# USING EUROPEAN FISH INDEX (EFI+) IN ASSESSING THE ECOLOGICAL STATUS OF BISTRITA RIVER

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**Key words:** *fish communities, IBI, EFI+, Bistrita River*

## INTRODUCTION

Bistrita River is a major tributary of the Siret River right. It springs from the Rodnei Mountains, and after a course of approx. 200 km flows into the Siret River downstream of the Bacau City.

The main course of the river receives several tributaries, among which the most important are Dorna, Neagra Şarului, Neagra Broştenilor, Barnar, Borca, Sabasa, Bistricioara, Bicaz, Tarcău, Calu, Iapa.

The waters of this river have had before human impact native fish fauna rich both in terms of quality and quantity, indicating an ecosystem less affected by human actions.

To observe the extent of damage to the aquatic ecosystem is important to know the changes that have suffered the communities of aquatic organisms, especially fish fauna as the final link in the food web.

Thus the study of fish fauna by applying synthetic ecological indexes (IBI, EFI+), we have accurately information on the extent of damage to the aquatic ecosystem.

## MATERIALS AND METHODS

Sampling was done in 2001-2006, 44 sampling sites (see Figure 1) and 65 collections, both on the main course of the river and the tributaries. In each location were recorded GPS coordinates and data on physical-chemical water.

Collection of fish samples was performed by electrofishing, the standardized method for rivers in Europe without sacrificing the captured.

In this regard it has been using a special electric fishing (5000 W) which produces a continuous current voltage of 250-600 V with an intensity of 1 to 20-30 A, which does not affect collected specimens of the species.

Collecting samples was done mainly in the season spring - summer.

Sample collection in the cold season (winter) proved to be ineffective because the water temperature below 7-8$^0$C most species do not react or react very poorly to electrical current.

Data processing was done in the laboratory, and by applying synthetic ecological indexes (IBI, EFI +) determine the overall ecological status Bistrita River

## RESULTS AND DISCUTIONS

Bistrita river waters were affected in the last 60 years of industry development and the development of reservoirs. Thus pollution and river adding barriers to had a negative impact on communities of aquatic organisms, particularly on fish fauna.

Pollution of river water began right from the springs because of exploitation of manganese ore and particularly the waste dumps that remained after the operation, the platform Dadu-Oita-Tolovanu on the left side of Bistrita Aurie River, the section Cârlibaba – Iacobeni (Popescu & Popescu, 2007).

Downstream an important source of pollution is acidic waters from waste dumps from the former mining sulfur Călimani which completely destroyed the fish fauna Neagra Şarului tributary.

The waste dumps from uranium exploitation Crucea also had a negative impact on communities of aquatic organisms.

In hilly and valley area of the Bistrita river acute pollution occurred until after 1990 spilled product to platform Săvineşti - Roznov, Buhuşi and Bacau. Even if these factories were closed chronic pollution persist in sediments.

The river water pollution and the emergence added numerous reservoirs on this river, from Izvorul Muntelui Bicaz Lake, Pângăraţi, Vaduri, Bâtca Doamnei, Reconstrucţia, Racova, Lilieci, Şerbăneşti, which changed the structure of fish communities.

To these factors we add excessive poaching in some areas.

All these factors have contributed to changing the structure of fish communities, which led to the extinction of native species while valuable (huchen, burbot). Other native species have restricted area, because of the inability to move, due to the emergence of dams (barbell).

# THE BISTRITA RIVER CATCHMENT AREA

## SAMPLING SITES

1. Bistrita Aurie - upstream Carlibaba
2. Bistrita Aurie - downstream Carlibaba
3. Bistrita Aurie - upstream Iacobeni
4. Bistrita Aurie - Argestru
5. Dornisoara
6. Negrisoara - Borcut
7. Negrisoara - Rosu
8. Dorna - Dorna Candreni
9. Bistrita - up. jonct. Neagra Sarului
10. Neagra Sarului - Sarul Dornei
11. Bistrita - Zugreni
12. Bistrita - Crucea
13. Bistrita - upstream jonction Barnar
14. Neagra Brostenilor - Brinzai
15. Neagra Brostenilor - up. jonct. Bistrita
16. Bistrita - Brosteni

