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RESEARCH ARTICLE

Illegal fishing in the Tisza River drainage within Ukraine: a threat for local fish stocks?

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Abstract. Illegal fishing in watercourses of the Tisza River drainage in Ukraine (Transcarpathian region) was investigated focusing on the use of illegal gears and techniques. It was found that this activity is traditional and widespread in the region and is primarily practiced by low-income residents of rural communities. Fish are harvested mainly for personal consumption, which contributes to the diversification of diets and increase of protein intake for local people. The investigated illegal gears and techniques included gill nets, lift nets, screen nets, electrofishing devices, spears, and concussion. In total, 31 species were observed in poachers' catches, among which the most abundant were nase, *Chondrosotma nasus* (L.), Carpathian barbel, *Barbus carpathicus* Kotlik, Tsigenopoulos, Rab et Berrebi, and chub, *Squalius cephalus* (L.). Electrofishing devices were the most effective illegal fishing gears as they caught the largest total number and weight of fish. However, the highest mean weight of fish was caught in gill nets. Effects of poaching on local fish populations are currently probably lower than or comparable with that of recreational fishing.

Keywords: poaching, mountain rivers, Tisza River, Carpathians, endangered species, fishing gears

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Introduction

Fish poaching or illegal fishing is a widespread problem worldwide and is widely recognized to have negative effects on resource sustainability and biodiversity as well as on economic and social sustainability (OESD 2004). Many studies have examined effects of illegal fishing in marine waters (Pitcher et al. 2002, MRAG 2005, Sumaila et al. 2006, Beddington et al. 2007, Agnew et al. 2009), but much less information is available regarding poaching in inland waters, especially in small rivers and streams (Gigliotti and Taylor 1990, Kukuła 1996, Sullivan 2002). Poaching usually originates from a lack of alternative food resources or sources of income for local communities and more often occurs in developing countries (MRAG 2005, Navy and Bhattarai 2009, Francis and Samuel 2010). Although it is widely accepted that poaching has negative effects on fish populations and fisheries, identification of the specific effects of poaching and the precise level of impact is often extremely difficult (Agnew et al. 2009).

Currently, illegal fish harvest is widely practiced in inland waters of Ukraine, due primarily to the poverty of local people, especially in rural areas. However, the extent and characteristics of this activity have never been assessed. Thus, the goals of our study were to analyze peculiarities of illegal fishing activities, compare poachers' catches obtained by different illegal gears and to try to asses their effect on

fish stocks in watercourses of the Tisza River drainage.

Although fish poaching is common in throughout Ukraine, in this study we focused on the Tisza River drainage (Danube River system), watercourses which flow from the western slopes of the Carpathian Mountains. These stream systems, which are located on the territory of Transcarpathian (Zakarpattya) region of Ukraine, are unique ecosystems containing the highest diversity of fish species in Ukraine including many endemics. Up to 61 fish species and sub-species inhabit these waters (Movchan 2000). Stocks of some fishes were exploited commercially as recently as the first half of the 20th century (Protasov 1948), but most of them have drastically declined because of various factors, the majority of which are human activities in the Transcarpathian region (Movchan 2000).

Poaching in Ukraine is defined as a violation of Ukrainian fisheries regulations, which may include fish harvest with the use of illegal gears or techniques, fishing during closed seasons, fishing in special protected areas, harvest of undersize fish and endangered species listed in the Red Book of Ukraine (Akimov 2009). Officially, open access recreational and sport fishing without any licensing is practiced in the Transcarpathian region (except specially protected territories) and only angling gears are allowed (although lift nets of certain specifications are allowed for catching live bait fish).

