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The danger in the anglers' bucket: qualitative and quantitative insight into bait fish market in Prague (Czech Republic)

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Abstract. Fish introductions and translocations represent a serious risk for aquatic communities and are a known driver of changes in ecosystem function. The use of live fish as bait for angling is already a recognized pathway for introductions/translocations of non-native fish, which facilitates their establishment and spread in freshwater, but no information on this exists for the Czech Republic. In this study, we surveyed the trade in selling live fish as bait in Prague in terms of their identity and the numbers sold, characteristics of this trade and the behaviour of the anglers likely to lead to these species being introduced and whether this trade/use of live fish as bait is an important route by which non native species are introduced into the Czech Republic. In addition, we reviewed the current regulations governing the use of fish as bait with particular reference to EU and the Czech Republic in order to determine the environmental effects and risks associated with using live fish as bait and identified ways in which they may be mitigated. Although the bait fish market in Prague is small in economic terms, we demonstrate that the bait fish trade and use of live fish as bait by anglers (trade in and common use of invasive species, high propagule pressure and the great distance over which these species are transported, which facilitates their establishment and spread into other areas) is an important pathway for new introductions and for the translocation of species between areas. We discuss the ineffectiveness and vague nature of current Czech legislation concerning non-native species and the use of live organisms as bait when compared with the existing international agreements and conventions, EU legislative frameworks, including the specific guidelines of FAO and EIFAC.

Key words. Ichthyology, fishery, angling, recreational fisheries, fish introductions, fish translocation, non-native species, Czech Republic.

INTRODUCTION

Recreational fishing is an important leisure activity for a large number of people all over the world (Arlinghaus & Cooke 2009). Apart from a way of relaxation for people in industrialized countries, recreational fishing certainly generates employment in rural areas in terms of related touristic and fishing services and may contribute to human nutrition (Cowx 2002). Nevertheless, the social, economic and environmental importance of recreational fisheries is often overlooked and underestimated by political stakeholders and the wider public in many countries (Arlinghaus et al. 2002).

Recreational fisheries in the Czech Republic have a long tradition that started at the end of 19th century when the first anglers' club was established (Adámek et al. 1995). Nowadays, 330 thousand anglers representing ~3% of all the inhabitants are organized in two major Anglers' Unions in the Czech Republic (Spurný 2009). Habits and motivation of men for fishing has changed considerably since ancient times and catching large quantities of fish for personal consumption brings

the greatest satisfaction from fishing only to 1.39% of all anglers in the Czech Republic. In contrast, 56.37% of the anglers referred to "being in nature" as the most important motive for recreational fishing (Spurný 2009). Of course, this activity requires adequate fishing environments that are consistent with the anglers idea of what is meant by "nature". Although recreational fishing is generally considered as environmentally friendly, it may have various direct and indirect effects on fish assemblages (Cooke & Cowx 2006, Lewin et al. 2006) and consequently on overall aquatic ecosystems (Gozlan 2008; Keller & Lodge 2007). Unfortunately, the environmental risks, which are associated with recreational fisheries, are often insufficiently addressed in the Czech Republic and there are several conflicts between the laws governing fisheries (Fisheries Law 2004) and natural conservation (Environmental Law 1992) in Czech legislation.

One of the important activities of recreational fishing is fishing using live fish as bait. Although it is forbidden in some European countries, it is still a common angling practice in the Czech Republic (Fishing Regulations 2011). The main target species for this type of fishing are large predators, mainly Northern pike, *Esox lucius* (Linnaeus, 1758), zander, *Sander lucioperca* (Linnaeus, 1758), and European catfish, *Silurus glanis* (Linnaeus, 1758) (Adámek et al. 1995). According to fishing regulations only non-protected species of a particular minimum size (if exists) can be used as a bait (Fishing Regulations 2011).

The bait fish industry in the Czech Republic is fairly unknown since there is no available information on its economic importance although it is an obvious commodity available in many angling shops. Besides the economy, there are potentially serious ecological effects of bait fishing on aquatic ecosystems.

