



A new trend in Central European recreational fishing: More fishing visits but lower yield and catch

Roman Lyach*, Martin Čech

Institute for Environmental Studies, Faculty of Science, Charles University, Benátská 2, 12801, Prague, Czech Republic

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ABSTRACT

Recreational fishing is a major leisure activity in many European countries but social aspects of angling are still understudied. This study aimed to examine long-term social trends in recreational fishing. Data was obtained from annual angling reports collected by the Czech Fishing Union. Data from annual angling reports is based on data from individual angling logbooks collected from 238 fishing grounds over the course of 11 years in Prague and Central Bohemia, Czech Republic. It was discovered that the numbers of individual anglers and angling visits on fishing grounds have been increasing. An average angler visits higher diversity of fishing grounds but anglers keep on returning to individual fishing grounds less frequently. Frequency of angling guard controls on fishing grounds has been increasing as well. On the other hand, angling yield and catch have been decreasing. The number of anglers who take home at least one fish has been increasing but percentage of anglers who take home at least one fish has been decreasing. In conclusion, recreational fishing is on the rise but fish catch and yield are decreasing.

1. Introduction

Recreational fishing is defined as fishing of aquatic animals (mainly fish) that do not constitute the individual's primary resource to meet basic nutritional needs and are not generally sold or otherwise traded on export, domestic, or black markets (FAO, 2012). Cooke and Cowx (2004, 2006) roughly estimated that all anglers around the world might catch up to 47 billion fish annually. Further, they claimed that the overall catch in recreational fishing is about 12% of catch in commercial fishing. By studying inland fisheries in developed countries, previous research has suggested that recreational fishing is more widespread than commercial fishing (Arlinghaus et al., 2002; Arlinghaus and Cooke, 2005; FAO, 2010). Arlinghaus et al. (2015) claimed that approximately 10.5% of population in developed countries practice angling. Many studies reported that recreational fishing has been on the rise (Marta et al., 2001; Rasmussen and Geertz-Hansen, 2001; Freire et al., 2012; Gupta et al., 2015). People still seek fishing experience and tranquil natural surroundings despite having access to variety of tempting ways to spend leisure time in the world of electronic gadgets and virtual reality (Morales-Nin et al., 2015). Angling is a major recreational activity in many countries because it holds many socio-economic benefits like recreation, socialization, and escape from reality (Arlinghaus and Cooke, 2009; Tufts et al., 2015). On the other hand, some authors recently reported downfall of recreational fishing in

Canada, Finland, Norway, Sweden, England, Wales, Ireland, and USA (Post et al., 2002; Schramm et al., 2003; Salmi et al., 2006; Aprahamian et al., 2010; Cowx, 2015).

Several authors suggested that recreational fishing has been overlooked and understudied even though it has significant effect on fish stocks (Arlinghaus et al., 2002; Cooke and Cowx, 2004; Altieri et al., 2012; Elmer et al., 2017). Post et al. (2002) claimed that recreational fishing has been collapsing but the collapse went unnoticed due to lack of interest between scientists, management, and anglers. Many studies suggested that better monitoring of the aspects in recreational fishing is required in order to understand its current state (Arlinghaus et al., 2002; Post et al., 2002; Ward et al., 2016; Elmer et al., 2017). Anglers throughout the world keep complaining that “fishing is not what it used to be” but scientific proof of this statement is lacking (Post et al., 2002). Humans are a crucial part of freshwater ecosystems and their behaviour should receive more attention because all inland waters are greatly influenced by human activities (Rasmussen and Geertz-Hansen, 2001; Post et al., 2002; Cooke and Cowx, 2004). Several researchers suggested that social aspects of recreational fishing are poorly understood and studies regarding social aspects in fishing are urgently needed (Arlinghaus et al., 2002; Lewin et al., 2006; Beardmore et al., 2015; Ward et al., 2016). It has been stated that social aspects play a very important role in sustainable management of recreational fishing and monitoring of trends in recreational fishing should definitely receive

* Corresponding author at: Milady Horákové 586/9, 251 01, Říčany, Czech Republic.

E-mail addresses: roman.lyach@natur.cuni.cz, lyach@seznam.cz (R. Lyach), carcharhinusleucas@yahoo.com, martin.cech@natur.cuni.cz (M. Čech).