17. Bistrita - upstream Borca
18. Borca - upstream jonction Bistrita
19. Sabasa - upstream jonction Bistrita
20. Bistrita - upstream Poiana Teiului Lake
21. Bistricioara - upstream Corbu
22. Bistricioara - downstream Corbu
23. Bistricioara - jonction Cautis
24. Bistricioara - jonction Grinties
25. Bicaz - quarry
26. Bicaz - downstream Tasca
27. Bicaz - downstream Bicaz City
28. Tarcau - jonction Bobeica
29. Bistrita - jonction Tarcau
30. Bistrita - Vaduri bridge
31. Bistrita - downstream Piatra Neamt

32. Calu - Zorileni
33. Calu - Carpini
34. Calu - upstream jonction Bistrita
35. Iapa - Largu
36. Iapa Frasin waterfall
37. Iapa - sabau
38. Iapa - Vitelu
39. Iapa - upstream jonction Bistrita
40. Bistrita - upstream Roznov bridge
41. Bistrita - upstream Racova Lake
42. Bistrita - downstream Racova Lake
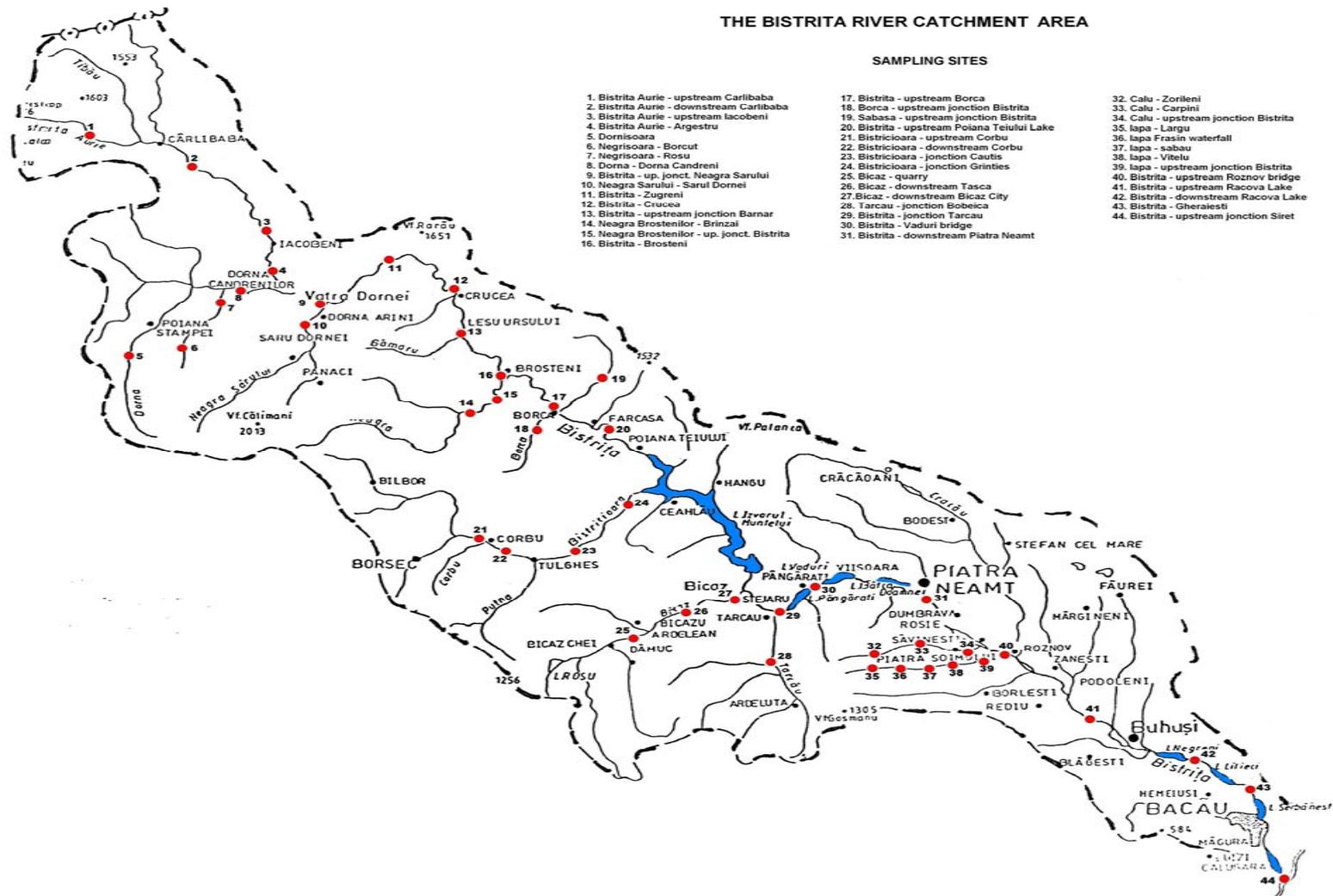43. Bistrita - Gheraiesti
44. Bistrita - upstream jonction Siret

