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## ENDANGERED ICHTHYOCOENOSSES OF THE SAVA AND ODRA RIVERS IN THE TUROPOLJE AREA

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In the Turopolje Valley, which occupies 600 km<sup>2</sup> of central Croatia, 22 fish species have been registered in the Odra River and 13 species in the Sava River. All native species are classified in one of the IUCN endangered categories. During the spring floods in March and April, photophilous fish species from both rivers spawn in this inundated area. A program that has been launched called »Sava 2000« should prevent further disastrous flooding. One proposed channel would drain the valley of the Odra and would alter the ecology of these wetlands. Compromise should be found to preserve at least part of these unique ecosystems.

**Key words:** Freshwater fishes, inundated area, spawning, Sava and Odra rivers, Turopolje Valley, Croatia

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U dolini Turopolja, koja zauzima površinu od 600 km<sup>2</sup> središnje Hrvatske, registrirane su 22 vrste riba u rijeci Odri i 13 vrsta u rijeci Savi. Sve su autohtone vrste klasificirane prema IUCN kategorijama ugroženosti. Tijekom proljetnih poplava u ožujku i travnju, fitofilne vrste riba iz Odre i Save dolaze na mrijest u ovo naplavljeno područje. Provedba projekta »Sava 2000« ima za cilj spriječiti buduće katastrofalne posljedice uzrokovane izlivanjem rijeka iz korita. Međutim, jedan će od projektiranih kanala isušiti dolinu Turopolja i nepovratno izmijeniti ekološku sliku postojećih vodenih i kopnenih staništa. Neophodno je pronaći kompromisno rješenje koje će sačuvati u sadašnjem stanju i obliku barem dio površina koje zauzimaju ovi jedinstveni ekosustavi.

**Ključne riječi:** slatkovodne ribe, poplavno područje, mriještenje, rijeke Sava i Odra, dolina Turopolja, Hrvatska

## INTRODUCTION

The public water management enterprise »Croatian Water Management« is in charge of overall water management in the Republic of Croatia. The hydrologic, climatic and pedologic conditions in Croatia and the agricultural requirements determine water drainage as one of the most important tasks of water management. According to BALIĆ *et al.* (1991), the land improvement area exceeds 1,789,000 ha and comprises canals and ditches to the length of 6,600 km. The network of canals has a length of 26,375 km with 23,000 structures and 82 pumping stations. The ground water drainage system operates over an area of 161,000 ha. Such a situation is not satisfactory in several respects. Only about 20 percent of total waste water in Croatia is purified. Only 8 percent of already used water is used for agricultural needs, which is far from satisfactory when compared with 40 percent in United States or the high 83 percent in Greece. Today only 63 percent of Croatian population is supplied with water from public waterworks.

Due to the immense economic losses caused by the Sava floods (BLAŠKOVIĆ, 1970), a program called »Sava 2000« was launched to prevent the further occurrence of flooding. Detailed information about this program was given by BUSCHENFELD (1987). The project will not only reduce the area almost regularly flooded to less than 10 percent of its former extent, but will also cause the disappearance of most semi-natural wet grasslands of the area. There will be considerable loss of habitats for the rare plants and animals of such biotopes (ERN, 1985). One projected channel, designed to remove the surplus waters of the larger rivers of the area, will drain the valley of the Odra River, Turopolje. Another one would cut through the retentions of Lonjsko Polje and Mokro Polje (Fig. 1). The Turopolje channel is half finished and a small fraction of the second channel (»Strug«) already drains the lower part of Mokro Polje (ERN, 1990). The ecology of these wetlands has been changed already, but once finished, these channels will cause further alterations. Famous Slavonian oak forests cover more than 130,000 ha along the Sava and Kupa rivers (TONKOVIĆ, 1986), and 15,000 ha belongs to the Turopolje area. The ecological situation of these forests has been reported by HORVAT (1939), KURIR (1975) and RAUŠ (1975). The reduced floods and decreased ground water level would cause rapid dieback of the forest and change in microclimatic conditions, and together would unpredictably alter the wildlife relationships in the valley.

We have no previous written data about economic benefits deriving from the fisheries in this area. Nor do we have any comparable information about significance of the area as a spawning ground. Angling is poorly regulated and controlled, and poaching is an everyday activity, especially on the Odra River. Personal communication with fishermen in the villages of Desno Željezno, Peščenica and Jezero Posavsko confirmed the fact that the number of large predatory fish, especially pike, has rapidly decreased within the last 8–10 years due to habitat changes and increased angling pressure. Most of the anglers are not from this area, but from the urban areas of Zagreb, Sisak and Karlovac and the local population calls them