Table 1
List of variables that were used in statistical analyses in this study.

Tested parameter
Number of anglers per fishing ground
Number of angling visits per fishing ground
Number of anglers per hectare of fishing grounds
Number of visits of a fishing ground by individual anglers
Angling yield [kg] per hectare
Angling catch [individual fish] per hectare
Angling yield [kg] per angler
Angling catch [individual fish] per angler
Number of anglers who took at least one fish
Percentage of anglers who took at least one fish
Number of angling guard controls per fishing ground
Number of angling guard controls per hectare of fishing grounds

more attention (Arlinghaus et al., 2002).

This paper aimed to examine long-term social trends in recreational fishing. Twelve basic parameters in recreational fishing were used to assess the trends (Table 1). It was expected that a majority of the observed parameters would show an increasing trend over time because recreational fishing seems to be gaining popularity. It is believed that an examination of those trends is important in order to understand the complex socio-ecological system of recreational fishing.

2. Methods

2.1. Study area

The study was carried out in the regions of Prague (50°N, 14.5°E) and Central Bohemia (49.5°–50.5°N, 13.5°–15.5°E), Czech Republic, Central Europe. The region covers an area of 11 500 km² (Fig. 1). The Central Bohemian region has mostly agricultural character. Prague, the capital of the Czech Republic, has mostly urban character. The study area is dominated by the rivers Elbe and Vltava. Both rivers belong to the upper Elbe River Basin. All rivers in the study area belong to the North Sea Drainage area. Studied fishing grounds are situated in lowlands with an altitude of 200–600 m above sea level. Waters in the study areas are mesotrophic or eutrophic. The study area includes salmonid streams (dominated by salmonids) and non-salmonid rivers and reservoirs (dominated by cyprinids).

2.2. Recreational fishing in the Czech Republic

Recreational fishing in the Czech Republic is organized by the Czech Fishing Union and is centralized for most of the country (with the exception of south-Moravian Region that is under supervision of the Moravian Fishing Union). Approximately 350 000 anglers are registered in the Czech Fishing Union. Professional and amateur angling guards are responsible for monitoring of angling activities in the field. Individual fishing grounds are managed by local angling organizations. One local angling organization usually shelters all anglers from one smaller city or one part of a larger city. Fishing grounds are defined as stream and river stretches where recreational fishing is conducted.

Each angler has to obtain a fishing license and a fishing permit before he or she can start practicing recreational fishing. A fishing licence allows anglers to practice fishing in the Czech Republic. A fishing permit allows anglers to practice fishing on individual fishing grounds (Table 2a).

Anglers are required to fill a report of both visits and catches in their own individual angling logbooks when they go fishing (Table 2b). Each angler is obliged to report a fishing visit even when he or she does not catch or keep any fish. In addition, each angler is obliged to write down every catch he or she wants to keep. Fish that are released back into water are not recorded. Anglers identify and measure each kept fish to the nearest cm. Anglers then assign weight to each fish according to

their own measurement or according to official length-weight calculations provided by the Czech Fishing Union for individual fish species. Those calculations are based on general long-term observations of fish in Czech rivers. At the end of the year, anglers are obliged to deliver summaries of their angling logbooks to the Czech Fishing Union (Table 2c). The content of each angling logbook is then checked by administrative workers for errors. Data from all angling logbooks is added to the central fisheries database. The database contains summarized information about each fishing ground for each year. An example of annual angling reports for two very different fishing grounds is provided in Table 3.

2.3. Data sources

Data from 238 inland freshwater fishing grounds over the course of years 2006–2016 was used for the purpose of this study. The data was originally collected by the Czech Fishing Union and then processed by the authors of this study. Studied fishing grounds cover an area of 128.5 km². Overall angling catch on selected fishing grounds over the course of years 2006–2016 was approximately 3.5 million fish and angling yield approximately 6 thousand tons of fish.

2.4. Statistical analysis

The statistical programme R (R i386 3.3.2., R Development Core Team, 2017) was used for statistical testing. Shapiro-Wilk test was used to test the data distribution. Generalized linear models (package ‘glm’) with Poisson data distribution were used to fit the models in statistical testing (Wilkinson and Rogers, 1973). Bonferroni correction was applied when multiple groups were compared in the statistical analysis. Minimum probability level of $p = .05$ was accepted for all the statistics, and all statistical tests were two-tailed. Twelve variables were used in statistical testing (Table 1). One fishing ground was used as one study unit for all the variables.

