



TRENDS IN THE AVERAGE WEIGHT OF FISH CAUGHT BY ARTISANAL FISHERS IN THE CROATIAN SECTION OF THE SAVA RIVER

Tomislav Treer

University of Zagreb Faculty of Agriculture, Svetošimunska c. 25, 10000 Zagreb, Croatia

*Corresponding Author: treer@agr.hr

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ABSTRACT

The number of artisanal fishers and consequently their catch in the Sava River have been declining significantly for years. The aim of this study is therefore to examine how this affects the average weight of the most important fish species caught. The average weight increased significantly for bream *Abramis brama* ($P < 0.01$), pike-perch *Sander lucioperca* ($P < 0.01$) and wels catfish *Silurus glanis* ($P < 0.05$), while this was not the case for common carp *Cyprinus carpio* and pike *Esox lucius* ($P > 0.05$). Although recreational anglers also catch fish in the same waters, together with the two groups of fishermen from Bosnia and Herzegovina from the other bank of the river, it is expected that the average weight of the main fish caught will not decrease under the current circumstances.

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INTRODUCTION

There are major differences in the importance of commercial freshwater fisheries in different areas of the world. Artisanal fishing is still a very important food source for the rural population, especially in low-income countries in Africa, Southeast Asia and Latin America (Lynch, 2020). In contrast, its importance in Europe, North America and Australia has steadily declined over several decades (Sipponen, 2010; Cowx, 2015). The same trend continues in Croatia (Treer, 2023, 2024). The decline in fishing effort can lead to a higher average individual weight of the fish caught (e.g. Zwanenburg 2000; Pawlowski and Lorange, 2009; Zimmermann et al., 2011, Valles et al.,

2015). ABC diagrams (abundance-biomass comparison) have also been created to apply to ichthyocoenoses (Lamshead et al., 1983; Warwick, 1986; Clarke and Warwick, 1994). The aim of this paper is to investigate the trends in the weight of individual fish caught by artisanal fishermen in the Croatian section of the Sava River over the last nineteen years. The Sava River is the longest Croatian river with the largest catchment area and is part of the Danube Basin (Hrvatske vode, 2017). In the lower part of the river, which flows along the border with Bosnia and Herzegovina, angling and commercial (i.e. artisanal) fishing are permitted in both countries.

MATERIALS AND METHODS

The monitoring of freshwater fish stocks is essential for the management of artisanal fisheries (Amarasinghe and Da Silva, 1999; Roos and Longo, 2021). Therefore, logbook data are important to support the sustainable management of freshwater fisheries and can be useful in determining the trends in catches, although the reliability of self-reporting of commercial catches was questioned in some cases (Lyach and Remr, 2019; Schubert et al., 2022). In FAO Technical Papers (Group author, 2020), it is stated that in countries where commercial freshwater fishing is important, in most cases the fishers were registered and obliged to report their catches, and Croatia is mentioned as an example based on logbook returns under development. The official data were obtained from the competent Directorate of Fisheries of the Ministry of Agriculture, Forestry and Fisheries based on the annual reports on artisanal fisheries (MP, 2004; 2005; 2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022). The data were analysed for the five most important species: common carp *Cyprinus carpio*, wels catfish *Silurus glanis*, pike-perch *Sander lucioperca*, northern pike *Esox lucius* and freshwater bream *Abramis brama*.

For all data, the correlation between the average weight by species and the respective year was determined, as well as the correlation between the average weight and total catch of each species. For average weight mean, standard deviation (SD), coefficient of variation (CV) and 95% confidence limits (CL) were calculated. Statistical analysis was calculated using IBM SPSS Statistics ver.19.

RESULTS AND DISCUSSION

Trends in the average weight of fish caught by artisanal fishers were not the same for all investigated most important fish species between 2004 and 2022. The increase of average weight was highest for bream and pike-perch ($P < 0.01$). It was also significant for wels catfish ($P < 0.05$), while it hardly changed for the other two species – common carp and pike ($P > 0.05$). The average weight of bream showed the largest and constant growth over the entire study period. In addition to smaller variations, it doubled from about 0.70 kg at the beginning to about 1.40 kg in 2022 (Fig. 1). The average weight over the entire period was 1.07 kg (SD = 0.30; CV = 27.83%; CL 95% = 0.92-1.22 kg).