Materials and Methods

In this study, we concentrated on one aspect of poaching – the use of illegal gears and techniques. If poachers are caught by local fish protection inspectors on the fishing site with their gears and catch, a protocol of offense is filed, which includes information, such as the number of fishes caught, a description of the fishing gear used, and weight of fish caught as well as some social information (date of

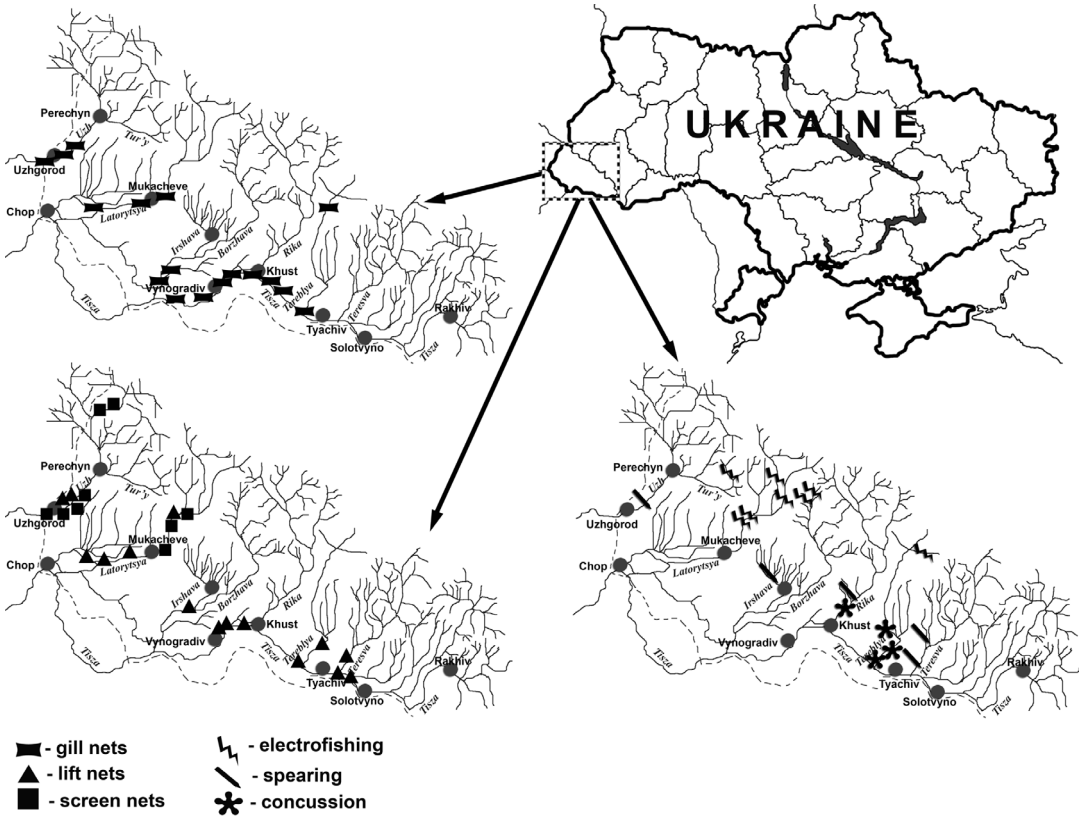

Figure 1. Locations of registered poaching events with the use of different types of illegal fishing gears in watercourses of the Tisza River basin in the Transcarpathian region of Ukraine.

Table 1
Species compositions of catches (mean (ind. per catch) ± SD), mean number of fish per catch, and mean weight of catches by gear type in watercourses of the Tisza River basin within Ukraine, average for 2008-2009