3. Results

3.1. Angling visits

The number of individual anglers who visited fishing grounds was increasing over time ($F = 27.6$, $p < .05$, d. f. = 2616). The number of individual anglers per fishing ground increased from 260 to 490 over 10 years but the number dropped to 360 anglers per fishing ground in year 2016; nevertheless, the overall long-term trend was increasing (Fig. 2a).

The number of all angling visits per fishing ground was increasing as well. The number of angling visits per fishing ground increased from 3500 to 4500 over the course of 11 years ($F = 6.78$, $p < .05$, d. f. = 2616). There was a drop in the number of angling visits per fishing ground over the course of years 2009–2012 but the overall long-term trend was increasing (Fig. 2b).

One hectare of fishing grounds was visited by more individual anglers each year ($F = 35.57$, $p < .05$, d. f. = 2616). The number of individual anglers per hectare of fishing grounds increased from 20 to 50 over the course of 11 years. The trend in the number of individual anglers per hectare of fishing grounds was stagnating over the course of years 2009–2013 but the overall long-term trend was increasing (Fig. 2c).

Anglers kept on returning to individual fishing grounds less frequently. The number of angling visits of each fishing ground by individual anglers was decreasing over time ($F = 58.1$, $p < .05$, d. f. = 2616). An individual angler visited one individual fishing ground 11 times a year in 2006 but the number of visits dropped to just 6 visits a year in 2016 (Fig. 2d).

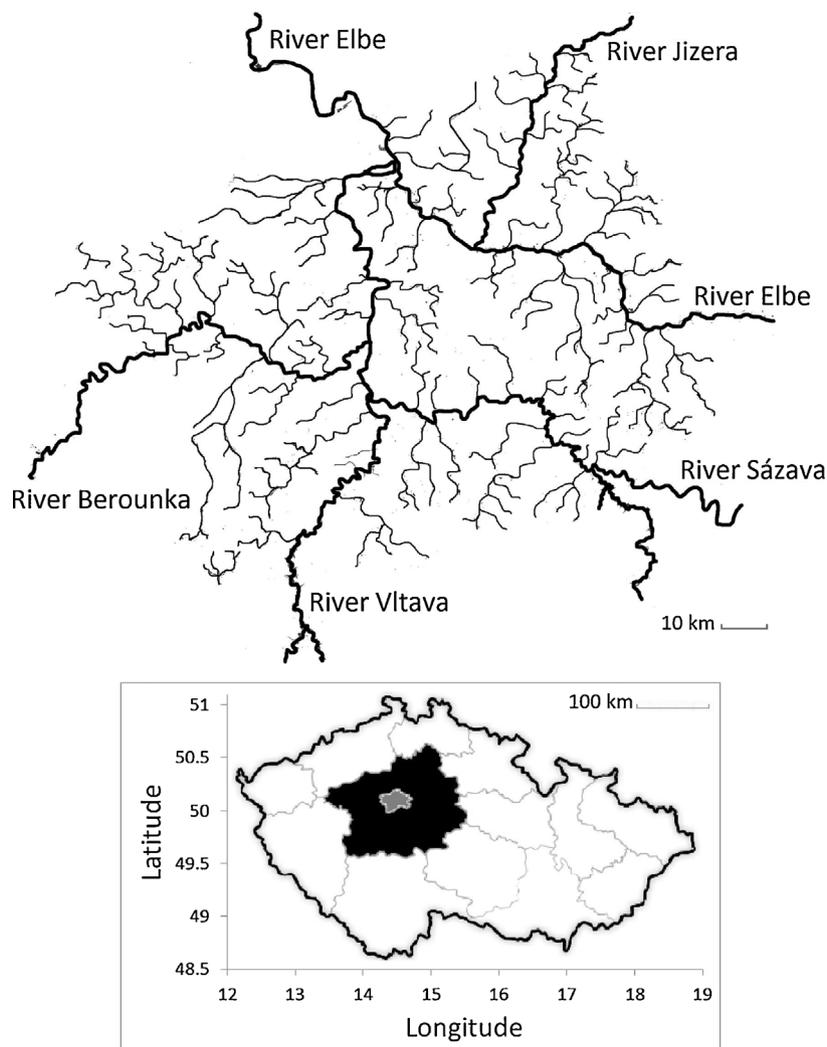


Fig. 1. Map of the study area with highlighted regions of Central Bohemia (in black; 49.5°–50.5°N, 13.5°–15.5°E) and Prague (in grey; 50°N, 14.5°E). Data was collected from 238 fishing grounds in the regions of Prague and Central Bohemia, Czech Republic, over the course of years 2006–2016.