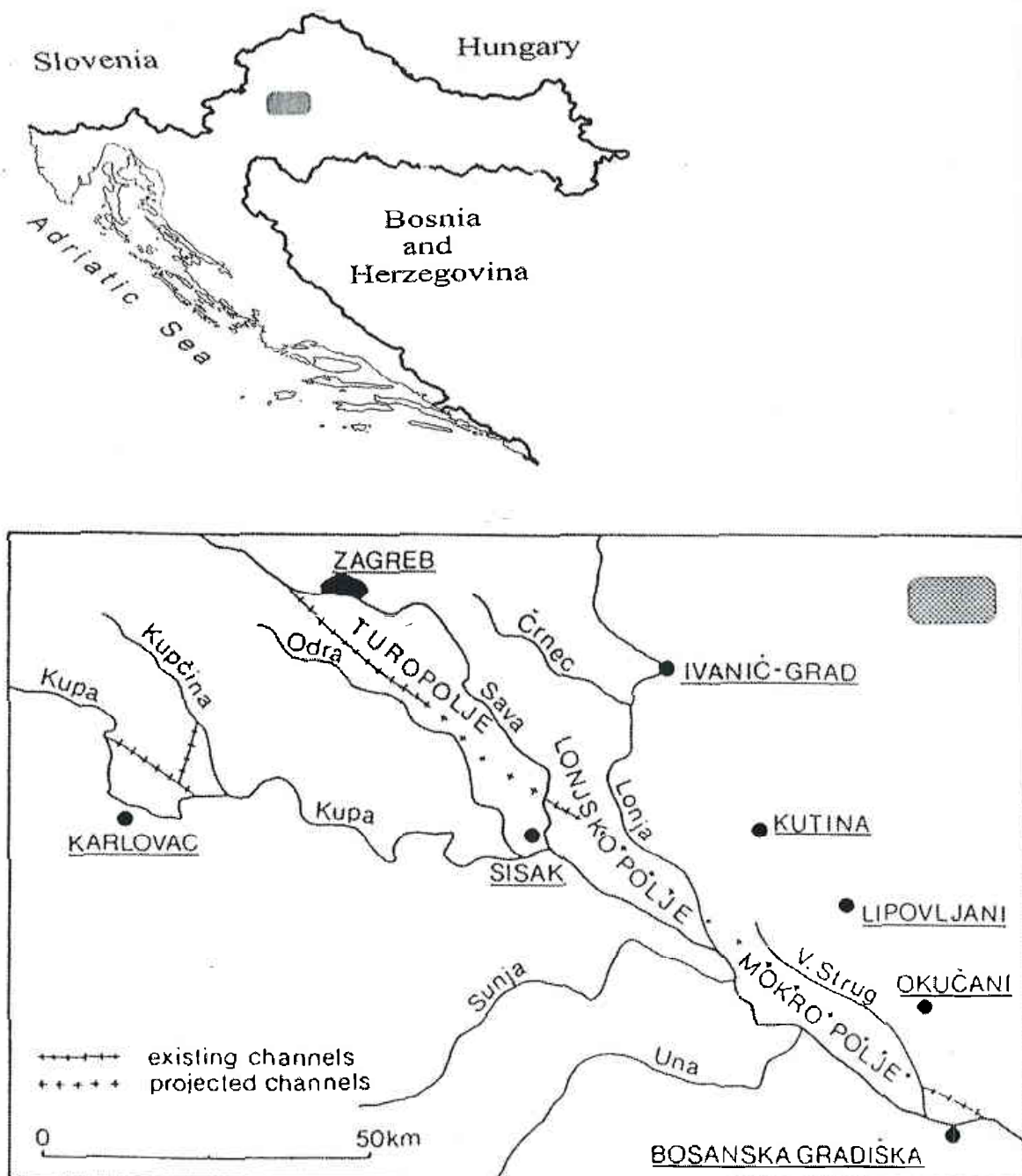


Fig. 1. Map showing the Turopolje Valley and some details of the main study area.

»weekend anglers.« Some of them have cabins along the Odra, and unfortunately most of them are not registered anglers. Artificial stocking is not properly controlled and has occasional dynamics without it being possible to supplement losses due to natural mortality, habitat changes, and illegal destruction of fish by using uncontrolled fishing gear and baits, forbidden nets, electricity, motorboats, and in the last several years dynamite and hand grenades.

Local fishermen have traditionally used nets and boats of oak to catch fish during floods. In the last decade or so, people have been able to distinguish fish from the Odra and Sava Rivers. As they say «Fish from the Sava smell and taste of oil." The increased phenol concentration in the Sava River cannot be hidden anymore, not even at times when the water is diluted with the cleaner Odra water

Except the allochthonous species *Carassius auratus*, *Ictalurus nebulosus*, *Lepomis gibbosus*, and the native *Alburnus alburnus*, all registered species are classified in one of the endangered categories (Fig. 2) as suggested by IUCN in 1980 and LELEK (1987). Among endangered (E) species, the Danube bream *Abramis sapa* is under threat because of the polluted water of the Sava in this area. Floods would make it possible for the species to find refuge in the cleaner water of Odra. The Danube bream in nearby Slovenia is listed in the category of probably extinct (Ex?) (POVŽ, 1992). The species *Silurus glanis* and *Stizostedion lucioperca* are under threat because of habitat destruction, illegal fishing, pollution and channel regulation. Eight species are listed as vulnerable (V) and seven as rare (R). According to a literature review (e.g., TALER, 1953; VUKOVIĆ & IVANOVIĆ, 1971) it can be expected, that 15 to 25 fish species that have a permanent or occasional home in the Odra River, have not been recorded through this period of study.