	Fishing gear/technique					
Species	Gill nets	Lift net	Screen net	Electrofishing	Spear	Concussion
*Hucho hucho**	0.04 ± 0.2	-	-	-	-	-
Oncorhynchus mykiss	-	-	-	1.2 ± 3.7	-	-
Salmo trutta m. *fario*	-	-	-	2.0 ± 5.0	-	-
*Thymallus thymallus**	-	0.1 ± 0.2	-	2.6 ± 3.8	-	0.2 ± 0.4
Chondrostoma nasus	4.4 ± 10.1	3.5 ± 9.4	3.3 ± 3.5	40.2 ± 100.3	3.0 ± 8.6	-
Squalius cephalus	1.4 ± 3.9	0.4 ± 0.8	0.6 ± 1.3	5.8 ± 8.7	2.1 ± 2.3	1.0 ± 2.4
Leuciscus idus	0.04 ± 0.2	-	-	-	-	-
*Telestes souffia**	-	0.2 ± 0.7	-	4.0 ± 9.7	0.1 ± 0.3	2.3 ± 3.1
Vimba vimba	0.1 ± 0.6	0.3 ± 1.0	-	-	-	-
*Barbus barbus**	0.5 ± 1.1	-	0.1 ± 0.5	0.9 ± 2.7	0.6 ± 0.9	0.2 ± 0.4
*Barbus carpathicus**	1.4 ± 3.9	2.9 ± 4.4	1.7 ± 3.5	13.8 ± 20.8	7.4 ± 7.4	17.7 ± 19.4
*Romanogobio uranoscopus**	-	-	-	-	0.1 ± 0.3	0.7 ± 0.8
Gobio carpathicus	0.1 ± 0.5	0.2 ± 0.9	-	-	-	0.2 ± 0.4
Rutilus rutilus	0.04 ± 0.3	0.1 ± 0.3	0.1 ± 0.2	3.4 ± 10.3	-	-
Blicca bjoerkna	0.6 ± 4.1	0.2 ± 0.9	-	-	-	-
Abramis brama	0.7 ± 2.2	0.1 ± 0.3	-	-	-	-
Alburnus alburnus	0.2 ± 1.0	10.5 ± 20.2	-	-	-	-
Alburnoides bipunctatus	-	-	-	0.9 ± 1.8	0.1 ± 0.3	1.7 ± 3.2
Phoxinus phoxinus	-	-	-	6.7 ± 20.0	-	4.0 ± 6.3
Aspius aspius	0.1 ± 0.5	-	-	-	-	-
Tinca tinca	-	0.1 ± 0.2	-	-	-	-
Carassius gibelio	1.2 ± 2.9	1.7 ± 5.5	-	-	-	-
Barbatula barbatula	-	-	-	-	-	0.2 ± 0.4
Ameirus nebulosus	0.1 ± 0.5	-	-	-	-	-
Esox lucius	0.4 ± 1.0	0.1 ± 0.2	-	-	-	-
*Lota lota**	0.2 ± 1.2	-	-	-	-	-
Cottus poecilopus	-	-	-	4.4 ± 11.9	-	-
Perca fluviatilis	0.5 ± 2.5	0.2 ± 0.7	-	-	-	-
*Gymnocephalus schraetser**	0.3 ± 1.8	-	-	-	-	-
*Zingel zingel**	0.2 ± 1.0	-	-	-	-	-
*Zingel streber**	0.02 ± 0.1	-	-	-	-	-
Mean number ± SD (ind.)	12.6 ± 20.0	20.0 ± 20.9	5.8 ± 3.8	84.3 ± 99.2	13.4 ± 4.1	28.0 ± 18.3
Mean weight ± SD (kg)	5.6 ± 10.9	2.4 ± 2.7	1.6 ± 1.3	10.5 ± 10.8	2.6 ± 2.5	0.7 ± 0.4

*Species listed as endangered or vulnerable in the Red Book of Ukraine (Akimov 2009)

birth, home address, etc.). These data can be used for characterization and assessment of different aspects of poaching.

Data were collected throughout 2008-2009 (all seasons) in the Zakarpattya (Transcarpathian) region of the Ukraine together with the Zakarpattya Fish Protection Inspection. We analyzed poachers' catches and fishing gears, which were seized by district fish protection inspectors in different areas of the Transcarpathian region (107 poaching events in 16 rivers) (Fig. 1).

All fish were identified, counted and total weight of the catch was recorded. Because different fishing gears of the same type were not standardized (e.g., nets had different mesh sizes, lengths, widths) and fishing efforts were not known, catches were pooled by numbers of each species caught in each gear type (all seasons and rivers together). Then we calculated the composition of catches (mean number of fish per species per catch), mean number of fish per catch, and mean weight of catches by each gear type.