3.2. Fish yield and catch

Angling yield and catch per hectare of fishing grounds showed a decreasing trend over time (yield: $F = 7.43$, $p < .05$, d. f. = 2616; catch: $F = 11.17$, $p < .05$, d. f. = 2616). Over the course of 11 years, angling yield decreased from 240 kg/ha to 170 kg/ha while angling catch decreased from 141 fish/ha to 99 fish/ha (Fig. 2e, f).

Angling yield and catch per one angler per one fishing ground also decreased over time (yield: $F = 35.44$, $p < .05$, d. f. = 2616; catch: $F = 58.23$, $p < .05$, d. f. = 2616). An average angler took 7.5 kg of fish per fishing ground in year 2006 but only 3.5 kg of fish per fishing ground in year 2016 (Fig. 3a). Similarly, an average angler took 6.2 fish per fishing ground in year 2006 but only 2.6 fish per fishing ground in year 2016 (Fig. 3b).

Over the course of years 2006–2014, the number of anglers who took at least one fish increased from 121 to 206 per fishing ground ($F = 14.79$, $p < .05$, d. f. = 2616). The number of anglers who took at least one fish then dropped from 206 to 122 per fishing ground over the course of years 2015–2016 but the overall long-term trend was increasing (Fig. 3c). However, the percentage of anglers who took at least one fish was decreasing over time ($F = 45.86$, $p < .05$, d. f. = 2616). The percentage of anglers who took at least one fish decreased from 63% to 51% over the course of 11 years (Fig. 3d).

3.3. Angling guard controls

Frequency of angling guard controls on fishing grounds was increasing over time ($F = 97.72$, $p < .05$, d. f. = 2616). The number of angling guard controls increased from 31 to 124 per fishing ground over the course of 11 years (Fig. 3e). One hectare of fishing grounds was monitored by angling guards at higher frequency each year as well ($F = 65.69$, $p < .05$, d. f. = 2616). The number of angling guard controls increased from 2.2 to 22.2 per hectare of fishing grounds over the course of 11 years (Fig. 3f).

4. Discussion

This paper found that popularity of angling has been increasing in the Czech Republic as more new anglers visit fishing grounds. The main driver is most likely an improvement in economic situation in the Czech Republic (Czech Statistical Office, unpubl. data). People are able to save more money to buy fishing equipment and to support their hobbies. Similar effect of correlation of financial wealth to popularity of fishing was discovered in the USA by Dotson and Charter (2003). Czech people with higher income seem to increasingly prefer outdoor activities like fishing. In case of large cities like Prague, fishing is one of the last remaining ways how people connect with nature. On the other hand, angling is also a low-risk and low-effort sport and generally one of the cheaper hobbies. That is optimal for older people with moderate or low

Table 2

An example of a fishing permit (a), a report of catches (b), and a summary of catches for the whole year (c).

a)					
Fishing permit					
ID of fishing ground	Validity dates (from – to)	Name, surname	issued by	date of issue	
411 046	1.1.2010–31.12.2010	Jan Novak	Prague 2	1.1.2010	

b)					
Report of catches					
date	ID of fishing ground	species	number	weight [kg]	size [cm]
8.7.2010	411 046	common carp	1	2.8	55
9.7.2010	411 046	common carp	1	2.5	65
21.7.2010	411 047	pike	1	2.1	58
23.7.2010	411 047	pike	1	2.6	68
18.8.2010	411 047	European catfish	1	9.5	97
20.8.2010	411 047	bream	1	1.1	41
21.9.2010	411 047	bream	1	0.8	35

c)					
Summary of catches for the whole year					
ID of fishing ground	name of fishing ground	common carp		pike	
		catches [n]	total weight [kg]	catches [n]	total weight [kg]
411 046	Elbe 14	6	12.1	2	4.4
411 047	Elbe 15	7	14.8	2	3.8

