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Water Quality Improvements Following Political Changes, Enhanced Fish Communities, and Fisheries in the Czech Republic

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Abstract.—Political and economic changes in 1989 in the Czech Republic (a part of the former Czechoslovakia) led to the collapse of several large industries (e.g., sugar refineries, paper mills), which utilized old technology that negatively affected water quality. Simultaneously, the financial resources available to the agricultural sector were considerably reduced, which was manifested by a decrease in the use of fertilizers and pesticides. In addition, old waste-water treatment plants were modernised and new ones constructed. Together these activities substantially increased the water quality of Czech rivers. In the River Morava (Danube basin), one of the largest rivers in the Czech Republic, we observed substantial changes in the fish community over this period. Fish species richness has increased continuously over the last 10 years and has almost reached the situation that existed 100 years ago. Anglers' statistics also document an increase in fish catches. Improvements in water quality and the absence of formerly regular seasonal acute fish poisoning have come about despite the physical structure of the river remaining unchanged. Further enhancement measures will necessitate river system revitalization measures, such as longitudinal reopening of the river channel and reconnection of the main channel with its floodplain and associated water bodies.

Introduction

The River Morava is one of the most important tributaries of the River Danube. However, it has been the subject of substantial anthropogenous impacts over the last 100 years; it was one of the most seriously affected rivers in the Czech Republic in terms of the amount of water pollution resulting from industrial, household and agricultural wastes (Penáz et al. 1986). As early as the 19th century serious pollution of its waters was recorded (Kaspar 1886), with the number of incidents increasing thereafter. Increasing levels of pollution resulted in the first fish kill in the thirties, and the frequency of sporadic fish kills peaked in the 1950s and the 1960s. The result was that its formerly rich fish fauna was impoverished, with the almost complete absence of many of the original fish species (Penáz

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et al. 1986). The source of much pollution was waste water from the cellulose industry and periodic releases from sugar refineries. This organic pollution decreased dissolved oxygen below critical levels and thereby directly affected all fish assemblages in the river.

Originally the morphology of the River Morava, in common with other temperate rivers, was a continuous lentic-to-lotic sequence of alternating riffles, raceways, and pools, with a highly heterogeneous shoreline and an extensive floodplain in its middle and lower reaches. This rich patchwork of different habitat types offered a variety of niches for many reproductive guilds of fishes and was responsible for the original species-rich fish assemblage. However, a major environmental change to the river resulted from drastic channelization and regulation of the river for flood control, water extraction, and a planned scheme for navigation in the lower sections (Penáz et al. 1986). River channelization, which began during the last century and was completed in the 1980s, resulted in the isolation of meanders and other floodplain water bodies from the main channel (Matejícek 1990). River regulation created a uniform trapezoidal channel and few natural sections of the river remain.

Study Area, Material and Methods

The River Morava rises at 1380 m a.s.l. and flows 352 km into the River Danube. The section under study included river kms 69–347 in the territory of the Czech Republic. The total area drained by the river catchment is 26,579.7 km^2. The river's flow regime is extremely variable, averaging about 110 m^3/s, but ranging between 15 and 700 m^3/s at the confluence with the Danube.

Data for the present study were obtained from a fish monitoring program undertaken between 1985 and 2003. Samples were obtained by electrofishing 120 localities along the longitudinal profile of the River Morava. About 25% of localities were sampled annually in 1991–2003.

According to Czech angling law, all fishes taken from a water must be recorded in a catch statistic list by the licence holder. The fishing practice of catch and return is not widely practiced and most fish caught are retained and included in statistics. The Anglers association summarized all these statistics in all river sections for each fish species. Data on water quality were obtained from Project Morava II.–IV., analyzed by the TGM Water Research Institute in Brno (Bernardová 2003).

