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THE CO-EXISTENCE OF RECREATIONAL AND ARTISANAL FISHERIES IN THE CENTRAL PARTS OF THE DANUBE AND SAVA RIVERS

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ABSTRACT

The official data on recreational and artisanal fisheries in Croatia and Hungary were analysed. The data from Croatia relates to the entire Croatian section of the Danube River and to the section of the Sava River along the border with Bosnia and Herzegovina. The data from Hungary covers 60 km of the Danube River north of the Croatian border. Absolute catches in kilograms, as well as CPUE (kg per fisherman per year) by both groups in all three river sections varied from year to year without dramatic changes. Fishing with nets, artisanal fishermen differ from the anglers in two major ways: they are less selective and they catch bigger specimens. According to the official data, the existing ratio between recreational and artisanal fishermen in these three river sections does not negatively affect each other's or overall fishing. Therefore, a conclusion can be drawn that medium-intensive artisanal fisheries qualify to co-exist with recreational fisheries.

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INTRODUCTION

The inland fisheries sector is of global importance. It is composed primarily of small-scale fishermen and provides employment for approximately 61 million people, 50% of whom are women (Bartley et al., 2015). Although inland waters commercial fisheries have declined throughout northern and eastern Europe, they still have some significance in several eastern European countries (Cowx, 2015). Artisanal fisheries have a long tradition in providing substantial socio-economic benefit. Regionally, they can also have significant cultural value and contribute an important amount of food protein (Cooke and Murchie, 2015). However, there are frequent conflicts between recreational and professional fishermen (Mendonça, 2014; Teramoto and Diegues, 2014), which is valid also for the rivers studied in this paper (Matulić et al., 2010; Smederevac-Lalic et al., 2012). It became increasingly relevant for fish management to understand the impact of recreational fishing on commercially fished stocks and *vice versa* (Strehlow et al., 2012; Griffiths and Fay, 2015; Marengo et al., 2015). Therefore, in this research we compare the official data on both kinds of fishing on the Sava and Danube rivers in Croatia and Hungary, before the commercial fishery in Hungary was banned in 2016 (Hirado.hu, 2015).

MATERIAL AND METHODS

The official data obtained by the responsible fishery divisions of the ministries in Croatia and Hungary enabled

us to analyse recreational (i.e. angling) and artisanal (i.e. commercial) fisheries in both countries.

Fig 1. Map of the investigated area (investigated sections of the rivers are bolded)

The data covers all fishermen from the investigated river sections, because they have to send their logbooks to the ministries annually. For the recreational fishermen only angling is allowed, while artisanal ones can use nets and traps defined by the law. Besides maximum daily catch, anglers are also limited by the number of rods and hooks which they can use. Artisanal fishermen are limited by the annual catch quotas for different fish species, and those quotas are rarely fulfilled (Suić et al., 2011). Both groups are also limited by the seasons and some locations closed for fishing. The Croatian data relates to the section of the Sava River along the border with Bosnia and Herzegovina (from 515 to 343 RKM) and to the entire Croatian section of the Danube River, along the border with Serbia (from 1433 to 1295 RKM). The Hungarian data refers to 60 km of the Danube River to the north of the border with Croatia (from 1493 to 1433 RKM), (Fig. 1) because the conditions in this sector of the river are most similar to the Croatian ones (Treer et al., 2014, 2015). During the study period (from 2004 to 2011 of the Croatian section, from 2002 to 2011 of the Hungarian, and from 2005 to 2010 of the Sava River) both types of fishing were allowed. Although there are significant differences in the fishing effort (hours spent fishing, tools, skills, location along the river, etc.) among individual fisherman (McCormick et al., 2015), it is assumed that the average effort does not change much within the study periods. Therefore, the catch per unit effort (CPUE) was calculated as the annual catch in kilograms by one fisherman. The correlation between CPUE and the number of fishermen per year was calculated using SPSS for Windows 11 ($p<0.01$ and $p<0.05$). The average share by weight (mean ± SD) of the most important species in each river and the type of fishing was also calculated. There is a difference between Croatian and Hungarian logbooks as the bream, *Abramis brama* (Linnaeus, 1758), one of the most common species, is recorded separately in Croatia, while in Hungary it is recorded together with other species. Similarly, in Hungary there was no data on the number of fish caught per species as the records are related only to the weight. Therefore, it was only possible to calculate the average weight from the fish caught in the Croatian rivers.