The aim of the present study is to understand the bait fish trade in the Czech Republic (the identification of the existing trade bait fish and the potential vs. ecological consequences of bait fishing and associated regulations) by carrying out a pilot study that focused on trade in Prague and consisted of: (i) inspection of fish tanks in angling shops in Prague; (ii) examinations of the bait fish trade in Prague; (iii) surveys of bait fishing practices by anglers; and (iv) review of the current bait fish regulations with specific focus on the EU and Czech Republic. Our findings are discussed and some recommendations presented for achieving better protection of the environment and sustainable freshwater recreational fisheries.

MATERIAL AND METHODS

During the spring of 2012 angling shops in Prague that offer bait fish were searched using the internet and personal contacts with anglers that use bait fish.

All of these were re-visited in the summer of 2012 to collect data by means of structured interviews with the owner or qualified shop personnel and all fish tanks were inspected and all species of live bait fish identified using Oliva & Baruš (1995) or Kottelat & Freyhof (2007) to confirm the information provided by shop owners or personnel.

The angling practices of the customers of bait fish dealers in Prague were surveyed using a questionnaire composed of open, closed and yes/no questions, which focussed on the: (1) numbers of bait fish bought and used, (2) usual way of disposing of the unused fish and (3) types of water bodies where anglers are fishing with bait fish, (4) distances travelled with live bait for angling. The questionnaire was available at www.vyplnto.cz and links to the questionnaire were on the anglers' web pages www.mrk.cz and www.chytej.cz as well as on the social network site www.facebook.com. Personal contacts were also included in the portfolio of surveyed anglers via email or face-to-face meetings. Only fully-completed questionnaires from Prague inhabitants, which came from 350 respondents, were included in this study, with 25 questionnaires excluded because they were irrelevant or incomplete. We used exploratory data analysis (EDA) to summarize the main characteristic of the data set obtained from the answers to the structured questionnaire. This approach includes calculation of basic descriptive statistics (minimum, maximum, mean, median, standard deviation) and visual presentations of the data (histograms and boxplots), without using particular statistical tests. This approach allowed us to identify trends and patterns in data that would merit further study. Data from questions requiring a quantitative reply (numbers, size, etc.) were summarized and presented as total sums or percentages. All calculations were done using MS Excel.

To analyse the current state of bait fish regulations within the Czech Republic, major international agreements and conventions (the Convention on Biological Diversity, Ramsar Convention on Wetlands, the Convention on Migratory

Table 1. Evaluation of the fish sold as bait in angling shops in Prague in terms of whether they are native or not

scientific name	common name	status
Rutilus rutilus (Linnaeus, 1758)	common roach	native
Gobio gobio (Linnaeus, 1758)	gudgeon	native
Carassius gibelio (Bloch, 1782)	Prussian carp	non-native (polyp. biotype)
Scardinius erythrophthalmus (Linnaeus, 1758)	common rudd	native
Pseudorasbora parva (Temminck et Schlegel, 1846)	topmouth gudgeon	non-native
Tinca tinca (Linnaeus, 1758)	tench	native
Leucaspius delineates (Heckel, 1843)	sunbleak	native

Species) along with accompanying EU legislation and guideline frameworks on environment and fisheries (Habitats Directive, Water Framework Directive, EC 2007, documents of FAO, EIFAC) with specific focus on the treatment of bait fish and non-native species, were reviewed and compared with current Czech legislation (Environmental Law 1992, Fisheries Law 2004).

RESULTS

Inspection of fish tanks in angling shops in Prague

Inspection of fish tanks in angling shops resulted in the identification of seven species that are commonly sold as bait. Among the species identified (Table 1), Prussian carp, *Carassius gibelio* (Bloch, 1782) (non-native polyploid biotypes henceforth referred to as Prussian carp) and topmouth gudgeon, *Pseudorasbora parva* (Temminck et Schlegel, 1846) were considered to be non-native species.

Examination of bait fish trade in Prague

Bait fish were sold in three size categories, each comprising a particular percentage of each species of fish available for purchase (Table 2). The most common species sold were common roach, *Rutilus rutilus* (Linnaeus, 1758), and rudd, *Scardinius erythrophthalmus* (Linnaeus, 1758), followed by topmouth gudgeon (*Pseudorasbora parva*) (Table 3). The period of availability of each bait fish category/species was distinct and ranged from 14 to 26 weeks during the angling season. The price of the fish was dependent on the size category/species and ranged from 2.50 CZK to 30 CZK i.e. ~0.1–2.2 EUR (Table 4).