income and Kelch et al. (2006) and Rees et al. (2017) reported that most anglers fall into this socio-economic category. It has already been stated that angling is a popular leisure activity because it has significant economic, social, cultural, and traditional value (Elmer et al., 2017). Studies from other countries also reported increasing popularity of recreational fishing in Europe generally (Wallentin, 2016) and also within individual European countries, e.g. in Denmark (Rasmussen and Geertz-Hansen, 2001), and in Germany (Wedekind et al., 2001). Countries outside of Europe also reported increased popularity of recreational fishing, e.g. Brazil (Freire et al., 2012), and India (Gupta et al., 2015). Cowx (2015) discovered that the increased popularity of inland recreational fishing is positively correlated to decreasing popularity of inland commercial fishing (Cowx, 2015).

On the contrary to our results, Aprahamian et al. (2010) reported decreasing numbers of anglers in England and Wales due to unfavorable angling conditions and introduction of restrictions on angling. Similarly, Salmi et al. (2006) reported decreasing numbers of anglers in Finland, Norway, and Sweden due to loss of interest in angling and also due to lack of time, equipment, and suitable fishing sites. Data collected by the Czech Fishing Union suggests that recreational fishing in the Czech Republic has neither of those issues.

The data shows that anglers return to fishing grounds less often than they used to. Anglers are getting less loyal to their favourite fishing grounds and they switch fishing grounds more frequently. Similar trend was observed in other geographical locations, e.g. in Baltic Sea marine fishery (Hammer, 2009) and in Californian marine fishery (Dotson and Charter, 2003). It is possible that people are getting pickier when it comes to choosing fishing grounds because they can now easily afford to travel—Wallentin (2016) discovered that wealthy anglers travel to

Table 3

An example of annual angling reports from two very different fishing grounds: a) a large popular fishing ground on the Vltava River (Slapy Reservoir); b) a small and less popular fishing ground on the Šembera stream.

a)		
ID of fishing ground	Name of fishing ground	Area [ha]
401 022	Vltava River	1000
Fish species	Catch [individual fish]	Yield [kg]
carp	22 266	57 424.9
tench	153	154.1
bream	1844	1939.4
chub	22	13.6
perch	1237	495.2
barbel	0	0.0
nase	0	0.0
vimba bream	0	0.0
pike	672	1513.3
zander	1600	3283.0
European catfish	567	3720.2
European eel	189	184.1
brown trout	3	3.0
rainbow trout	19	12.1
grayling	1	0.3
brook trout	4	2.0
asp	37	145.8
whitefish	0	0.0
common huchen	1	4.5
grass carp	188	804.3
silver carp	7	97.4
crucian carp	165	123.6
burbot	0	0.0
other fish species	1969	236.3
Total	30 944	70 157.1

Parameters		
Catches per ha [individual fish]		30.94
Yield per ha [kg]		70.16
Number of individual anglers		8585
Number of anglers that caught at least one fish		4231
Number of all angler visits		88 193
Number of visits per angler		10.27
Catches per angler [individual fish]		3.60
Yield per angler [kg]		8.17
Number of visits per ha		88.19
Number of angler guard notes in all angling logbooks		1445

b)		
ID of fishing ground	Name of fishing ground	Area [ha]
413 031	Šembera stream	3
Fish species	Catch [individual fish]	Yield [kg]
carp	0	0.0
tench	0	0.0
bream	0	0.0
chub	0	0.0
perch	0	0.0
barbel	0	0.0
nase	0	0.0
vimba bream	0	0.0
pike	0	0.0
zander	0	0.0
European catfish	0	0.0
European eel	0	0.0
brown trout	4	1.2
rainbow trout	51	15.9
grayling	0	0.0
brook trout	2	0.6
asp	0	0.0
whitefish	0	0.0
common huchen	0	0.0
grass carp	0	0.0
silver carp	0	0.0
crucian carp	0	0.0
burbot	0	0.0
other fish species	0	0.0

(continued on next page)