RESULTS

During the years of investigation, the number of anglers varied from 3541 to 4953 on the Sava River, 4607 to 7358 on the Croatian section of the Danube and 1346 to 2698 on the Hungarian section. The number of artisanal fishermen varied from 6 to 9 on the Sava River, 21 to 29 on the Croatian Danube and 47 to 53 on the Hungarian Danube. The average number of artisanal fishermen in proportion to all the fishermen, and their contribution to the total annual catch (in brackets) were 0.20±0.04% (11.98±4.04%) in the Sava River, 0.40±0.06% (31.37±4.39) in the Croatian and 2.27±0.53% (58.32±2.39) in the Hungarian sections of the Danube.

Absolute catch in kilograms (Fig. 2) as well as CPUE (kg per fisherman per year) of both groups in all three river sections were relatively stable, varied from year to year but with no dramatic change. The average annual total catch in the Sava River per angler was 13.25±3.51 kg while per commercial fisherman it was 899±398 kg. In the Croatian section of the Danube, the average annual catch was 14.25±3.04 kg (angler) and 1653±233 kg (commercial fisherman).

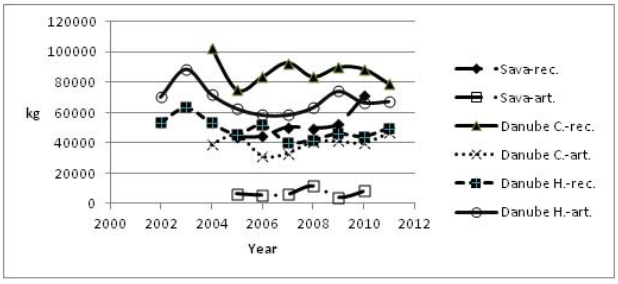

Fig 2. Comparison of total catch (kg) by recreational (rec.) and artisanal (art.) fishermen in the Sava River and in the Croatian (C.) and Hungarian (H.) sections of the Danube

In the Hungarian section of the Danube the average annual catch was 22.80 ±6.34 kg (angler) and 1379±160 kg (commercial fisherman). There was no correlation in the total catch between these two groups in Croatia (Table 1), indicating that the catch of one group did not affect the catch of the other.

Table 1. Correlations between the total catch (kg) of recreational and artisanal fishermen (b=slope of the regression line; R2= coefficient of determination; p=probability value, * p<0.05)

River	Country	Number of years	b	R^2	p
Sava	Croatia	6	0.051	0.036	0.721
Danube	Croatia	8	-0,713	0.201	0.266
Danube	Hungary	10	0.574	0.574	0.011*

However, in Hungary, where the sampling has been going on for a number of years (10), there was a positive correlation between the catch in both groups (p<0.05), showing that during the good years both groups caught more fish (Table 1).

Artisanal fishermen appear to be less selective, so in the Sava River where bream is the dominant species (Treer et al., 2003; Suić et al., 2011), it has also been dominant in the catch (Fig. 3). Similar results were obtained in two sections of the Danube. Commercial catches in the Croatian part showed bream (Fig. 4) as the most numerous species, while in Hungary all the other species, bream included, were more numerous (Fig. 5). The anglers in the Sava River (Fig. 3) and in the Croatian and Hungarian sections of the Danube River (Fig. 4 and 5) deliberately catch a higher percentage of common carp, *Cyprinus carpio* (Linnaeus,. 1758), northern pike, *Esox lucius* (Linnaeus,. 1758) and non-native species, mostly grasscarp, *Ctenopharyngodon idella* (Valenciennes, 1844) and Prussian carp, *Carassius gibelio* (Bloch, 1782). The average weight of the fish species caught was also higher in the commercial than in the recreational catch (Fig. 6).

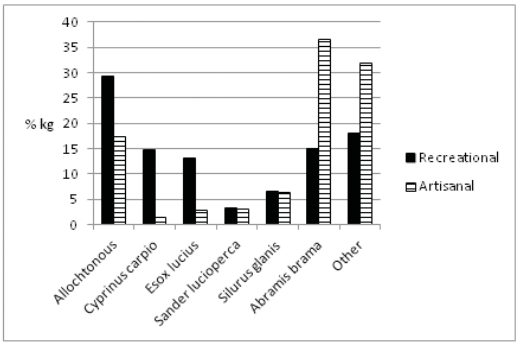

Fig 3. Average annual share of species in total catch (% kg) by recreational (full columns) and artisanal fishermen (dashed columns) in the Sava River

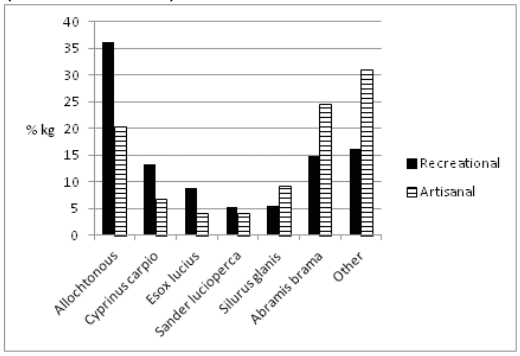

Fig 4. Average annual share of species in total catch (% kg) by recreational (full columns) and artisanal fishermen (dashed columns) in the Croatian section of the Danube