The average weight of pike-perch was about 1.50 kg until 2015. Since then, it has suddenly increased significantly (Fig. 2). During the entire period, its mean was 1.77 kg (SD = 0.39; CV = 21.83%; CL 95% = 1.58-1.96 kg). There was a slightly lower but steady growth in the average weight of wels catfish. For most of the period, it was around 2.50 kg, with two peaks in 2010 and 2020 (Fig. 3).

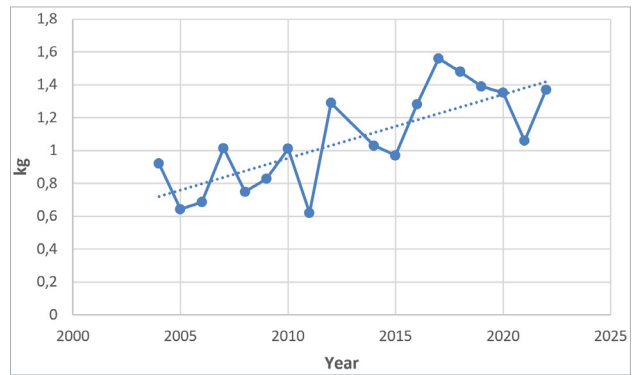


Fig 1. Trends in the average weight of bream *Abramis brama* caught by artisanal fishers in the Sava River from 2004 to 2022 ($R^2 = 0.570$; $P < 0.01$)

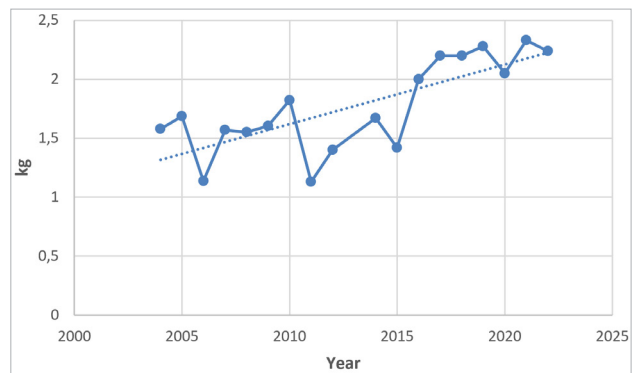


Fig 2. Trends in the average weight of pike-perch *Sander lucioperca* caught by artisanal fishers in the Sava River from 2004 to 2022 ($R^2 = 0.572$; $P < 0.01$)

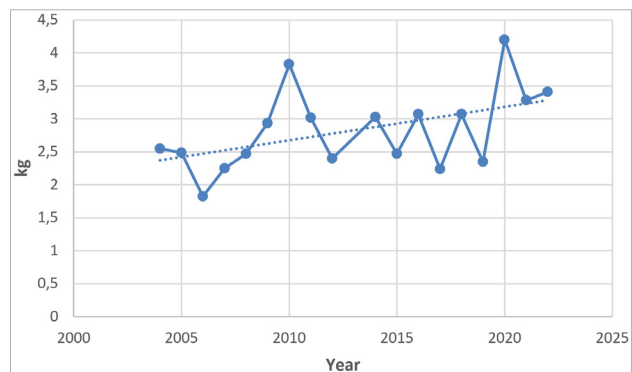


Fig 3. Trends in the average weight of wels catfish *Silurus glanis* caught by artisanal fishers in the Sava River from 2004 to 2022 ($R^2 = 0.235$; $P < 0.05$)

The average weight over the entire period was 2.83 kg (SD = 0.60; CV = 21.34%; CL 95% = 2.53-3.13 kg). Similar to wels catfish, the weight of common carp was around 2.50 kg with two peaks in 2009 and 2019-2020. However, while the weight of wels catfish has increased in recent years and become statistically significant, this was not the case for common carp (Fig. 4).

