial environment, and they are rarely bounded by the area selected for study. These activities, historical and contemporary, include road construction, forest harvesting, water abstraction, agricultural, industrial, and municipal uses, which influence the timing and quantity of flow within channels. Degradation of the stream valley ecosystems and the riparian zones that link streams with their catchments are likely to diminish a catchment's capacity to provide critical riverine functions necessary for streams and their biota (Osborne & Kovacic 1993).

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