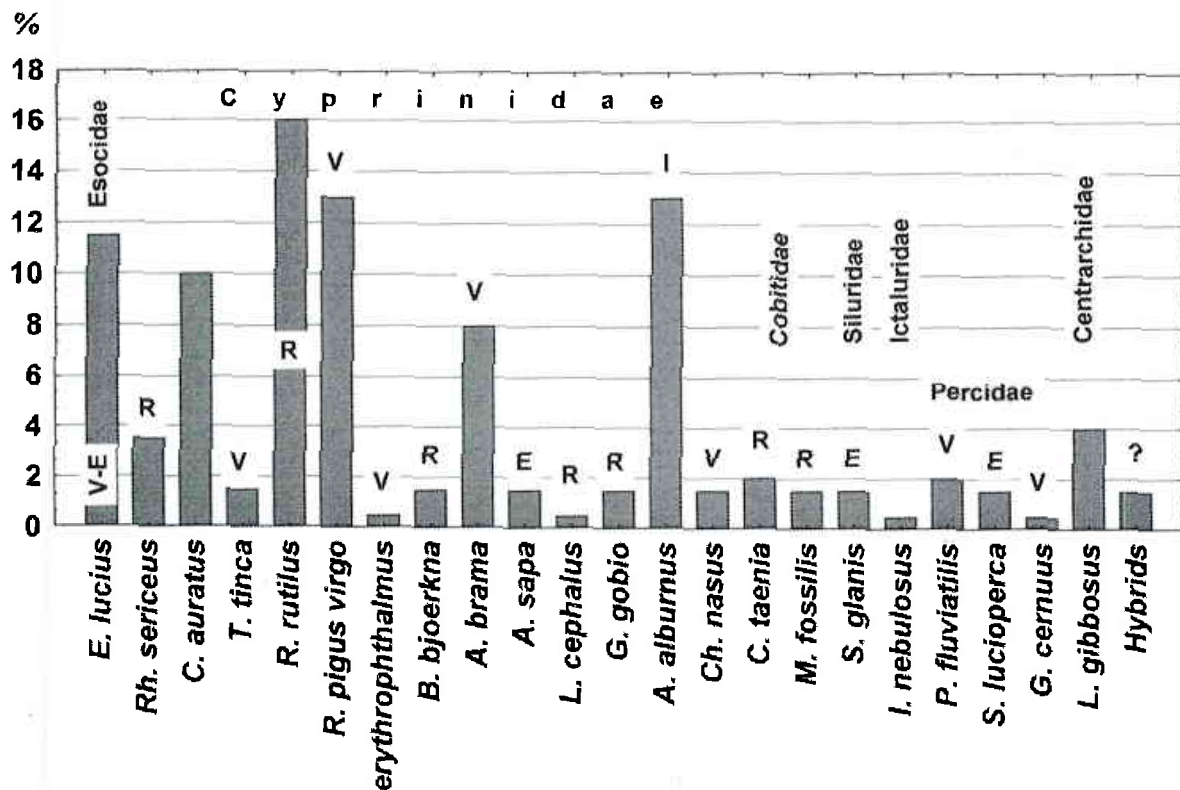


Fig. 2. Species composition of the Odra River fish fauna and their relative frequency. The meaning of the categories: endangered (E), vulnerable (V), rare (R), and indeterminate (I) are adopted from IUCN (1980) and LELEK (1987).