Results and Discussion

Water Quality Improvement

Political change in the Czech Republic (a part of the former Czechoslovakia) in 1989 (the so-called "Velvet Revolution") led to the collapse of several large industries that utilized old technology, which had hitherto negatively affected water quality in the country. Simultaneously, the financial resources available to the agricultural sector were considerably reduced, which was manifested by a decrease in the use of fertilizers and pesticides. Use of industrial fertilizers (NPK) in the River Morava basin decreased from 250 kg/ha/year in the 1980s to 75 kg/ha/year in 1997 (Figure 1). In addition, old waste water treatment plants servicing large conurbations were modernised, while new water treatment plants were constructed (Figure 1). The result was a significant decrease (>75%) in the organic load (BOD5) of rivers over the last 10 years. In addition, the load of toxic pollutants has been substantially limited (Bernardová 2003). All these direct and indirect activities have in-

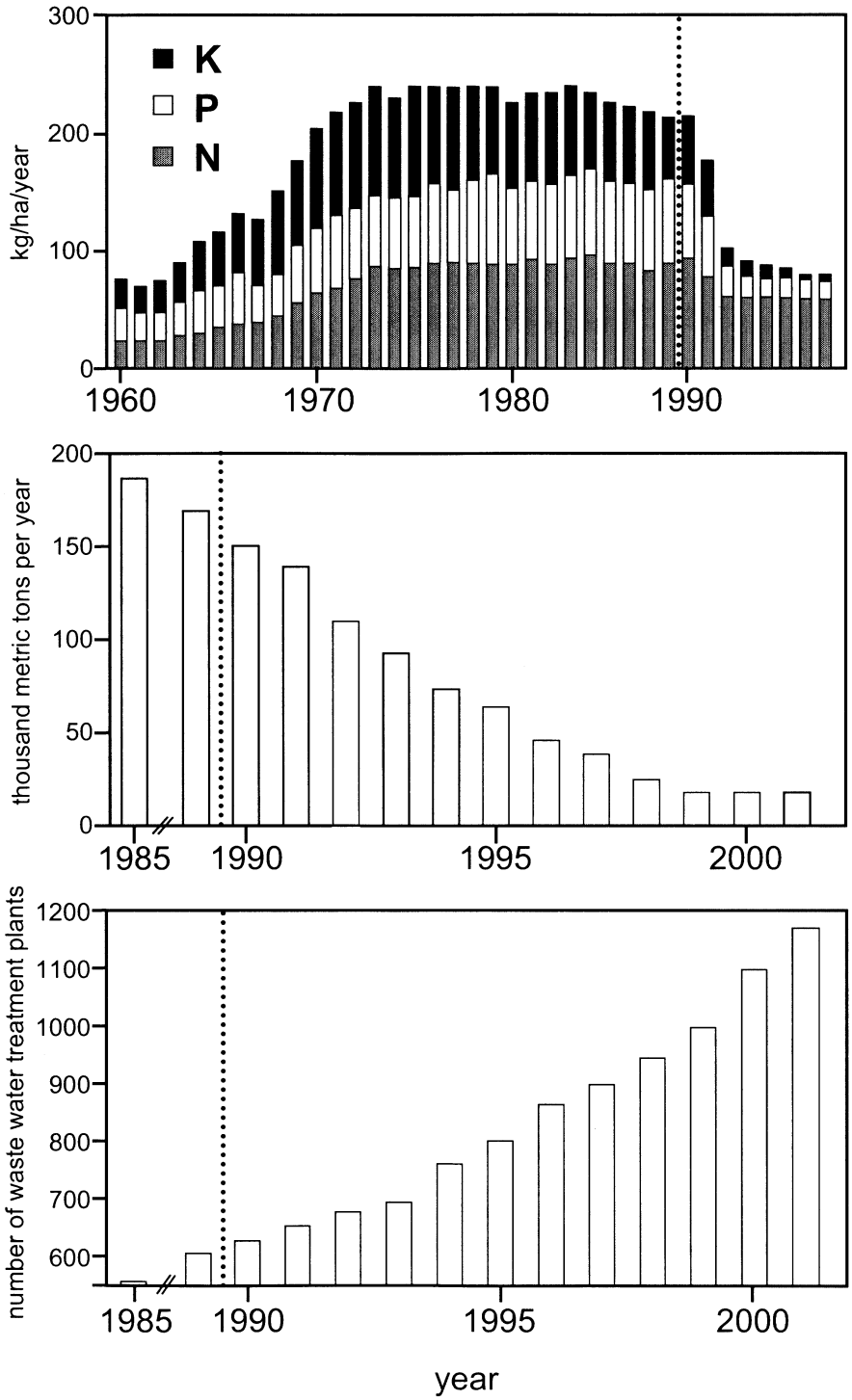

Figure 1. Application of industrial fertilisers in the River Morava basin between 1960 and 1998 (upper). Pollution discharged from point sources in the Czech Republic (BOD_5 index) between 1985 and 2001 (middle), and number of waste water treatment plants in the Czech Republic between 1985 and 2001 (lower). 1989, the year in which political changes began, is indicated by a dotted line.

creased water quality in Czech rivers substantially (Anonymous 2003).

Physical Habitat of River

No dams were built on the main channel of the River Morava, though 37 weirs were installed. These weirs, with heights up to 7.5 m, were built to regulate water levels and have had the effect of interrupting the river continuum. The general character of the modified river habitat, comprising a regulated river channel without a connection to the floodplain or adjacent water bodies, has not been substantially improved during the last 14 years and almost no rehabilitation activities have been undertaken.

Species Richness