In addition, we collected some social and fisheries related information, which included data on poachers' age, employment status and income, place of residence, purpose for fishing, target fishes, fishing seasons, preferred gears and modes of their deployment, peculiarities of fish protection activities, and peculiarities of recreational fishing in the Transcarpathian region. Some of this information was contained in the protocols of offense and some was collected by interviewing selected poachers, recreational fishermen, fish protection inspectors, and local people (more than 50 people in total).

Results and Discussion

The analyzed poachers' fishing gears and techniques included gill nets, lift nets, screen nets, electrofishing, spears and concussion. Gill nets, which ranged in dimensions of length 20-100 m, depth 1.0-2.0 m, bar mesh size 10-40 mm, were involved in 47 protocols of offense at 27 sites in 8 rivers. Lift nets were constructed of a 1.0 × 1.0 to 4.0 × 4.0 m, 10-30 mm bar mesh sheet of netting mounted on a horizontally oriented square metal frame attached with ropes to a handle. Fish were caught by lifting the net out of the water when fish concentrated over the net, which occurred at intervals of 1 to 30 minutes. Lift nets were involved in 18 protocols of offense at 12 sites in 6 rivers. Screen nets consisted of a vertically oriented sheet of netting attached to a metallic bottom line and top line, which was attached with ropes to a handle. Dimensions of screen nets ranged: length 0.7-1.5 m, depth 0.7-1.5 m, and bar mesh size 15-30 mm. Fish were captured by holding the net under the water above the bottom or in the water column in current for periods of 1-15 minutes. Fish in screen nets were usually caught by gilling or wedging and these nets were involved in 18 protocols of offense at 11 sites in 2 rivers. Electrofishing devices were usually home-made and portable with various constructions and power characteristics. These devices were involved in 9 protocols of offense at 9 sites in 6 rivers. Spears, were usually constructed of a pitchfork or table fork attached to an elongated handle and were involved in 9 protocols of offense at 7 sites in 5 rivers. Concussion consisted of striking large stones protruding from the water with a sledge hammer as strongly as possible. Concussed fish were then collected by dip nets and by hand. Concussion was involved in 6 protocols of offense at 5 sites in 2 rivers.

The majority of detained poachers belong to working-age population (mean age is 39.5 years; 19-67 years) and 80.4% of them are residents of rural communities. Virtually all poachers claim to be unemployed, however, according to fish protection inspectors and local people, about 55-60% of illegal fisherman have regular jobs (but usually low--income), 30-35% have part-time or temporary jobs, and 5-10% are unemployed. Less than 10% of illegal fisherman harvest fish for sale at local markets or for exchange for other products or services, while the majority harvest fish for personal consumption. Few poachers (<1-2%) can be considered "professional", i.e., those who harvest fish regularly and whose catches are largest (usually >10 kg of fish per fishing trip). However, the majority of illegal fishermen are "amateur" poachers, who harvest fish sporadically with relatively low landings, which often can be less than those of anglers.

In total, 31 species were registered in poachers' catches, ten among which were listed as endangered in the Red Book of Ukraine (Table 1). The highest species diversity was observed in gill net catches (21 species). The most abundant were nase, *Chondrosotma nasus* (L.), chub, *Squalius cephalus* (L.), and Carpathian barbel, *Barbus carpathicus* Kotlik, Tsigenopoulos, Rab et Berrebi. Fifteen species were caught in the lift nets, among which the most abundant were bleak, *Alburnus alburnus* (L.), nase, and Carpathian barbel. Five species were caught by the screen nets, in which nase, Carpathian barbel, and chub were the most abundant. In electrofishing catches, 12 species were observed, among which the most abundant were nase and Carpathian barbel. Seven and ten species were caught using spears and concussion, respectively, and the dominant species was Carpathian barbel.