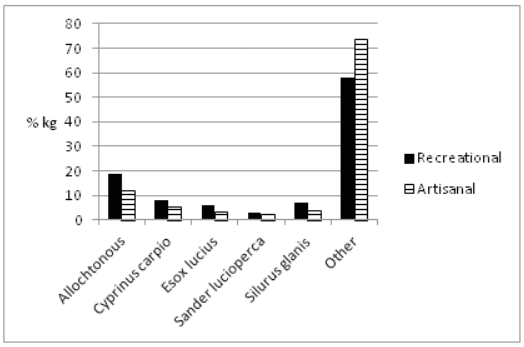

Fig 5. Average annual share of species in total catch (% kg) by recreational (full columns) and artisanal fishermen (dashed columns) in the Hungarian section of the Danube

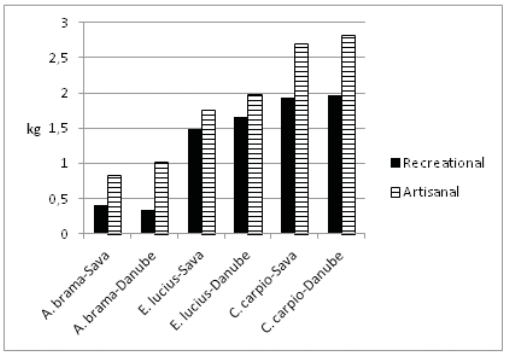

Fig 6. Average weight (kg) of the most important species caught by recreational (full columns) and artisanal fishermen (dashed columns) in the Sava River and in the Croatian section of the Danube River

As the number of artisanal fishermen is small (in tens in each country), small annual changes in their number did not cause changes in their CPUE (Table 2).

On the other hand, thousands of anglers in each country have higher annual fluctuations in number, and this is why the statistically significant negative correlations were registered between the number of recreational fishermen and their total CPUE in the Danube (p<0.01, R2 = 0.823 in Croatia and p<0.01, R2 = 0.728 in Hungary).

Moreover, the correlations in Hungary were highly significant (p<0.01) for the following most important species: European catfish, *Silurus glanis* (Linaeus, 1758), northern pike, pike-perch, *Sander lucioperca* (Linaeus, 1758), non-native species and at a lower level (p<0.05) for other species. In Croatia it was nearly significant (p = 0.052) for non-native species. The same trend was registered in the Sava River with only six years of investigation, and although not statistically significant, all the b coefficients (slopes of the regression lines) were negative. Finally, in comparing the completely independently obtained data from the Danube, combining the catch of both fishermen groups in Croatia and Hungary, a positive, although not statistically significant correlation, was found (p = 0.096; R^2 = 0.394; n = 8). This suggests that the good and bad years' catch in these neighbouring river sections has been synchronized.

Table 2. Correlations between the CPUE (kg per fisherman annually) and the number of fishermen (b=slope of the regression line; R2= coefficient of determination; p=probability value, * p<0.05; * * p<0.01)

River	Country	Number of years	Fishermen type	Fish species	b	R^2	p
Sava	Croatia	6	Recreational	All species	-0.004	0.407	0.173
Sava	Croatia	6	Recreational	Common carp	-0.001	0.361	0.208
Sava	Croatia	6	Recreational	Catfish	-0.000	0.392	0.184
Sava	Croatia	6	Recreational	Pikeperch	-0.000	0.331	0.232
Sava	Croatia	6	Recreational	Pike	-0.001	0.430	0.157
Sava	Croatia	6	Recreational	Allochthonous	-0.002	0.227	0.339
Sava	Croatia	6	Recreational	Bream	-0.000	0.002	0.942
Sava	Croatia	6	Recreational	Other species	-0.001	0.516	0.108
Danube	Croatia	8	Recreational	All species	-0.002	0.823	0.002**
Danube	Croatia	8	Recreational	Common carp	-0.000	0.315	0.147
Danube	Croatia	8	Recreational	Catfish	-0.000	0.291	0.168
Danube	Croatia	8	Recreational	Pikeperch	-0.000	0.080	0.498
Danube	Croatia	8	Recreational	Pike	-0.000	0.459	0.065
Danube	Croatia	8	Recreational	Allochthonous	-0.001	0.494	0.052
Danube	Croatia	8	Recreational	Bream	-0.000	0.104	0.435
Danube	Croatia	8	Recreational	Other species	-0.001	0.602	0.024*
Danube	Hungary	10	Recreational	All species	-0.016	0.728	0.002**
Danube	Hungary	10	Recreational	Common carp	-0.001	0.341	0.076
Danube	Hungary	10	Recreational	Catfish	-0.001	0.737	0.001**
Danube	Hungary	10	Recreational	Pikeperch	-0.001	0.717	0.002**
Danube	Hungary	10	Recreational	Pike	-0.003	0.823	0.000**
Danube	Hungary	10	Recreational	Allochthonous	-0.003	0.659	0.004**
Danube	Hungary	10	Recreational	Other species (incl. bream)	-0.006	0.406	0.048*
Sava	Croatia	6	Artisanal	All species	-93.946	0.089	0.566
Danube	Croatia	8	Artisanal	All species	-32.245	0.161	0.325
Danube	Hungary	10	Artisanal	All species	-0.105	0.000	0.996