Fig. 1 The Sampling site in the Bistrita River catchment area

So instead of native species, once well represented, it was taken resistant species, which have adapted very quickly to their new habitat (chub, common gudgeon, european perch)

The ecological determine overall Bistrita River were used for collections made in 2001-2006 fishery two indices, namely:

- **Biological Integrity Index (IBI)** – elaborated on the model developed by Karr and Dudley decade 10 some river basins in the US, based on a grid of 15 parameters, referring to species-rich composition of fish communities, trophic composition and abundance of fish populations and the health of their (developed by Battes et al.);

- **European Fish Index (EFI+)** – developed by a European consortium, coordinated by Prof. Stefan Schmutz, from the Agricultural University of Vienna, completed in 2009, that provided unifying and standardizing the methodology for investigating state watercourses in the European Union (EU).

In determining this index were used a total of over 30 parameters, which refers to the location of sampling points, collection method, environment variables abiotic, data characterizing the fish populations, general information on ecoregions, types of river in Europe and Mediterranean.

Optionally were collected data on the human impact.

Figure 1 shows the locations where fish were sampled.

The 44 sites for sampling are placed on the main course of Bistrita from the source (upstream Cârlibaba) flows into the Siret (Bacau) and the main tributaries of the river (Dorne, Neagra Șarului, Neagra Broștenilor, Borca, Sabasa, Bistricioara, Bicaz, Tarcău, Calu, Iapa).

The distance between sites does not exceed 30-40 Km away and can determine structural and functional changes of the fish communities along the entire course of Bistrita.

The sampling was done over a period of six years and a total of 13 sampling points were made two or three collections. Strictly abide methodology, ensuring accuracy and correctness of the data obtained.

In the determination of EFI + was calculated ST index (% intolerant species) with values between 0-1 (see Table 1).

Values of this index below 0.2 indicates a river ciprinicol and values over 0.2 to 1.0, indicating a river salmonids.

To between 0.2-0.8 expert opinions are needed, with a high degree of uncertainty placement fisheries community one of two types (using other parameters). EFI+ index values between 0 and 1, determines grades integrity by between 1 and 5.

Table 2 presents the main results on the abundance of species, abundance numerical, IBI and EFI + values and river fishing area.

The richness in species ranges between 1 and 11. The fish communities of the upper areas of the river and main tributaries (streams) have a small number of species (under 3 and even 1 to a total of 16 sites). In the middle of Bistrita number of species is 5-9, less than optimum (10-11).

On the lower reaches of the river due to the construction of dams on the river Bistrita, this number does not exceed 11 is still lower than the optimum.

Table 1 The index values of integrity fishing classes (EFI+)

| Classes integrity | Value index fisheries | |
|---|---|---|
| | Zone salmonids | Zone ciprinicola |
| I | 0,911 – 1 | 0,939 - 1 |
| II | 0,755 - 0,911 | 0,655 - 0,939 |
| III | 0,503 -0,755 | 0,437 - 0,655 |
| IV | 0,252 -0,503 | 0,218 – 0, 437 |
| V | 0 -0,252 | 0 – 0,218 |

Abundance is also reduced under optimum (usually not exceeding tens of copies) on the upper and average over 500 specimens.

These results were due to environmental pollution and the upper ($SO_3$ - downstream of the confluence the Neagra Șarului with Bistrita presence and mining) and hydro-technical management of the lower (downstream Poiana Teiului).

At the confluence with the Siret, at Bacau, organic pollution resulted in total degradation of the ecosystem.

Values structural indicator however indicates good to very good integrity. EFI + and IBI values are between 1 and 2 in 35 and 36 sampling sites.

The zoning fish, IBI fall 17 sites in the trout zone - that the upper and its tributaries.

EFI + - places salmoniocola zone the 33 sites and 11 sites in the ciprinicola on the lower river.

A total of 13 sites are index values between 0.25 and 0.78 ST contained, making it uncertain placing them in the salmonids zone.

If we consider this, 20 sites in the area as trout and 24 in the ciprinicola, a situation confirmed by the presence of dominant species of cyprinids (mediterranean barbel, common nase, chub) in the sites of the latter.