Among local fishes, the most valued by poachers are salmonids (however, rare in their gears), nase, chub, and barbels, which usually compose the largest part of catches. Illegal fishermen usually harvest fish throughout the year, but are most active and numerous during spring, after rains and during rise of water levels in rivers, when catches become significantly higher due to an increase of gear catchability associated with increase of water turbidity. Exceptions are techniques, which require transparent and shallow water (e.g., spearing and concussion).

Differences in catches of illegal gears are related to their technical characteristics, peculiarities of deployment, and environments in which they could be used. Gill nets are the most preferred gears for illegal fish harvest in the Transcarpathian region as they are relatively cheap, easy to install and fish can be collected during the night hidden from direct sight. Gill nets are size selective and catch only relatively large individuals. However, they can be used only in specific environments (mainly on relatively deep sites with slow or no currents) in lowland rivers and are not suitable for catching fish in shallow streams with fast current, which are typical for mountain and sub-mountain sections of Carpathian watercourses. This explains the highest number of species caught by gill nets in comparison to other gears, because they are usually used in lowland rivers, which have the highest biodiversity. Gill nets were ranked the 5th among the examined illegal fishing gears by number of fish caught, but were second most efficient after electrofishing in the weight of fish caught per protocol of offense because they captured relatively larger fish (mean fish weight was 378 g).

Lift net catches were significantly different from gill net catches. The lift nets effectively catch small schooling species such as bleak and juveniles of larger species, which inhabit the water column. This gear can be used in a wider range of habitats from lentic environments to shallow mountain streams. Therefore, even though the mean number of fish in lift nets catches exceeded that of gill nets catches, the mean weight of fish in lift net catches (112 g) was lower than that of gill net catches.

Screen nets were the least effective as they caught the lowest amount of fishes among all analyzed fishing gears. However, in mean weight of fish caught (283 g) they were second after gill nets. Lift nets and screen nets are inexpensive and the simplest gears to operate, but because they usually catch small fish, they are not considered serious gears by local poachers and most often are used by children and sometimes they are deployed for harvesting small-size fish for pets.

Electrofishing devices were the least selective gears and the only ones that captured European grayling, brown trout and rainbow trout. Electrofishing is the most effective technique for fishing as it caught the highest number and weight of fish per protocol of offense. However, on mean, smaller fish were caught by this technique (mean fish weight was 132 g) in comparison with gill nets, screen nets, and spearing catches. Lower number of species caught by this method in comparison with gill nets can be explained by the fact that poachers most often use portable electrofishing devices, which can be applied in very shallow mountain and sub-mountain streams characterized by low biodiversity. Electrofishing devices are the most expensive gears and they are mostly used by urban dwellers and "professional" poachers.

Hand spears are rarely used for fish harvest. Poachers use them in shallow streams with transparent water that allows direct observation of target fish. Such habitats are typical for mountain and sub-mountain watercourses of the Carpathians. The spear is a highly selective gear because the poacher usually selects the largest individuals if several fish are in the field of view (ranked the third gear by mean weight of fish in catches (203 g) after gill nets and screen nets). This fishing method is directed mainly towards bottom-dwelling and relatively large fish such as barbels and nase, which are easier to hit by spear. Spearing is especially effective on spawning grounds during spawning periods, when some fishes concentrate in shallow waters and become less wary and consequently more vulnerable.

Concussion of fish with the aid of sledge hummers seems to be less selective than spearing (10

species). This technique is usually used by older people (mean age of 55.2 years) because it is considered to be an ancient method requiring special skills and it is less known among younger people. Concussion can be used in similar environments as spears but it requires large stones to serve as resonators, which transform the energy of the hit into shock waves.

In spearing and concussion catches, the highest ratio of endangered fishes was observed (61.1% and 75.0%, respectively); however, this was mostly the Carpathian barbel, which had been listed in the Red Book of Ukraine as recently as in 2009 probably due to the lack of information, but in reality is one of the most abundant species in the Transcarpathian watercourses (Velykopolsky and Didenko 2010). However, as spearing and concussion catches are usually relatively small and these techniques are not widespread, their effect on local fish fauna is negligible.