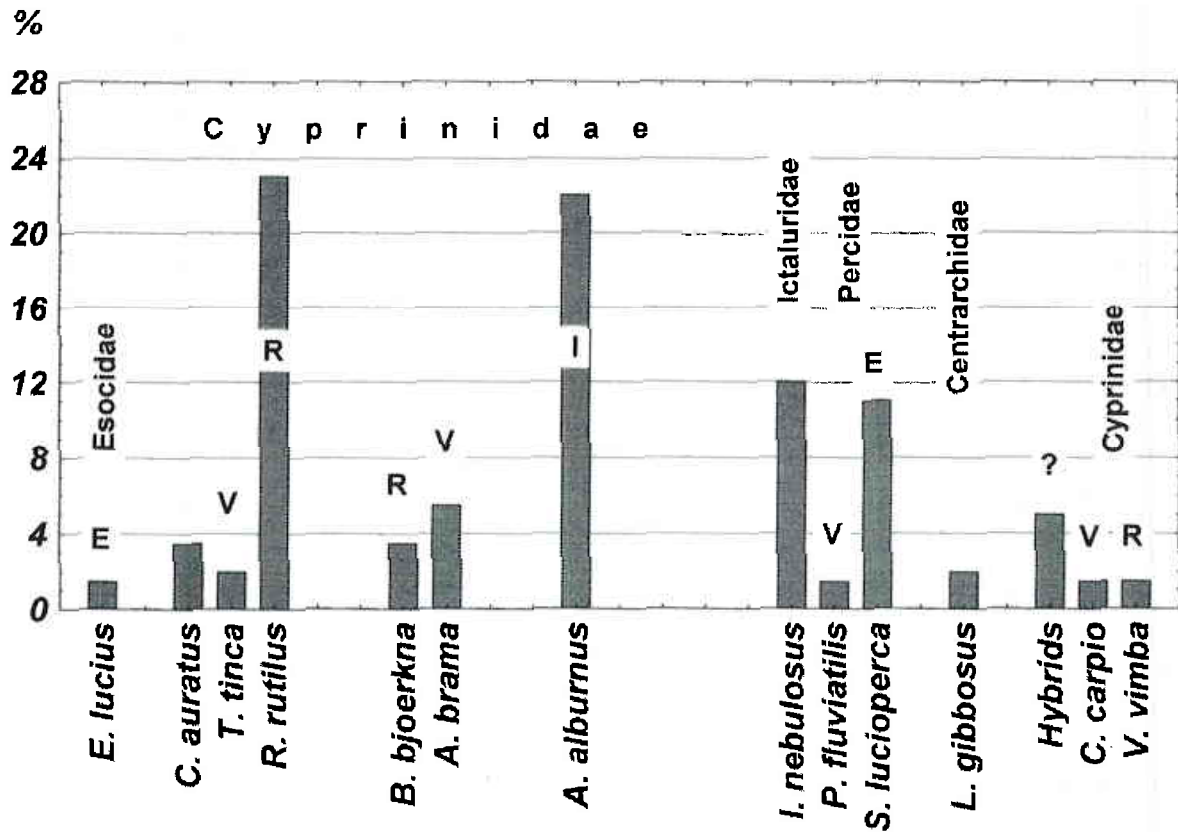


Fig. 3. Species composition of the Sava River fish fauna and their relative frequency. The meaning of the categories: endangered (E), vulnerable (V), rare (R), and indeterminate (I) are adopted from IUCN (1980) and LELEK (1987).

Endangered categories (Fig. 3) are given identically as for the Odra species, with the exception of pike, because of additional pollution caused by effluent from the Zagreb area. According to the literature (e.g., KARAMAN, 1952; TALER, 1953; SKET, 1967; VUKOVIĆ & IVANOVIĆ, 1971), under present conditions in this area, it can be expected not more than 20 additional species.

## STUDY AREA

Turopolje is an extended floodplain area in central Croatia, bordered by the Sava River on the east and north. The Kupa River is on the south, and Vukomeričke Mts on the west (Fig.1), occupying about 600 km<sup>2</sup> (45 km long and up to 23 km wide). The north-western part includes the suburbs of Zagreb, while the south-eastern part takes in the Sisak area. The valley has an average elevation of 120 m.

The Odra River, the main stream of the valley, has a number of tributaries: the Lomnica, Buna, Lekenik, and smaller creeks. It is 82.7 km long with a surface catchment area of 604 km<sup>2</sup>. Average relative slopes are very low, 0.13 ‰, which favors the creation of many meanders. The water level is in close connection with the Sava

River water level (2-3 days' difference), and most of the water mass in the Odra is already filtrated water from the Sava. The average width of the Odra channel is 25 to 30 m. Water depths do not exceed five meters. The banks are low and most of the riparian area includes willows, meadow grasses and mixed forests. The bottom of the stream is gravelly, in places covered with different layers of sand, silt or mud. The abundant macrophytic vegetation is dominated by *Ceratophyllum*, *Myriophyllum*, *Elodea*, *Sagittaria*, *Potamogeton*, and *Chara*. In shallower stream sections *Juncus* and *Scirpus* are dominant, and in deeper sites *Sagittaria* and *Vallisneria*. The water temperature varies because of underground springs, of which there are many in the upper and middle sections. Average water temperature is 17-19 C in July and 7-9 C in December.

The Sava River flows 562 km in Croatia with a drainage area of 23,243 km<sup>2</sup>. The average water flow is 1,772 m<sup>3</sup> s<sup>-1</sup> with the highest water level in November and March and the lowest in August. In central Croatia, the Sava is 199 km long, receiving waters from the Kupa, the largest tributary (296 km long) with a drainage area of 11,500 km<sup>2</sup>. The Kupa with its tributaries brings nine billion m<sup>3</sup>/yr of water into the Sava, reducing its velocity and increasing a tide of high water. Low and average flow remains in the Sava channel, while high waters tend to flood the central area called Posavlje, of which Turopolje is a part. In this area, the Sava has an average gradient of 0.098 % (BALIĆ *et al.*, 1991), and a slow current velocity. This transitional segment to the middle section of Sava is characterized by a river bed covered with gravel and sand, and along the bank a sedimentation of mud and organic matter originates from industrial effluent of Zagreb. Water quality data collected through many years (e.g., MATONIČKIN *et al.*, 1969; MEŠTROV *et al.*, 1976; STILINOVIĆ & FUTAČ, 1983 and 1985; MALOSEJA, 1983; BALIĆ, 1991) shows that the level of pollution is higher every year and that the Sava, in the studied sections, belongs to quality class III - IV (KREDBA, 1963; LIEBMANN & REIMANN, 1964) and the water of the Odra to quality class II.

## MATERIAL AND METHODS

Fish were collected from three sections on the Odra River (Selce bridge WL95; Donji Gaz WL95, Peščenka-Vratovo channel WL95) and from three sections on the Sava River (Prevlaka WL95; Desno Željezno Village XL05; Jezero Posavsko Village XL05). The Universal Transfers Mercator (UTM) coordinates net (SIVEC, 1980) is given for the sections. In each section, three to five sites (30 to 150 m in length) were chosen to represent the widest range of fish habitat types. Stream sites were visited two to eight times over the study period.