Table 2. The percentages and numbers of individuals of different species of fish in the different size categories sold as bait for fishing (no. inds.– number of individuals)

	size category of the bait fish					
	small (8–12 cm)		middle (12–20 cm)		big (>25cm)	
fish species	%	no. inds	%	no. inds	%	no. inds
common roach		0	40	104,000	15	945
gudgeon		0	10	26,000		0
Prussian carp		0	10	26,000	50	3,150
common rudd		0	40	104,000	15	945
topmouth gudgeon	95	66,500		0		0
tench		0		0	20	1,260
sunbleak	5	3,500		0		0
total	100	70,000	100	260,000	100	6,300

Table 3. Numbers and percentages of the different species of fish sold in shops as bait (no. inds. – number of individuals)

fish species	no. inds.	%
common roach	104,945	31.2
gudgeon	26,000	7.7
Prussian carp	29,150	8.7
common rudd	104,945	31.2
topmouth gudgeon	66,500	19.8
tench	1,260	0.4
sunbleak	3,500	1.0
total	336,300	100.0

Survey of fishing practices of customers of bait fish dealers in Prague

The responses to the questionnaire (Table 5) indicate that many anglers released live bait fish remaining on completion of fishing. Bait fish are released most often into attractive fishing locations, such as rivers and dams, located even over 50 km from Prague (Table 6).

DISCUSSION

Of the species identified during the inspection of fish tanks in angling shops in Prague (Table 1), two species, Prussian carp and topmouth gudgeon, are considered to be non-native (Musil et al. 2010) and both are also listed as invasive (Gozlan et al. 2010, Musil et al. 2010). Although the status of the nativeness of the taxon *Carassius gibelio* Bloch, 1782 has been recently changed (Kalous et al. 2012) the gynogenetic polyploid biotypes here referred as Prussian carp is still considered as non-native and invasive.

All fish dealers were able to identify the fish but did not consider the fact that they were not native and/or invasive as important.

Concerning the bait fish trade, Prague is the only big city in the Czech Republic at least in the European context with approximately 2.3 million people living in its metropolitan area, which differ in many socio-economic characteristics from those in the rest of the country (Sýkora 2007). The difference can be demonstrated clearly in terms of the GDP of Prague, which accounts for 25% of that of the whole state. Moreover GDP of Prague is almost 5 times greater than that of the second-ranking city in the Czech Republic (Csomós 2008). Because of this one would expect to find the highest number of angling shops, the largest market for bait fish and highest number of customers willing to buy bait fish in Prague. Recreational fishing thrives and is increasing (Spurný 2009) but the total revenue from the sale of bait fish in Prague is currently approximately 3 mil-

Table 4. Basic numerical characteristics of the trade in Prague of selling fish of different sizes as bait

	size category of the bait fish		
	small (8–12 cm)	middle (12–20 cm)	big (>25 cm)
weeks of the season	20	26	14
number of shops	7	25	15
price per fish (CZK)	2.5	10	30
amount of fish sold per season	70,000	260,000	6,300
total sell of fish per season (CZK)	175,000	2,600,000	189,000
total (CZK)	2,964,000		

Table 5. Survey of bait fish practices of customers of angling shops in Prague used in the calculations

type of question	result of the evaluation of the answers
Open question	On average 5 fish are used by anglers as bait per fishing session.
Yes/no question	In 50% of the cases the remaining "unused" bait fish were released into the water body that was fished.
Open question	The number of fish released was on average 20% of those bought for fishing.
Closed question	The types of water bodies preferred by anglers using bait fish: river 42%; reservoirs 32%; ponds 25% and small streams 1%.
Closed question	Distances travelled with live bait for fishing (<10km – 10%; 11–50 km – 55%; >50 km –35%)

lion CZK (~120 000 EUR) per year (Table 2). Therefore, the bait fish trade is not considered to be economically viable and attractive enough for the establishment of a specialized aquaculture industry in the Czech Republic. In contrast, the bait fish trade is the fourth largest aquaculture industry in the United States of America (Gunderson & Tucker 2000). However, it should be noted that based on the structured interviews, many of the bait fish traded are wild caught fish, which is currently illegal in the Czech Republic (Fisheries Law 2004).