Table 2. The index values of biological integrity (IBI) and the European Fish Index (EFI +)
on the Bistrita River catchment area

| No Crt. | River name | Sampling sites | No sp. / catch | IBI | | EFI+ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Clss Integrity | Fishing area | Index sp. Intol. (ST) | Fisheries index (0-1) | Clss Integrity | Fishing area |
| 1 | Bistriţa Aurie | upstream Cârlibaba | 4/91 | 1 | Salmo. | 0,9670 | 0,9400 | 1 | Salmo. |
| 2 | Bistriţa Aurie | downstream Cârlibaba | 6/99 | 1 | Salmo. | 0,9191 | 1,0000 | 1 | Salmo. |
| 3 | Bistriţa Aurie | upstream Iacobeni | 4/40 | 2 | Salmo. | 0,9750 | 1,0000 | 1 | Salmo. |
| 4 | Bistriţa Aurie | Argestru | 8/90 | 1 | Salmo. | 1,0000 | 0,9107 | 2 | Salmo. |
| 5 | Dornişoara | Dornişoara | (3/22) | 1 | Salmo. | 0,7272 | 0,8018 | 2 | Salmo. |
| 6 | Negrişoara | Borcut | (4/19) | - | - | 1,0000 | 0,9169 | 1 | Salmo. |
| 7 | Negrişoara | Roşu | 7/283 | 1 | Salmo. | 1,0000 | 0,9962 | 1 | Salmo. |
| 8 | Dorna | Dorna Cândreni | 6/107 | 1 | Salmo. | 0,9413 | 1,0000 | 1 | Salmo. |
| 9 | Bistriţa | up. jonct. Neagra Şarului | 3/48 | 4 | - | 0,8541 | 1,0000 | 1 | Salmo. |
| 10 | Neagra Şarului | Bistriţa bridge | - | 5 | - | - | - | - | - |
| 11 | Bistriţa | Zugreni | 9/97 | 1 | Sco. | 0,1340 | 0,8634 | 2 | Cyprinic |
| 12 | Bistriţa | Crucea | 5/56 | 1 | Sco. | 0,4821 | 0,9861 | 1 | Salmo. |
| 13 | Bistriţa | up. jonct. Barnar | 9/62 | 1 | Sco. | 0,1774 | 0,8127 | 2 | Cyprinic |
| 14 | Neagra Broştenilor | Brînzăi | 5/25 | 1 | Salmo. | 0,9600 | 0,8562 | 2 | Salmo. |
| 15 | Neagra Broştenilor | up. jonct. Bistriţa | 2/13 | 1 | Salmo. | 1,0000 | 0,8914 | 2 | Salmo. |
| 16 | Bistriţa | Broşteni | 5/42 | 2 | Sco. | 0,0476 | 0,7773 | 2 | Cyprinic |
| 17 | Bistriţa | upstream Borca | 6/195 | 3 | Sco. | 0,6512 | 1,0000 | 1 | Salmo. |
| 18 | Borca | up. jonct.. Bistriţa | 2/11 | 2 | Salmo. | 1,0000 | 0,8606 | 2 | Salmo. |
| 19 | Săbasa | up. jonct. Bistriţa | 3/23 | 2 | Salmo. | 1,0000 | 1,0000 | 1 | Salmo. |
| 20 | Bistriţa | up. Poiana Teiului lake | 9/317 | 1 | Sco. | 0,3785 | 0,8381 | 2 | Salmo. |
| 21 | Bistricioara | upstream Corbu | 2/10 | 2 | Salmo. | 1,0000 | 0,9887 | 1 | Salmo. |
| 22 | Bistricioara | downstream Corbu | 1/4 | 2 | Salmo. | 1,0000 | 0,8296 | 2 | Salmo. |
| 23 | Bistricioara | jonction Cautiş | 4/18 | 2 | Salmo. | 0,7777 | 0,9706 | 1 | Salmo. |
| 24 | Bistricioara | jonction Grintieş | 3/29 | 3 | Salmo. | 0,8275 | 1,0000 | 1 | Salmo. |
| 25 | Bicaz | Bicaz quarry | 2/4 | 2 | Salmo. | 1,0000 | 0,8972 | 2 | Salmo. |
| 26 | Bicaz | dowunstream Taşca | 2/2 | 3 | Salmo. | 0,5000 | 0,9152 | 1 | Salmo. |
| 27 | Bicaz | downstream Bicaz City | 9/132 | 1 | Salmo. | 0,4621 | 0,7815 | 2 | Salmo. |
| 28 | Tarcău | jonction Bobeica | 2/8 | 1 | Salmo. | 1,0000 | 0,9047 | 2 | Salmo. |
| 29 | Bistriţa | jonction Tarcău | 7/278 | 2 | Sco. | 0,1187 | 0,8031 | 2 | Cyprinic |
| 30 | Bistriţa | Vaduri bridge | 4/20 | 2 | Sco. | 0,2500 | 0,7088 | 3 | Salmo. |
| 31 | Bistriţa | Downstream Piatra Neamţ | 8/81 | 2 | Sco. | 0,3086 | 0,9315 | 1 | Salmo. |
| 32 | Calu | Zorleni | 3/23 | 2 | Cl. | 0,1739 | 0,9046 | 2 | Salmo. |
| 33 | Calu | Carpini | 5/54 | 3 | Cl. | 0,2962 | 0,6614 | 3 | Salmo. |
| 34 | Calu | upstream jonction Bistriţa | 6/51 | 2 | Cl. | 0,0588 | 0,3626 | 4 | Cyprinic |
| 35 | Iapa | Largu | 1/2 | 1 | Salmo. | 1,0000 | 0,8739 | 2 | Salmo. |
| 36 | Iapa | Frasin waterfall | 3/11 | 1 | Salmo. | 0,9090 | 0,8506 | 2 | Salmo. |
| 37 | Iapa | Sabău | 4/49 | 1 | Cl. | 0,3877 | 0,9690 | 1 | Salmo. |
| 38 | Iapa | Vitelău | 6/62 | 1 | Cl. | 0,4132 | 0,8245 | 2 | Salmo. |
| 39 | Iapa | up. jonct. Bistriţa | 8/53 | 1 | Cl. | 0,5094 | 0,8986 | 2 | Salmo. |
| 40 | Bistriţa | upstream Roznov bridge | 9/142 | 2 | Cl. | 0,1971 | 0,5569 | 3 | Cyprinic |
| 41 | Bistriţa | upstream Racova lake | 7/349 | 3 | Cl. | 0,5042 | 0,9711 | 1 | Salmo. |
| 42 | Bistriţa | downstream Racova | 11/209 | 2 | Cl. | 0,8133 | 1,0000 | 1 | Salmo. |
| 43 | Bistriţa | Gherăeşti | 11/520 | 2 | Cl. | 0,0000 | 0,5080 | 3 | Cyprinic |
| 44 | Bistriţa | up. jonct. Siret | - | 5 | - | - | - | - | - |