Data were collected in December of 1985; March, April, May of 1986; July and December of 1993; April of 1994. During March and April floods, fish were collected throughout the 24-hour period by using three 3.5 cm floated gill nets 45 m long in the area between Jezero Posavsko, Suša and Desno Željezno, - the area flooded by the Sava and Odra. All available methods were used: electrofishing with a »Potok

1200«, 1.2 kw current backpack electroshocker, angling, netting, and interviewing domestic fishermen. Captured fish were identified to species level and combined data are presented for the following purposes only: to estimate species composition of the fish fauna in the area flooded in spring, and to establish the composition of fish species in the two target rivers outside the spring period. Not for this study, specimens were weighed, measured and released, if not kept for age determination.

Additional information was provided from the Croatian Natural History Museum fish collections (CNHM). Objective circumstances in Croatia did not allow sampling periodicity, intensity and the purchase of equipment necessary for sampling large streams and water bodies as had been planned. So, whenever these results are used, this should be considered. Nevertheless, the data should make clear the unique ichthyological significance of the Turopolje valley for central Croatia. Taxonomy follows LELEK (1987) and HOLČIK (1989).

## RESULTS

### Species composition of the fish fauna in the Odra River

During the study, 1278 specimens were caught in the Odra, with a total of 22 species (Fig. 2) belonging to seven families: Esocidae, Cyprinidae, Cobitidae, Siluridae, Ictaluridae, Percidae, and Centrarchidae. The most frequent among them was Cyprinidae, represented by 13 species or 59 %. The pike (*Esox lucius*) is the typical predatory fish of the Odra. The pike-perch (*Stizostedion lucioperca*) and wels (*Silurus glanis*) are occasional guests that will remain after the flood water retreats. Among native species, *Rutilus rutilus*, *Rutilus pigus virgo*, and *Alburnus alburnus* represent major prey for the pike and other facultative predators such as *Leuciscus cephalus* and *Perca fluviatilis*.

### Species composition of the fish fauna in the Sava River

A total of 1233 specimens was caught and 13 species were determined (Fig. 3) belonging to five families: Esocidae, Cyprinidae, Ictaluridae, Percidae, and Centrarchidae. Species of the families Cobitidae and Siluridae were not recorded. Species *S. glanis* lives in this segment of the Sava, but it is quite rare for it to be caught in a water course. The presence of the spined loach (*Cobitis taenia*) and the pond loach (*Misgurnus fossilis*) is questionable. As benthic fishes, both species are endangered if not extinct in this segment of the river because of heavy sedimentation and oxygen depletion in the summer months and anoxic conditions at the bottom. Species that occupy the upper water layers, *R. rutilus* and *A. alburnus*, were the most frequent, as in the Odra. *Cyprinus carpio* and *Vimba vimba* were two species not registered in the Odra but caught in the Sava. The pike specimens (7 cm average total lengths) were caught in a small backwater on May 26, 1986, with many 4 cm in total length juveniles of the pike-perch. This finding shows again the importance