According to local people and fish protection inspectors, the current level of illegal fishing in this region is currently much lower than it was in the 1990s, when after collapse of the Soviet Union a significant decline in industrial and agricultural production occurred and many people lost their jobs. Besides, as few as 2-3 fish protection inspectors patrolled the region at that time and their activities were geographically very limited. During that period, poaching was virtually uncontrolled. The largest landings were obtained from fish concentrations on wintering and spawning grounds and during spawning migrations. Such activities resulted in significant decline of fish stocks, which was observed from the end of the 1990s to the beginning of the 2000s.

Since then, this situation has changed. According to recreational anglers and fish protection inspectors, a noticeable steady increase of catches per unit of effort in angling gears has been observed during the last 4-5 years in watercourses of the Transcarpathian region. This may be attributed to an increase of the number of regional fish protection inspectors up to 13 persons in 2007 and their more active work. In addition, up to 20 public inspectors participate in fish protection activities. The most important acts of these inspectors were that they inhibited poachers' access to major known wintering grounds and strengthened protection during spawning periods. Fines for poaching were also raised, and local people reported violations of fishing regulations to the regional fish protection inspection more frequently. As a result, illegal fishing activities significantly dropped. According to local fish protection inspectors, poachers' current catches probably account for < 20% of the total catch realized in the Tisza River drainage within Ukraine, while the rest is attributed to anglers.

According to local recreational fishermen, few of them strictly observe fishing regulations when angling. While attention of fish protection inspectors is directed mainly on the use of illegal fishing gears, it is not rare for anglers to exceed the daily allowable catch (3 kg), to harvest fish during closed seasons, and to keep undersize fish and endangered species. Considering poachers often deploy more selective gears than anglers and may harvest different species, the effect of poaching on fish populations is currently lower than that of recreational fishing.

Fish harvest using illegal fishing gears is widely practiced in watercourses of the Tisza River drainage on the territory of the Transcarpathian region of Ukraine. By harvesting fish from these rivers, poachers undoubtedly contribute to reductions in the resource base, which otherwise could have been caught by recreational fishermen, as well as to decreases in biodiversity, especially when endangered species compose almost one third of the total local fish fauna. But because illegal fishing is hidden and not advertised, it is difficult to estimate the exact number of people involved and their precise effect on fish populations.

While an increase of fish abundance has recently been observed in Transcarpathian region, these mountain and sub-mountain rivers and streams are fragile ecosystems and there is a number of other factors, which can potentially have negative effects on fish populations. For example, in some mountain river systems in Europe, fish stocks have declined during last 20-30 years due to a combination of several factors including fish health issues, habitat degradation, water pollution, and climatic changes (Hari et al. 2006, Burkhardt-Holm and Scheurer 2007,

Zimmerli et al. 2007, Scheurer et al. 2008). These declines occur despite regulated recreational fishing, control of poaching, and artificial stocking. In Carpathian rivers flowing across Poland, a decline of fish stocks since 1960-1990s also occurred, resulting from deterioration of habitat quality by pollution and hydrotechnical alterations of stream channels, fragmentation of watercourses by dams, excessive exploitation of local fish populations, and introduction of alien species (Kukuła 2002, Kukuła 2003, Amirowicz and Kukuła 2005).

However, several factors contribute to preservation of fish fauna in the Transcarpathian region of Ukraine. First, a significant part of the Tisza River is closed to fishing because it has a special status of the State border zone, which borders with Hungary and Romania. Hence, this river reach serves as a refuge, which permanently replenishes other reaches and numerous smaller tributaries with fish (Movchan 2000). Second, a considerable part of the Ukrainian Carpathians (13.5% of the Transcarpathian region area) is protected by national parks and reserves, where any fish harvest is prohibited (Movchan 2000, SBEP 2010). Finally, many small rivers and streams are located in remote mountain areas, which are difficult to access by fishermen, and from where fish can migrate downstream and replenish destroyed fish stocks. Such small streams are especially important for natural recruitment of brown trout (Schager et al. 2007).