Salmo. – salmonid zone; Sco. – common nase zone; Cl. – chub zone; Cyprinic. – ciprinicola area

## CONCLUSIONS

Pollution and reservoirs appearance led to changing the structure of fish communities and even their disappearance in their entirety (the Neagra Şarului, Bistrita - Bacau downstream).

Fish communities in the upper areas of the river and main tributaries (streams) have a small number of species. In the middle of Bistrita number of species increases, as is normal, but is lower than the optimum. On the lower reaches of the river due appeared reservoirs on the river Bistrita, this number does not exceed the optimum.

Abundance is also reduced, sub-optimal due to pollution of the upper medium (SO$_3$ - downstream of the confluence the Bistrita with Neagra Şarului and presence mining) and hydro-technical management of the lower (downstream Poiana Teiului). At the confluence with the Siret, at Bacau, organic pollution resulted in total degradation of the ecosystem.

The zoning fish, IBI fall 17 sites in the trout zone - that the upper and its tributaries.

EFI + - places salmoniocola zone the 33 sites and 11 sites in the ciprinicola on the lower river. If we consider this, 20 sites in the area as trout and 24 in the ciprinicola, a situation confirmed by the

presence of dominant species of cyprinids (mediterranean barbel, common nase, chub) in the sites of the latter.

## ABSTRACT

Water pollution plus Bistrita River and crossing the river had a major negative impact on communities of aquatic organisms, particularly on fish communities.

Sampling of biological material from sampling points and data processing have led to results on the overall environmental condition of the river Bistrita.

Rich in species abundance and gives an indication of the specific degree of impairment of human impact aquatic ecosystems.

By applying synthetic ecological indexes such as IBI and EFI +, put out both the level of damage in each sampling and classification of each river section in a given fishing zone.

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