



## TRENDS IN TOTAL ANGLERS' CATCHES AT THE CROATIAN SECTION OF THE SAVA RIVER BASIN

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### ABSTRACT

The aim of this research is to analyse trends of anglers' total catches of the most important fish species caught by angling in different parts of the Sava River Basin in Croatia (*Cyprinus carpio*, *Silurus glanis*, *Esox lucius* and *Sander lucioperca*). In all investigated counties, with the exception of Vukovar-Sirmium, common carp is the dominant fish species, usually present in significantly higher quantities compared to the other three species. Only in Vukovar-Sirmium county, northern pike is the dominant species caught. In most counties there are no dramatic changes in the catches of these four fish species, apart from the usual oscillations. Due to high fishing pressure and possibly inflow of polluted water from the Bosna River, Vukovar-Sirmium county is also particularly characterised by the trend of declining catches of all four species. The significant negative correlation between the average catch and the respective value of the coefficient of variation (CV) was also found for all data.

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## INTRODUCTION

The analyses of catch trends of individual fish species are very important in fish management. Generally known analyses are the ones for Atlantic cod *Gadus morhua* Linnaeus 1758 (Mello et al., 2010) and for Atlantic bluefin tuna *Thunnus thynnus* (Linnaeus 1758) (Pillai and Satheeshkumar, 2012). That, of course, also applies to the catch in inland waters, like the big analysis of fish catches in African Lake Victoria (Hecky et al., 2010). In addition to the analysis of commercial catches, the catches of recreational fishers are also important. Lych and Remr (2019) found that in 12 years (2005-2016) catches of European perch *Perca fluviatilis* Linnaeus 1758 by angling in the Czech Republic declined by up to 60%.

The Sava River is the longest Croatian river with the largest catchment area and is part of the Danube catchment area (Hrvatske vode, 2017). The upper part of the river is entirely located in Croatia where only recreational fisheries by angling are allowed. In the lower part of the river that flows along the border with Bosnia and Herzegovina, angling and commercial (i.e. artisanal) fisheries are allowed in both countries. Therefore, the aim of this research is to analyse trends of anglers' total catch of the most important fish species caught by angling in different parts of the Sava River Basin in Croatia.

## MATERIALS AND METHODS

The official data was obtained by the competent Directorate of Fisheries of the Croatian Ministry of Agriculture (HŠRS, 2005; 2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013, 2014, 2015, 2016, 2017, 2018, 2019). The data from annual angling reports is based on the data from individual angling logbooks collected by all freshwater fishing clubs in Croatia. Despite the possible limitations in data collection, the data may be useful in determining catch trends (e.g. Lych, 2020). Recreational fishers are only allowed to engage in angling. Besides maximum daily catch, they are also limited by the number of rods and hooks they can use, as well as by the seasons and locations closed for fishing.

The total catch weight of the following four most important fish species was calculated across the counties in the Sava River Basin for 15 years (from 2005 to 2019): common carp *Cyprinus carpio* Linnaeus 1758, wels catfish *Silurus glanis* Linnaeus 1758, northern pike *Esox lucius* Linnaeus 1758 and pike-perch *Sander lucioperca* (Linnaeus 1758). Five of these counties are located at the River Sava (Zagreb, City of Zagreb, Sisak-Moslavina, Slavonski Brod-Posavina and Vukovar-Sirmium), while the other three are located at the Sava catchment area (Krapina-Zagorje, Bjelovar-Bilogora and Požega-Slavonia). The specificity of the catch records in the City of Zagreb is that there is data from all fishing clubs for the period between 2005 and 2009, while between 2010 and 2019 there are no catch data from the

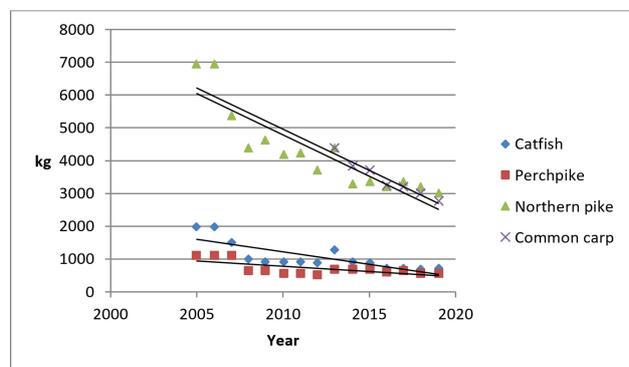
clubs with large catches, so these data serve only as an indication of possible trends. Both flowing and stagnant waters in each county are included.