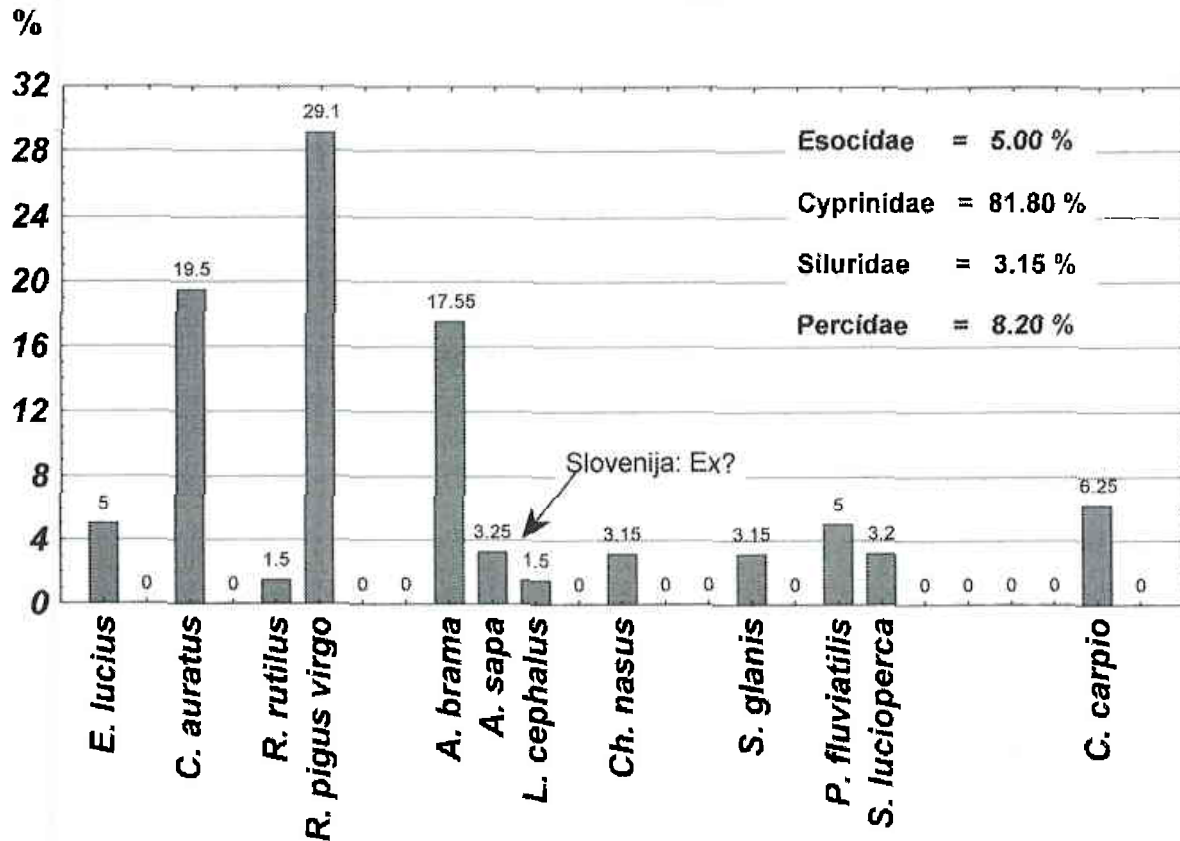


Fig. 4. Composition of the registered fish fauna during the spring floods in the Turopolje Valley.

of unregulated river segments. High water peaks would fill back channels, depressions, pockets and pools along the main river course enabling fish to use these waters as spawning and nourishing areas. The number of gibel carp collected (*Carassius auratus*) does not reflect real abundance and relation to other species. This gynogenetic and allochthonous form is very persistent and quite abundant in this area, and I assume that the population is still in expansion in the Sava between Zagreb and Sisak and further downstream. LUSK *et al.* (1977) explained the reasons for the decline of the crucian carp (*Carassius carassius*) which is gradually being replaced by *C. auratus*; the decline is linked with the drainage of wetlands. The crucian carp was not registered at all, although it was characteristic species in the waters of Turopolje not long ago. Adding its resistance to extreme environmental conditions, I can only support the reasons for its decline as stated by LUSK & al. (1977).

### Composition of fish fauna during spring floods

Almost 35,000 ha was flooded in the period of March 20 to April 10 1986 when we collected most of the fish. The Odra River flooded an area along 30 km of its course, and fish from the Sava and Odra came together at their yearly meeting. In a period of four x 24 hours 549 fish were caught by floating nets. A total of 12



species was recorded (Fig. 4) belonging to four families: Esocidae, Cyprinidae, Siluridae, and Percidae. Total weight of fish caught was 497.25 kg with an average individual fish weight of 0.906 kg. Assuming that our effort resulted in an absolute catch over 10 ha and that only 20 % of the inundated area was suitable for or occupied by fishes, then in the short and most important period, the inundated area of the Turopolje valleys will be occupied by 348,075 kg of fish or 384,300 specimens. Among them, the majority would be mature and ready to spawn. The inundated areas and the Sava and Odra rivers habitats enable ecologically and behaviorally varied reproductive methods of fish in the Turopolje area (Table 1).

**Table 1.** Ecoethological guilds of fishes recorded during research in the Sava and Odra rivers. For additional information refers to the Figures 2, 3, and 4.

Species	Strategy of spawning	Sava river (% of specimens)	Odra river (% of specimens)	Period of floods (% of specimens)
<i>Esox lucius</i>	photophilous	1.5	11.5	5.0
<i>Rhodeus sericeus</i>	ostracophilous	?	3.5	?
<i>Cyprinus carpio</i>	photophilous	1.5	?	6.0
<i>Vimba vimba</i>	lithophilous	1.5	?	?
<i>Carassius auratus</i>	phytophilous	3.5	10.0	19.5
<i>Tinca tinca</i>	phytophilous	2.0	1.5	?
<i>Rutilus rutilus</i>	phytophilous	23.0	16.0	1.5
<i>Rutilus pigus virgo</i>	phytophilous	?	13.0	29.0
<i>Scardinius erythrophthalmus</i>	phytophilous	?	0.5	?
<i>Blicca bjoerkna</i>	phytophilous	3.5	1.5	?
<i>Abramis brama</i>	phytophilous	5.5	8.0	17.5
<i>Abramis sapa</i>	lithophilous	?	1.5	3.0
<i>Leuciscus cephalus</i>	phytophilous	?	0.5	1.5
<i>Gobio gobio</i>	phyto-lithophilous	?	1.5	?
<i>Alburnus alburnus</i>	lithophilous	22.0	13.0	?
<i>Chondrostoma nasus</i>	lithophilous	?	1.5	3.0
<i>Cobitis taenia</i>	phyto-lithophilous	?	2.0	?
<i>Misgurnus fossilis</i>	phytophilous	?	1.5	?
<i>Silurus glanis</i>	phytophilous (guarders)	?	1.5	3.0
<i>Ictalurus nebulosus</i>	psammophilous (guarders)	12.0	0.5	?
<i>Perca fluviatilis</i>	phyto-lithophilous	1.5	2.0	5.0
<i>Stizostedion lucioperca</i>	phytophilous (nest, guarders)	11.0	1.5	3.0
<i>Gymnocephalus cernuus</i>	phyto-lithophilous	?	0.5	?
<i>Lepomis gibbosus</i>	phytophilous (guarders)	2.0	4.0	?