DISCUSSION

Logbook data can provide valuable information about the fishing trends because a large number of fishermen catch fish almost every day along the whole water area (e.g. Jansen et al., 2013; Cabanellas-Reboredo, 2014; Dunn, 2014; Eero, 2015). Such data is further expanded with new innovations (Schratwieser, 2014; Wilson, 2014) and by the help of the volunteers through the citizen science (Fairclough, 2014).

Because fishing nets are the main tool, the composition of the fish species in the artisanal catch is close to the actual composition of any water body. Bigger specimens are also caught by nets. Recreational fishermen, who catch the fish only by angling, can be and are more selective. As the differences in the share of each species and the size of the fish caught by these two groups have been recorded by many authors (Changeux and Zylberblat, 1993b; West and Gordon, 1994; Kendall and Quinn, 2011) it can be concluded that, as far as the targeted species are concerned, there is no strong competition between the recreational and commercial fishermen.

The annual catch in all three investigated river sections did not change significantly over the years, while the CPUE of the anglers decreased proportionally with the increase of the number of anglers. This effect was not observed among the artisanal fishermen, whose number is much smaller. Better estimates for recreational fishermen according to their large number were also registered by Changeux and Zylberblat (1993a).

In two neighbouring sections of the Danube in Croatia and Hungary synchronised good and bad fishing years were recorded for both groups of fishermen. So, it could be

concluded that, according to the official data, the existing ratio between the recreational and the artisanal fishermen in these three river sections does not have negative effect on each other nor does it affect the overall fishery. The only consequence of higher number of recreational fishermen is lower CPUE per one angler, but the overall catch remains the same. Therefore, contrary to the situations where they are not in balance (Marengo et al., 2015), medium-intensive artisanal fisheries can co-exist with recreational fisheries (Cook and McGow, 1996; Wo os and Trella, 2015). These findings are supported by other authors (e.g. Garvey et al., 2010; Dedual et al., 2013; Cooke and Murchie, 2015; Cowx, 2015; Koehn, 2015) and suggest that creating a joint body that would include all interested stakeholders from the neighbouring countries and adopting holistic approach would prove beneficial for the management of the fisheries of the certain river basin.

Sažetak

KOEGZISTENCIJA REKREATIVNOG I GOSPODARSKOG RIBOLOVA U SREDIŠNJIM DIJELOVIMA RIJEKA DUNAVA I SAVE

Analizirani su podaci rekreativnog i gospodarskog ribolova u Hrvatskoj i Mađarskoj. Podaci za Hrvatsku odnose se na cijeli hrvatski dio Dunava i na dio rijeke Save duž granice s Bosnom i Hercegovinom. Podaci iz Mađarske pokrivaju 60 km toka Dunava sjeverno od hrvatske granice. Ukupni ulov u kilogramima, kao i ulov po jedinici napora (CPUE, izražen kao kg po ribaru godišnje) za obje skupine ribara u sva tri dijela rijeka varirali su kroz godine bez velikih promjena. Ulov gospodarskih ribara, obzirom na lov mrežama, razlikuje se od onoga ribiča na dva značajna načina: njihov je ulov manje selektivan, te love veće primjerke. Prema službenim podacima postojeći odnos u broju rekreativnih i gospodarskih ribara na ovim dijelovima rijeka ne utječe negativno jedan na drugog, kao niti na cjelokupni ulov. Stoga se može zaključiti da gospodarski ribolov srednjeg intenziteta može koegzistirati s rekreativnim ribolovom.

Ključne riječi: ribiči, komercijalni ribari, Hrvatska, slatke vode, Mađarska, tradicionalni ribolov

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