In each county, the correlation between years and catch (trend) was determined for each fish species, as well as the extent of the coefficient of variation (CV, % share of standard deviation in the mean value of the catch size). Also, for all the data, the correlation between the average catch size and the respective coefficient of variation was determined. Statistical analysis was calculated using IBM SPSS Statistics 19.

## RESULTS AND DISCUSSION

In all surveyed counties, except in Vukovar-Sirmium, the dominant species in the catch is common carp, mostly in much larger quantities than the three other species. Only in Vukovar-Sirmium county, northern pike is mostly caught (Table 1).

In most counties, the catch of these four species of fish, with the usual oscillations, did not change dramatically. However, compared to the first few years of research, a statistically significant trend of increasing catches was observed in three counties for northern pike, in two for common carp, and in one for wels catfish and pike-perch. In contrast, a statistically significant decline in catches was observed in two counties for common carp, especially Vukovar-Sirmium county where there was a marked trend of decline in catches throughout the research period for wels catfish, pike-perch and northern pike, and from 2013 for common carp ( $p < 0.01$ ) (Fig. 1).



**Fig 1.** Negative trends of the quantity of catch (kg) during entire investigated period (2005-2019) for wels catfish, pike-perch and northern pike, and during 2013-2019 for common carp (all  $p < 0.01$ ) in Vukovar-Sirmium county

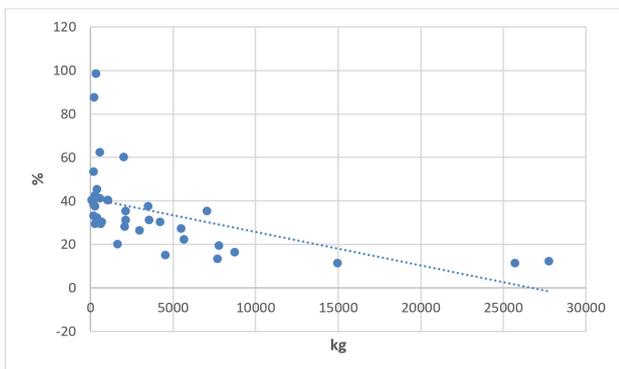
In the section of the Sava River in Vukovar-Sirmium county, the participation in the total anglers' catches surpasses the participation in the number of anglers compared to the entire Croatian Sava River Basin (Piria et al., 2020). The artisanal fishery is most developed there. Furthermore, commercial and recreational fishers from Bosnia and Herzegovina from the right bank of the river also participate in the catch.

**Table 1.** Average yearly total weight (g) with standard deviation (SD), slope of the regression line (b, \*p<0.05, \*\*p<0.01) and coefficient of variation (CV) according to species and counties (K-Z= Krapina-Zagorje, Zag= Zagreb, GZ= City of Zagreb, S-M= Sisak-Moslavina, B-B= Bjelovar-Bilogora, P-S = Požega-Slavonia, B-P= Slavonski Brod-Posavina V-S= Vukovar-Sirmium). All counties from 2005 to 2019, except for the City of Zagreb (2005-2009 and 2010-2019)