The historical ichthyofauna of the River Morava is probably one of the best documented in central Europe. The first scientific lists of fishes were already published in the mid-1800's by Heinrich (1856) and Jeitteles (1863, 1864), followed by faunal records by Kitt (1905). Based on these historical records, 2 lampreys and 51 fish species were recorded as native to the River Morava system in the territory of the Czech Republic (upstream of river km 69). During the fifties and sixties of the 20th century, when anthropogenous impacts were most severe, many sensitive species disappeared from the main channel (Kux 1956). At the beginning of the nineties 34 fish species was recorded in the river. In subsequent years species richness has continually increased, reaching a tally of 47 native species by 2003 (Figure 2). In total, including exotic species, the ichthyofauna of the River Morava now amounts to 53 species.

Angling Statistics of Catches

In this study we present angler's catches from the main channel of the River Morava between 1985 and 2002. Considerable increases in catches by anglers were apparent approximately five years following political and economic change, and reflected water quality improvements. The total catch by anglers reached almost 25 metric tons of all species in 2002, that is about 500% higher than at the beginning of nineties (Figure 2).

Conclusions

Political and subsequent economic changes in 1989 in the Czech Republic led to sudden changes to the industrial and agricultural sectors; old industries collapsed while the financial resources available to farmers were considerably limited, manifested by a decrease in the use of fertilisers and pesticides. Simultaneously, the Czech government invested in upgrading waste water treatment facilities. Together these activities substantially improved the water quality of Czech rivers. In the River Morava, fish species richness has increased, almost attaining the same situation that existed 100 years earlier. Anglers' statistics corroborate our findings, documenting a significant increase in fish catches over the same period. These improvements to the fish community have come despite few improvements to the physical condition of river habitats.

Our results demonstrate the potentially dramatic improvements to fish community richness that can arise from substantially improved water quality. Future improvements to the fish community and fisheries of the River Morava will depend on further conservation measures and rehabilitation of the river channel. The implementation of plans to create a link between the Danube, Oder and Elbe rivers, through the River Morava and a network of canals, could considerably affected the fish fauna in the Morava and Danube river systems.