Table 3 (continued)

b)		
ID of fishing ground	Name of fishing ground	Area [ha]
413 031	Šembera stream	3
Fish species	Catch [individual fish]	Yield [kg]
Total	57	17.70
Parameters		
Catches per ha [individual fish]		19.00
Yield per ha [kg]		5.90
Number of individual anglers		17
Number of anglers that caught at least one fish		9
Number of all angler visits		45
Number of visits per angler		2.65
Catches per angler [individual fish]		3.35
Yield per angler [kg]		1.04
Number of visits per ha		15.00
Number of angler guard notes in all angling logbooks		0

distant fishing ground more often. It has been suggested that this is because European anglers are becoming increasingly adventurous, selective, and demanding (Cooke and Cowx, 2006). Anglers were reported to travel tens of kilometers from home to catch specific fish species that are unavailable on their home fishing grounds (Sipponen and Gréboval, 2001; Wedekind et al., 2001; Dotson and Charter, 2003; Kelch et al., 2006). At that point, it probably pays off to be selective in terms of choosing between fishing grounds.

Increased desire to visit distant fishing grounds is most likely driven by improved economic situation in the Czech Republic. The economic recession from year 2008 ended in Europe several years ago (approximately in years 2012–2014) and people are compensating by spending more money on their hobbies (Czech Statistical Office, unpubl. data).

Anglers are discovering new hobbies but they still want to maintain fishing as one of those hobbies. Anglers can also afford to buy various fishing equipment that is needed for different types of angling waters (e.g. small salmonid streams versus large non-salmonid rivers or reservoirs). The Czech Fishing Union has been promoting advertisement of intensive stocking of large-sized and commercially valuable fish into Czech rivers. The goal of similar fish stocking is to lure new anglers to different fishing grounds. Positive effect of similar advertisement on angling visit rates is well known because anglers usually prefer sites with high fish abundance and clean environment (Schramm et al., 2003; Aprahamian et al., 2010; Turpie and Goss, 2014; Melstrom et al., 2015; Curtis and Breen, 2017).

Results of this study showed that the number of anglers who take home at least one fish is increasing. On the contrary, the results also showed that the percentage of anglers who take home at least one fish is decreasing. Those two results seem contradictory but their coexistence can be explained. The data shows that the number of anglers who take no fish is increasing more rapidly than the number of anglers who take at least one fish.

This study discovered that the two most important parameters in recreational fishing—fish yield and catch—have been decreasing in the last decade. In addition, individual anglers take home fewer fish than they used to. In those cases, fish yield and catch are becoming less important than the actual angling experience. Decreased yield and catch corresponds well with the increased mobility of anglers and desire of anglers to visit new fishing grounds. Newly incoming and inexperienced anglers have lower chances to land a catch because they firstly need to discover the best fishing spots and learn the most suitable fishing techniques for individual localities in order to maximize their chances of successfully landing a catch. Lower yield and catch are also caused by world-widely increased popularity of catch-and-release