Species	County	Average	SD	b	CV
<b>Common carp</b> <i>Cyprinus carpio</i>	K-Z	7823	1489	192.007*	19
	Zag	25769	2775	-389.071*	11
	GZ (2005-2009)	14991	1575	-511.7	11
	GZ (2010-2019)	7700	1030	84.752	13
	S-M	8814	1436	-39.696	16
	B-B	27838	3291	-546.654**	12
	P-S	4589	702	123.625**	15
	B-P	7108	2515	286.057	35
	V-S	3027	799	39.279	26
<b>Wels catfish</b> <i>Silurus glanis</i>	K-Z	306	88	-1.979	29
	Zag	1674	329	-4.575	20
	GZ (2005-2009)	3608	1107	287.1	31
	GZ (2010-2019)	412	405	71.964	98
	S-M	5564	1481	106.725	27
	B-B	459	147	-9.257	32
	P-S	118	47	-4.639	40
	B-P	2172	758	96.582*	35
	V-S	1071	428	-75.918**	40
<b>Pike-perch</b> <i>Sander lucioperca</i>	K-Z	199	76	4.471	38
	Zag	654	189	6.382	29
	GZ (2005-2009)	636	258	-115.2	41
	GZ (2010-2019)	303	264	54.327	87
	S-M	2139	602	11.979	28
	B-B	345	127	5.025	37
	P-S	223	118	3.871	53
	B-P	1092	434	81.496**	40
	V-S	716	216	-32.682**	30
<b>Northern pike</b> <i>Esox lucius</i>	K-Z	310	131	14.511	42
	Zag	2199	692	-54.043	31
	GZ (2005-2009)	3539	1294	465.5	37
	GZ (2010-2019)	614	378	81.764*	62
	S-M	5712	1251	206.025**	22
	B-B	436	194	-0.143	45
	P-S	227	75	4.404	33
	B-P	2054	1227	175.611*	60
	V-S	4278	1270	-251.457**	30

All this makes fishing pressure much higher than in counties upstream where only Croatian anglers fish. The additional indicator of high fishing pressure in Vukovar-Sirmium county is the fact that the significantly ( $p < 0.05$ ) smallest specimens of these four fish species are caught there (Treer, 2021). The additional negative influence could be the polluted waters of the big Bosnian River Bosna which, prior to flowing into the lower section of the Sava River, passes through urban and industrial cities (Tousova et al., 2019).

The coefficient of variation (CV) is an important tool in quantifying annual variation in fish catchability (e.g. Shelton, 2017). In the case of fish species caught in smaller quantities, occasionally higher or lower catches can result in significant oscillations and, in these cases, it is more difficult to determine trends with certainty. In contrast, for species that are caught in large quantities, annual variations in catches are lower and the trends are more noticeable and reliable. Thus, in the investigated case of the catch of four significant fish species of the Croatian Sava River Basin, a marked negative correlation ( $p < 0.01$ ) was found between the average size of the catch (kg) and the size of the respective coefficient of variation (%) (Fig. 2). This can be seen in all Sava counties. On average, 11,962 kg of common carp are fished by county, with an average coefficient of variation of 17.6%. Catches of wels catfish, pike-perch and northern pike are significantly lower, on average between 700 kg and 2152 kg, and the coefficients of variation for these species average between 39.1% and 42.6%. Therefore, Francis et al. (2003) suggest that CVs of the annual variation component should not be ignored, together with the use of other issues connected with recreational fisheries (Matulić et al., 2010).



**Fig 2.** The relationship between the average quantity of the catch (kg) and respective coefficient of variation (%) of all analysed fish in counties of the River Sava catchment area ( $y = 41.218 - 0.002x$ ;  $p < 0.01$ )

## TRENDOVI U UKUPNOJ MASI RIBIČKOG ULOVA U HRVATSKOM DIJELU PORJEČJA SAVE

### SAŽETAK

Cilj ovoga rada je utvrditi trendove ukupne mase ulova udičarenjem četiri najvažnije vrste riba u ribarstvu (*Cyprinus carpio*, *Silurus glanis*, *Esox lucius* i *Sander lucioperca*) u pojedinim županijama porječja rijeke Save. U svim istraživanim županijama, osim u Vukovarsko-srijemskoj, dominantna vrsta u ulovu je šaran, većinom u znatno većim količinama nego tri ostale vrste. Jedino se u Vukovarsko-srijemskoj županiji najviše lovi štuka. U većini slučajeva ulov ove četiri vrste riba, uz uobičajene oscilacije, nema dramatične promjene u savskim županijama. Vukovarsko-srijemska županija je specifična i u izrazitom trendu pada ulova sve četiri istraživane vrste, najvjerojatnije zbog velikog ribolovnog pritiska, a i dotoka onečišćene vode iz rijeke Bosne. Uz to, kod svih podataka utvrđena je snažna negativna korelacija između prosječne veličine ulova i njegovog varijacionog koeficijenta (CV).

**Ključne riječi:** slatke vode, rekreativni ribolovci, *Cyprinus carpio*, *Silurus glanis*, *Esox lucius*, *Sander lucioperca*

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