The heaviest pike caught was 3.5 kg, but local fishermen used to catch specimens up to 15 kg. In 1985, a 14 kg male pike-perch was caught at the same location and the same time near Desno Željezno village. The heaviest pike-perch caught through the period of this study was 1.5 kg. According to fishermen interviewed, formerly wels of 110 kg were caught, and specimens between 20 and 50 kg were caught regularly during floods. We caught four specimens between 1.5 and 4.0 kg. Twenty percent of our catch was the gibel carp, confirming its interesting but not desirable way of reproduction at this time in this area (Fig. 4). The most frequent species were Danubian roach (*R. p. virgo*) and bream (*A. brama*). One of the most endangered species in Croatia, the Danube bream (*A. sapa*) regularly spawns in this area during spring floods (Fig. 4). I have found only one comparable research work (SABIONCELLO *et al.*, 1969) about fish fauna in the Odra River. These results showed 13 species, including three species not recorded in our research: the ide (*Leuciscus idus*), asp (*Aspius aspius*), and bullhead (*Cottus gobio*). Selected data from the CNHM in Zagreb should additionally confirm that Turropolje valley used to be a unique area for fish fauna, deserving to be protected and managed accordingly. All the fish listed were caught or registered in the Sava or Odra rivers or their tributaries between Zagreb and the Sisak area. Beside the species name, the last year of the CNHM species record is shown (Tab. 2).

Species of the genus *Acipenser* are classified as possibly extinct (Ex?) in this area. The same is true for species: *H. huso*, *T. thymallus*, *P. cultratus*, *S. volgensis* and *Z. zingel*. Other species are classified as endangered (E) or vulnerable (V).

**Table 2.** Data of the CNHM about registered fish species in the research area.

Species	CNHM last record/entry
Russian sturgeon – <i>Acipenser gueldenstaedti</i> Brandt, 1833	/1899/
Stellate sturgeon – <i>A. stellatus</i> Pallas, 1771	/1887/
Spiny sturgeon – <i>A. nudiventris</i> Lovetsky, 1828	/1946/
Sterlet – <i>A. ruthenus</i> Linnaeus, 1758	/1902/
Great sturgeon – <i>Huso huso</i> (Linnaeus, 1758)	/1946/
Grayling – <i>Thymallus thymallus</i> (Linnaeus, 1758)	/1903/
Blue bream – <i>Abramis ballerus</i> (Linnaeus, 1758)	/no record for this area/
Asp – <i>Aspius aspius</i> (Linnaeus, 1758) /1981/	
Mediterranean barbel – <i>Barbus meridionalis</i> Risso, 1826 ssp. <i>petenyi</i>	/1886/
Ide – <i>Leuciscus idus</i> (Linnaeus, 1758)	/1983/
Ziege – <i>Pelecus cultratus</i> (Linnaeus, 1758)	/1954/
Minnnow – <i>Phoxinus phoxinus</i> (Linnaeus, 1758)	/1983/
Volga pike-perch – <i>Stizostedion volgensis</i> (Gmelin, 1788)	/1903/
Zingel – <i>Zingel zingel</i> (Linnaeus, 1766)	/1917/
Striped ruffe – <i>Gymnocephalus (Acerina) schraetser</i> (Linnaeus, 1758)	/1983/
Bullhead – <i>Cottus gobio</i> Linnaeus, 1758	/1969/
Burbot – <i>Lota lota</i> (Linnaeus, 1758)	/1985/
Crucian carp – <i>Carassius carassius</i> (Linnaeus, 1758)	/1990/



Old flow of the Odra river.



Inundated Turopolje Valley.

## DISCUSSION

Large scale pollution of streams, lakes and ponds, ground waters and the sea, with the previously mentioned problems, affects the human standard of living. This framework gives the idea that priorities other than particular environmental issues have to be solved first. Without arguing against this, environmentalists should exert pressure to be included in the solutions to the problem. Of the many reasons, one is crucial - we are running out of time for the preservation of the particular ecological values of certain areas. These values represent an important factor of people's well-being in developed countries. The Turopolje Valley environmental problem is an example that shows time to be a limiting factor for the freshwater fish that use this area as a spawning ground and feeding territory. This paper should not be understood as an opposition to the »Sava 2000« program, because I support every effort dealing with the prevention of further disastrous flooding. Nevertheless, controlled periodical floods on a particular area, such as the Turopolje Valley, at an exact time, is an ecological necessity and no project should prevent it. Fishery managers, ichthyologists, biologists from all fields, forestry experts, and environmentalists should be included in the solution of the problem. A compromise has to be found. The local people's way of life and their opinions have to be taken into account as well. This should be a multidisciplinary project that will bring social, economic and environmental progress to the area. Without such an approach, it will be impossible to predict the future of the wetlands and wildlife of Turopolje. I would propose immediate action to create a »Turopolje Nature Park«. The biological diversity and varied possibilities offered by this unique natural spawning ground, contributing to the exchange of genetic material of fish populations from two rivers, nesting grounds for waterfowl and other migratory and nonmigratory birds, bird-watching, trophy fishing, development of small fish farms and ecological camps cannot be replaced by the transformation of this area into purely agricultural land. It cannot be justified either economically or ethically, and definitely not ecologically. There are so few such refuges left that every effort made to preserve them is worthwhile.