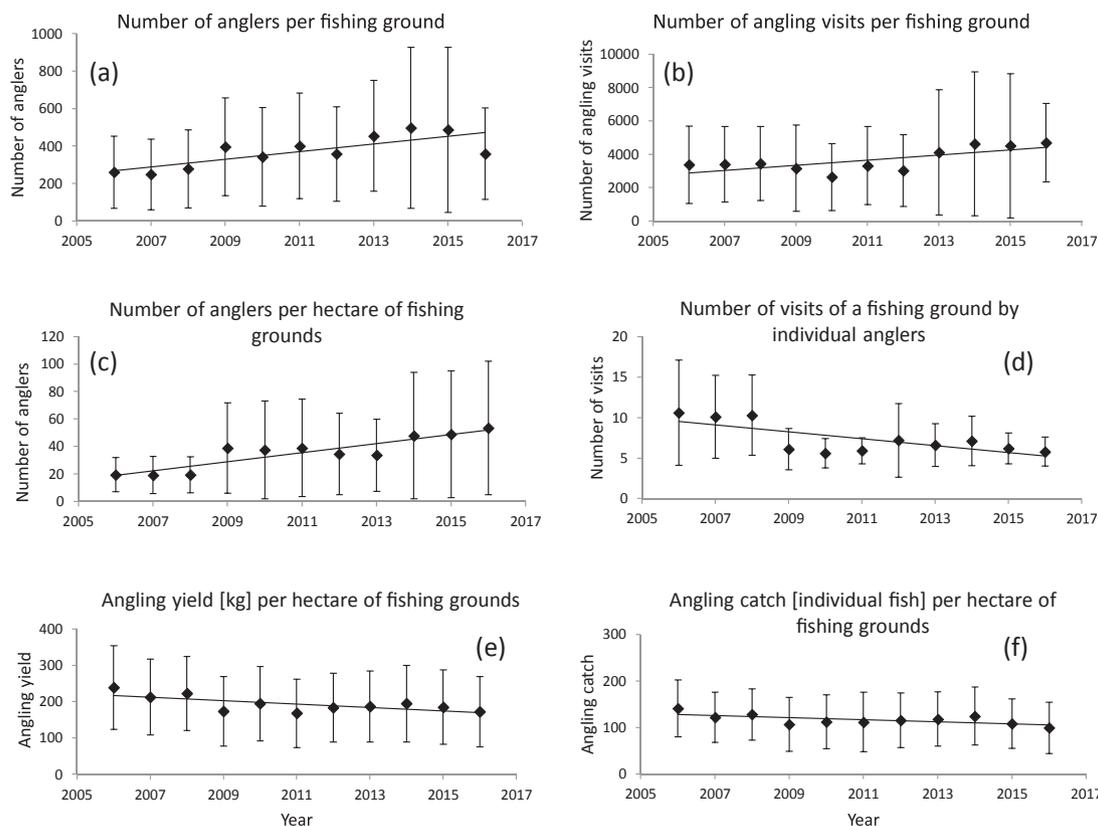


Fig. 2. Time trends displayed for basic parameters in recreational fishing over the course of time (values with 95% confidence intervals). Note: (a) the number of individual anglers per fishing ground, (b) the number of angling visits per fishing ground, (c) the number of individual anglers per one hectare of fishing grounds, (d) the number of visits of a fishing ground by individual anglers, (e) angling yield [kg] per one hectare of fishing grounds, (f) angling catch [individual fish] per one hectare of fishing grounds. Data is for 238 fishing grounds in the Czech Republic over the course of years 2006–2016.