In the market, the bait fish are sub-divided into three size categories for use in angling for different piscivorous fish. Each category includes a different proportion of the different species of bait fish. Also the period of sale of each category of bait fish is distinct. The category "small fish" (8–12 cm) is used mainly for fishing for small predators like European perch (*Perca fluviatilis*) or for ice fishing for salmonids. The sale of this size category of fish is restricted to 20 weeks starting in October. Surprisingly, the invasive non-native topmouth gudgeon (*Pseudorasbora parva*) makes up 95% of all sales in this category (see Table 3). The second size category "middle" fish (12–20 cm) is the largest category used for fishing for European pike (*Esox lucius*) or zander (*Sander lucioperca*). The period of sales of this size category of fish begins in the middle of June and lasts for approximately 26 weeks. Common roach (*Rutilus rutilus*) and common rudd (*Scardinius erythrophthalmus*) make up 80% of the sales and Prussian carp (*Carassius gibelio*) 10% (Table 3). In contrast, in the last size category "big" fish (> 25cm), which are used when fishing for European catfish (*Silurus glanis*), Prussian carp (*Carassius gibelio*) dominate making up 50% of the sales followed by tench (*Tinca tinca*, L) at 20% (Table 3). Sales of these species continue for 14 weeks and end in October. The price of the fish depends on its size and ranges from 2.50 CZK to 30 CZK i.e. ~0.1 to 2.2 EUR (Table 2) and varies depending on location, time of the year etc. The profit margin of the bait fish dealers is usually up to 100% of the purchase price.

Based on the answers to questionnaires ~ 67,000 bait fish are sold in Prague per year 20% of which are released into water bodies in the Czech Republic. In terms of the localities where the bait fish are released, rivers dominate, making up 42% (~28,000 fish). In terms of the two non-

Table 6. Percentage and numbers of fish transported different distances from the shop from which they were purchased (no. inds.– number of individuals)

distance transported	%	no. inds.
< 10 km	10	33,630
11–50 km	55	184,965
> 50 km	35	117,705
total number	336,300	

native fish, the topmouth gudgeon (*Pseudorasbora parva*) and Prussian carp (*Carassius gibelio*) ~13,000 and ~6,000 individuals, respectively, are released into water bodies each year. Thirty five percent of the anglers travelled more than 50 km from Prague, which means that bait fish are being introduced into a large area of the Czech Republic and probably even other countries. These results (identified non-native species, the propagule pressure and the distance over which these species are spread and might become established) clearly demonstrate the significant role of the bait fish trade as an important pathway that facilitates the introduction and establishment of new populations and spread of non-native species. This is true for both the non-native fishes (topmouth gudgeon and Prussian carp) for which it is reported that the most important pathway is that associated with their common use as bait fish (Musil et al. 2010). In Europe, both these species are successful pan-continental invaders (Gozlan et al. 2010).

However, there are identical and/or similar adverse effects and risks for freshwater ecology associated with the introduction of both non-native and native species that originate from anglers' buckets. The translocation of native species outside their native ranges may have a severe effect on local populations (Vrijenhoek 1998). Mixing populations from different water basins may result in genetic outbreeding depression due to interspecific hybridization (Edmands & Timmerman 2003). Novel infectious agents (e.g. viruses, bacteria, fungi and macro-parasites) could be introduced into new areas via infected bait fish (Lambert 1997). The probability of a pathogen becoming established in another ecosystem depends on propagule pressure (Copp et al. 2007). Based on the results of the present study, these ecological risks are particularly high because of a large number of bait fish are introduced or translocated.