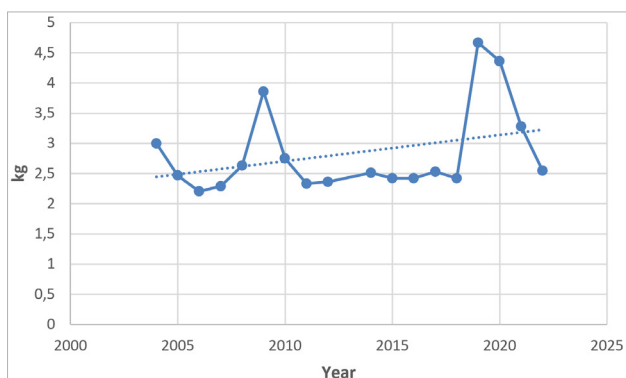


Fig 4. Trends in the average weight of common carp *Cyprinus carpio* caught by artisanal fishers in the Sava River from 2004 to 2022 ($R^2 = 0.118$; $P > 0.05$)

The average weight of common carp over the entire study period was 2.84 kg (SD=0.73; CV=25.81%; CL 95%=2.47-3.20 kg). Finally, the average weight of pike fluctuated around 1.50 kg (Fig. 5) with the lowest CV. During the entire period, it was 1.66 kg (SD=0.34; CV=20.42%; CL 95%=1.49-1.83 kg).

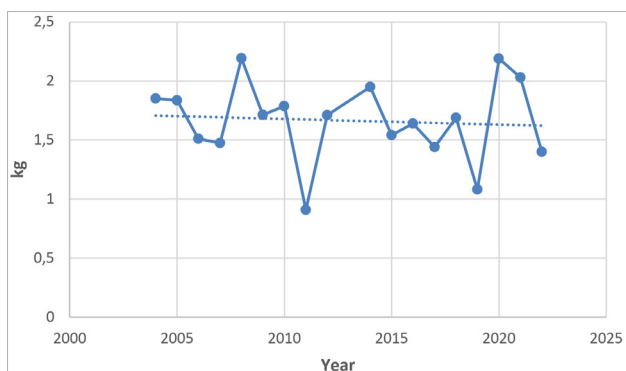


Fig 5. Trends in the average weight of pike *Esox lucius* caught by artisanal fishers in the Sava River from 2004 to 2022 ($R^2 = 0.006$; $P > 0.05$)

The relationship between total catch and average weight was negative for all species studied and even statistically significant for pike-perch ($P < 0.05$). This is in agreement with the statement by Zimmerman et al. (2011) that a simple negative relationship between fishing effort and average individual weight can be assumed. Although recreational anglers fish in the same waters, together with both groups of fishermen from Bosnia and Herzegovina from the other river bank, the significant decrease in artisanal fishing by different efficient tools (Treer, 2023, 2024) led to an increase in the average weight of some important fish species. Zwanenburg (2000) showed that the average weight of demersal fish species on the Scotian Shelf in Canada decreased when fishing effort doubled and was more prevalent for target species than

non-target species. The reverse is also true. Therefore, it can be expected that the average weight of the most important fish caught will not decrease under the current circumstances.

TRENDOVI PROSJEČNE MASE ULOVA GOSPODARSKIH RIBARA U HRVATSKOM DIJELU RIJEKE SAVE

SAŽETAK

Broj gospodarskih ribara i posljedično njihovog ulova u rijeci Savi godinama značajno opada. Stoga je cilj ovoga rada istražiti kako to utječe na prosječnu masu najvažnijih vrsta riba u njihovom ulovu. Prosječna masa je značajno porasla za deveriku *Abramis brama* ($P < 0,01$), smuđa *Sander lucioperca* ($P < 0,01$) i soma *Silurus glanis* ($P < 0,05$), dok se to nije dogodilo ($P > 0,05$) za šarana *Cyprinus carpio* i štuku *Esox lucius*. Iako u istim vodama love i rekreativni ribiči, zajedno s obje skupine ribara s druge obale iz Bosne i Hercegovine, može se očekivati da u trenutnim okolnostima prosječna masa ulova najvažnijih vrsta riba neće opadati.

Ključne riječi: slatke vode, gospodarski ribari, *Cyprinus carpio*, *Silurus glanis*, *Esox lucius*, *Sander lucioperca*, *Abramis brama*

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