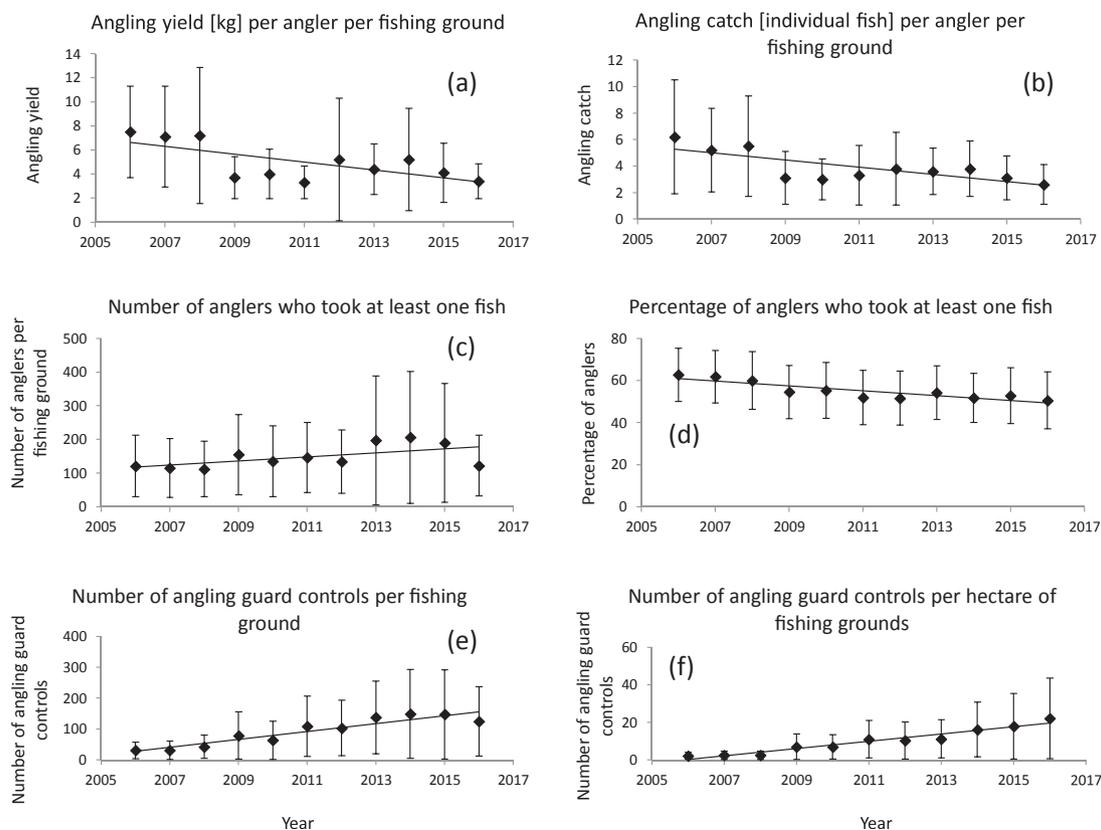


Fig. 3. Time trends displayed for basic parameters in recreational fishing over the course of time (values with 95% confidence intervals). Note: (a) angling yield [kg] per angler per fishing ground, (b) angling catch [individual fish] per angler per fishing ground, (c) the number of anglers who took at least one fish per fishing ground, (d) the percentage of anglers who took at least one fish per fishing ground, (e) the number of angling guard controls per fishing ground, (f) the number of angling guard controls per hectare of fishing grounds. Data is for 238 fishing grounds in the Czech Republic over the course of years 2006–2016.

fishing strategy (Bartholomew and Bohnsack, 2005; Cooke and Cowx, 2006; Arlinghaus et al., 2007; Gaeta et al., 2013; Brownscombe et al., 2017). People release fish back to water because they are getting increasingly interested in fish well-being and protection (Kearney, 1999). Increase in fish timidity and vigilance due to elevated fishing pressure also negatively affects chances of landing a catch (Arlinghaus et al., 2017). It has been reported that recreational fishing became more about enjoying tranquil natural surroundings than about the actual act of fishing (Smallwood and Beckley, 2012; Morales-Nin et al., 2015). The improvement in economic situation means that people will rather buy fish at local supermarket instead of eating fish from unknown environment—it is much easier to buy fish in the store than to prepare it at home.

This paper found that the frequency of angling guard controls in the field has been increasing. It is a response to increasing number of both anglers and poachers in the field (Czech Fishing Union, unpubl. data). Angling guards have also gotten more mobile. The increased frequency of guard controls in the field is mainly caused by increased numbers of professional angling guards in the region of Central Bohemia; the number of professional angling guards increased from 250 guards over years 2006–2010 to 940 guards over years 2011–2016 (Czech Fishing Union, unpubl. data). In the Czech Republic, professional angling guards possess similar status as police officers. That serves as prevention against poaching. Data from the Czech Fishing Union suggests that the number of active angling guards (guards who check > 10 anglers per year) has been increasing as well.

This study found that the number of angling visits per hectare of fishing grounds is increasing more rapidly than the number of angling visits per one individual fishing ground. Similarly, the number of angling guard controls per hectare is increasing more rapidly than the number of angling guard controls per one individual fishing ground.

Such observation suggests that the trends in angling visits and guard controls depend on type of fishing ground—previous studies found that different fishing grounds might show different trends (Humpl et al., 2009; Jankovsky et al., 2011; Boukal et al., 2012).

5. Conclusion

It was discovered that the numbers of anglers and angling visits have been increasing but angling catch and yield have been decreasing. Individual fishing grounds are visited by higher diversity of anglers each year. Anglers are returning to individual fishing grounds less frequently and they choose to visit different fishing grounds instead. The number of anglers who take home at least one fish is increasing but percentage of anglers who take home at least one fish is decreasing. Catch and yield per angler are also decreasing. Frequency of angling guard controls is increasing. Increasing popularity of recreational fishing is probably caused by improvement in economic situation in the Czech Republic. The decreasing catch and yield is probably a result of increased popularity of catch-and-release strategy. This study suggests that future studies should focus on extracting more information from angling logbooks and annual angling reports. For example, evaluation of angling catch and yield of important game fish species over time would certainly be useful to scientists, fisheries management, and public.

Data statement

The data is owned by and was provided by the Czech Fishing Union—the main authority in recreational fishing in the Czech Republic. Therefore, we did not include the dataset with this article.

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