Non-native species may affect the functioning of ecosystems and result in declines in abundances of native species (Garcia-Berthou 2007, Gozlan et al. 2010). This is widely acknowledged in terms of many international agreements or conventions and associated EU legislation, which are aimed at protecting and conserving biodiversity or natural habitats. Therefore "the legally" authorized introductions of non-native species into natural water bodies either by management agencies or anglers should cease. Within the EU, the only "little exception" is the aquaculture sector, for which the introductions and transport of aquatic animals have to be pre-approved in terms of their potential effect on ecosystems as part of a common management practice (EC 2007). In accordance with general legislative framework on environmental conservation, the differences in the attitudes of the different fisheries to the threat from non-native aquatic species (among others) was highlighted by the Food and Agriculture Organization of the United Nations (FAO) as in need of harmonization in terms of nature conservation objectives of protecting aquatic biodiversity and developing sustainable fisheries (Arlinghaus et al. 2012, Cowx et al. 2010). The most important documents of FAO dealing with non-native species include the Code of Conduct for Responsible Fisheries (FAO 2005), Precautionary Approach to Capture Fisheries and Species Introductions (FAO 1996) and the EIFAC Code of Practice for Recreational Fisheries – CoP (FAO 2010). The CoP defines the minimum standards for environmentally friendly and acceptable recreational fishing and its management. In particular, the CoP addresses the undesirable effects of recreational fishing associated with the use of live bait and recommends that the use of non-native species as a bait should cease and transfer of aquatic live bait from one water body to another avoided etc. Therefore, theoretically, it should be difficult for agencies and anglers to introduce or release species that are not native to the region or even to continue stocking with hatchery reared strains (Rahel 2004). Is this the case in the Czech Republic?

Despite the fact that all the above agreements, conventions and EU legislative frameworks are also obligatory in the Czech Republic the buying and releasing of non-native species by anglers is a common practice. Major reasons for the current situation is: i) the existence of contradictory legislation that does not fully conform with international conventions and legislative fra-

meworks governing either the environment or fisheries (Fisheries Law 2004), ii) overlapping mandates of the responsible state institutions, iii) slow and frequently inappropriate adoption of existing directives (e.g. EC 2007), iv) overall ignorance of current guidelines and recommendations (e.g. FAO, EIFAC, ICES), v) very limited co-operation between state institutions and the scientific community resulting in a lack or even absence of strong scientific knowledge based decisions and vi) lack of appropriate control mechanisms.

A good example is the difference in the definition of a non-native species in two major documents on environmental legislation: Environmental Law (1992) and Fisheries Law (2004). The Environmental Law (1992) is in accordance with international conventions, directives and EU legislation. Here, non-native species are correctly defined as species that are not native to a specific region. Special permission is required for spreading non-native species. In contrast, Fisheries Law (2004) defines non-native species as those that have been present in a specific region for more than three generations. It is important to note that according to this definition almost all non-native species, including the most invasive (Musil et al. 2010), are native species. Not surprisingly, it is possible to obtain permission for stocking rivers in the Czech Republic by non-native species. Both responsible institutions (Ministry of Environment of the Czech Republic and Ministry of Agriculture of the Czech Republic) have overlapping mandates and neither is explicitly responsible for the management of fisheries.

CONCLUSIONS AND RECOMMENDATIONS

Although the bait fish market in Prague is small in economic terms, we demonstrate the significant role of bait fish trade and the use of live bait fish by anglers as an important introduction/translocation pathway, which could be associated with numerous adverse effects on, and risks to the freshwater environment.

There are many ways of dealing with this problem (see Keller & Lodge 2007, Rahel 2004, Perrings et al. 2010). First, there is an urgent need to achieve uniformity and consistency between the already existing international agreements and conventions (The Czech Republic is among the signatory countries) and in particular with EU legislative frameworks including specific guidelines of the FAO and EIFAC concerning non-native species or the use of live organisms as bait. The overall reason is that current Czech legislation is ineffective and very vague. The long-term solution is that fishery biologists should run educational programmes for angling societies that obviously play a fundamental role because their views have a strong effect on responsible institutions and thus legislation (Fisheries Law 2004). These programmes should also influence the attitude of anglers in the safe use of live fish as bait in public freshwaters. The education of the general public and responsible institutions should include instruction on the negative consequences of transferring and introducing fish into new water bodies and aim at convincing them that this may require management to undertake unpopular actions, such as the eradication of certain species and banning certain practices.

Nevertheless, this study leaves many things unresolved (e.g. identification/certification of "safe" fish for use as bait) because recreational fisheries has always been and should remain an essential part of effective nature protection and conservation.

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