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## REFERENCES:

- BALIĆ, Z., BOLIĆ, J., DOROGHY, I., JAKOPINEC, B. & RIČKOVIĆ, M., 1991: Vode Hrvatske: monografija o vodama i vodoprivredi Republike Hrvatske. Ministarstvo vodoprivrede Republike Hrvatske. Zagreb.
- BLAŠKOVIĆ, P., 1970: Dolina Save - prošlost, sadašnjost i budućnost. *Priroda* 57, 97-101.
- BUSCHENFELD, H., 1987: Naturnahe Save-Auwalder in Gefahr. Das Programm »Sava 2000« birgt Konflikt zwischen Ökonomie und Ökologie. *Geographische Rundschau* 39, 350-356.
- ERN, H., 1985: Die Save-Auen in Jugoslawien. *Berichte der Deutschen Sektion des Internationalen Rates für Vogelschutz* 25, 51-64.
- ERN, H., 1990: Threatened wetland ecosystems in the floodplains of the River Sava and its tributaries (Northern Yugoslavia). *Vegetation and flora of temperate zones*, pp. 51-59.
- HOLČIK, J., (ed.) 1989: General Introduction to Fishes /Acipenseriformes Vol. 1, Part II. In *The Freshwater Fishes of Europe*. Aula Verlag Wiesbaden.
- HORVAT, I., 1939: Stari hrastovi i lužnjaci u turopoljskom lugu. *Priroda* 29, 185-186.
- IUCN, 1980: How to use the IUCN Red Data Book Categories. Kew.
- KARAMAN, S., 1952: Prilog poznavanju slatkovodnih riba Jugoslavije. *Prirodoslovna izdanja* 25, JAZU, Zagreb.
- KREDBA, M., 1963. Standard criteria for evaluation of water quality of CMEA-VTS. *Vyzkumny ustav vodohospodarsky* 1-6. Praha.
- KURIR, A., 1975: Problematik des Schutzes der Eichenbestände in der Ebene von Drau und Save während der letzten 150 Jahre. In: *Symposium 100 Years of Scientifically Organized Forestry in Southeastern Slavonia*, pp. 35-48. Zagreb.
- LELEK, A., 1987: Threatened fishes of Europe Vol 9. In *The Freshwater Fishes of Europe*, ed. The Europ. Committee for the conservation of Nature and Natural Resources. Aula Verlag Wiesbaden.
- LIEBMANN, H., & REIMANN, K., 1964: Hydrobiologische Prüfungsmethoden. *Informationsblatt* 11, 43-53.
- LUSK, S., BARUŠ, V., & VESELY, V., 1977: On the occurrence of *Carassius auratus* in the Morava River drainage area. *Folia Zoologica* 26, 663-704.
- MALOŠEJA, Ž., 1983: Sezonske promjene kvalitativnog i kvantitativnog sastava biljnih obraštaja u rijeci Savi. *Acta Biologica* 9, 61-74.
- MATONIČKIN, I., PAVLETIĆ, Z., HABDIJA, I. & STILINOVIĆ, B., 1969: Prilog limnologiji gornjeg toka rijeke Save. *Ekologija* 4, 91-124.
- MEŠTROV, M., STILINOVIĆ, B., HABDIJA, I., KEROVEC, M., KRKAČ, N.,
- LATTINGER, R., LUI, A., MALOŠEJA, Ž., TAVČAR, V. & ŽNIDARIĆ, D., 1976: Ökologische Untersuchungen der Flussstrecke des Flusses Sava Stromabwärts von Zagreb (Oborovo-Tišina). I Die Gestaltung und Anordnung von Biozönosen und physico-chemische Eigenarten des Flusses Sava. *Bull. Scientifique A*, 21, 10-12.
- POVŽ, M., 1992: Rdeči seznam ogroženih slatkovodnih rib (Pisces) in piškurjev (Cyclostomata) v Sloveniji. *Varstvo Narave* 17, 51-59.
- RAUŠ, D., 1975. Vegetacijski i sinekološki odnosi šuma u bazenu Spačva. *Annales pro experimentis foresticis* 18, 225-346.
- SABIONCELLO, I., MARKO, S. & PAŽUR, K., 1969: Ribarsko-biološka ispitivanja rijeke Odre. *Ribarstvo Jugoslavije* 24, 45-47.
- SIVEC, I., 1980: Kartiranje nevretenčarjev Evrope predstavitev in razlaga. *Biološki Vestnik* 28, 169-194.

- SKET, B., 1967: Ključi za določevanje živali - I Sladkovodne ribe (Pisces). Inštitut za biologijo Univerze v Ljubljani pp. 89.
- STILINOVIĆ, B. & FUTAČ, N., 1983: Bakteriološke karakteristike rijeke Save od Krškog do Gal-dova. *Acta Biologica* 9, 35-47.
- STILINOVIĆ, B. & FUTAČ, N., 1985: Einfluss der organischen Belastung auf das bakteriologische Bild im Sediment des Flusses Sava von Krško bis Oborovo. 25 Arbeitstagung der IAD, 171-175. Bratislava.
- TALER, Z., 1953: Rasprostranjenje i popis slatkovodnih riba Jugoslavije. *Glasnik Prirodopisnog Muzeja*, B/5-6.
- TONKOVIĆ, D., 1986: Stari slavonski hrastici. Privlaka. Vinkovci.
- VUKOVIĆ, T. & IVANOVIĆ, B., 1971: Slatkovodne ribe Jugoslavije. Svjetlost. Sarajevo.