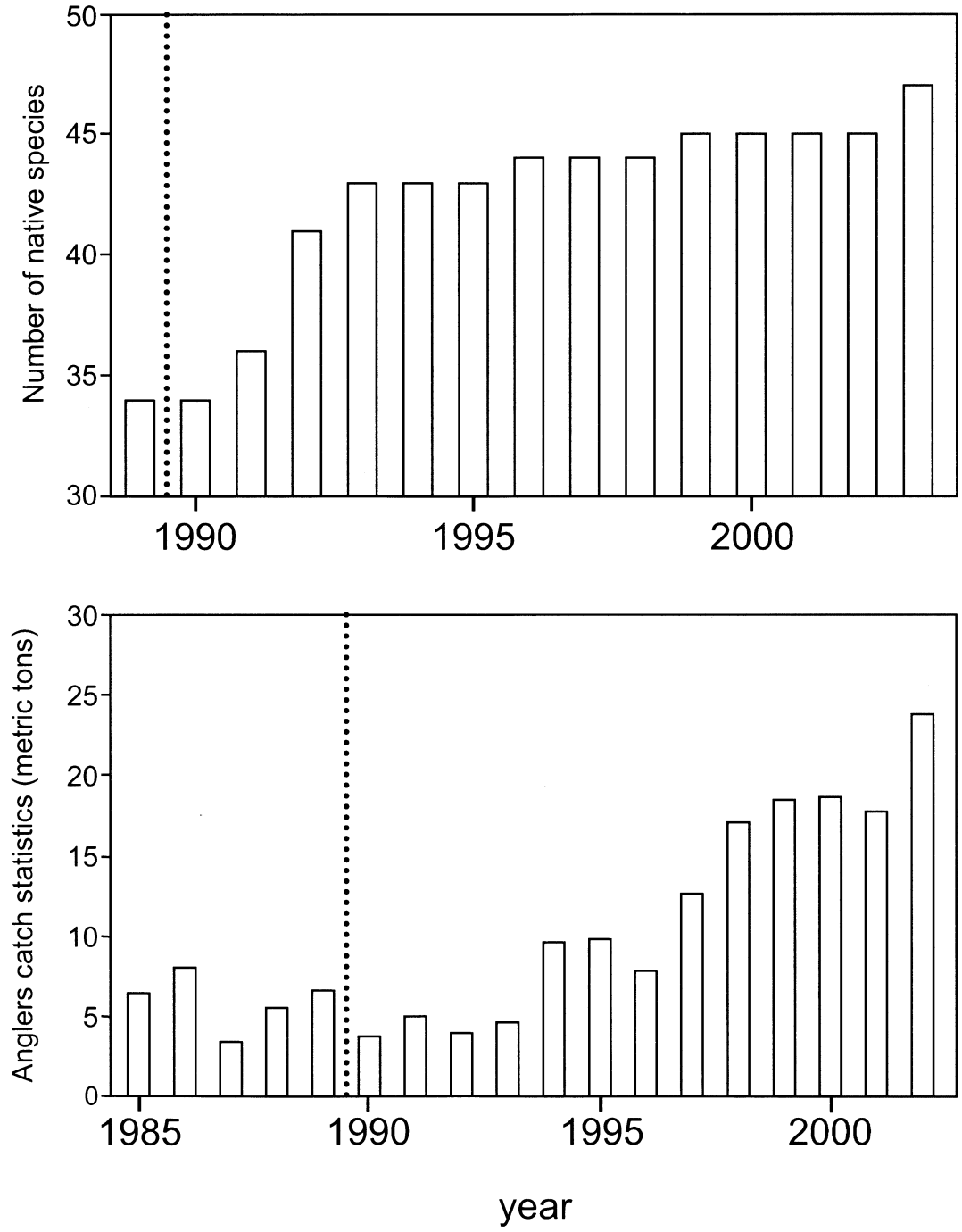

Figure 2. Cumulative species richness of fish in the River Morava (Czech Republic) between 1989 and 2003 (upper) and the dynamics of angler's catches of all fishes (in metric tons) in the River Morava (Czech Republic) between 1985 and 2002 (lower). 1989, the year in which political changes began, is indicated by a dotted line.

Acknowledgments

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