When investigating illegal fishing, it is necessary to account for social issues and local traditions. In the opinion of those who inhabit the Transcarpathian region, there is a clear separation between habitual poaching (fish harvest with the use of nets) and destructive poaching (fish harvest with the use electric current and explosives). While the attitude towards the second type is extremely negative in the society, the habitual poaching is a widespread activity of local people, who consider aquatic living resources as a constituent part of public natural resources of the region. Traditionally, fishing has been important in this region. A significant part of local people forms the segment of anglers, who go fishing both for leisure and for food. However, to catch a sufficient amount of fish for personal consumption or for sale is easier and faster with illegal gears. In addition, illegal fishing intensifies during conditions of low wages or in the absence of fixed incomes and high prices on fish on the market. Current depressed social-economic situation in the Transcarpathian region, which has an absence of large industrial centers and predominance of rural communities located in mountains with low productive soils and shortage of arable lands, contributes to prerequisites for poaching. A dense river and stream network creates favorable conditions for implementation of poaching. In contrast, the relatively low concentrations of commercially valuable and marketable size fish in mountain watercourses in comparison with Ukrainian lowland reservoirs makes “professional” poaching less profitable in this region, which limits its mass development.

Effects of moderate “controlled” poaching using illegal fishing gears (especially selective ones) currently practiced in watercourses of the Tisza River drainage are likely lower or comparable to that of recreational fishing. The main exception is harvest of fish on sites of their mass concentrations, which include wintering and spawning grounds and migratory pathways, where they are more vulnerable to poachers. Therefore, poaching enforcement should focus on the protection of such sites for maximum effect. Any excessive fishing including recreational and illegal can contribute to elimination of native species and alteration of community compositions in mountain streams (Wohl 2006). Alternatively, fishing with illegal gears is a traditional activity in the region and in conditions of poor economical situation and mass unemployment can contribute to diversification of diets and increase of protein intake of local people.

In conclusion, while poaching impacts fishes of the Tisza River drainage within the Transcarpathian region of Ukraine, additional studies and special approaches are needed for both qualitative and quantitative assessment of the relative effects of both illegal and recreational fishing. These studies would also need to account for social issues and environmental peculiarities for effective management of local fish resources.

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Streszczenie

Nielegalne połowy ryb w dorzeczu Cisy: zagrożenie dla lokalnych populacji ryb?

W pracy scharakteryzowano nielegalne połowy ryb w ukraińskiej części dorzecza Cisy (Zakarpacie) w latach 2008-2009. Na podstawie rejestrów nielegalnych połowów ryb w 16 rzekach zebranych przez służby zajmujące się ochroną ichtiofauny omówiono metody i narzędzia wykorzystywane przez kłusowników. Nielegalne połowy ryb były i są tradycyjnym i szeroko rozpowszechnionym zajęciem, szczególnie ubogiej części społeczeństwa zamieszkującej tereny wiejskie. Ryby poławiane były przede wszystkim na własny użytek. Odnotowano stosowanie sześciu grup technik i narzędzi do połowu ryb. Nielegalne odłowy ryb przeprowadzane były za pomocą sieci, pułapek, przestaw, ościeni, elektropołowów oraz przez ogłuszanie ryb. W odłowach kłusowniczych stwierdzono występowanie 31 gatunków ryb wśród których najliczniejsze były świnka *Chondrosotma nasus* (L.), brzanka karpacka *Barbus carpathicus* Kotlik, Tsigenopoulos, Rab et Berrebi, i kleń *Squalius cephalus* (L.). Największą ilość gatunków i biomasę złowionych ryb zarejestrowano w połowach narzędziami elektrycznymi, co sugeruje, że jest to najefektywniejszy sposób połowu ryb na analizowanym obszarze. Nielegalne połowy ryb mają obecnie prawdopodobnie mniejszy wpływ na populacje poszczególnych gatunków niż połowy wędkarskie.