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PERIODICAL APPEARANCE OF PIKE (*ESOX LUCIUS* LINNAEUS, 1758) IN THE DANUBE RIVER IN NORTH-WESTERN VOJVODINA (N SERBIA)

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This study presents the periodical but irregular appearance of pike (*Esox lucius* L.) in the Danube River and its inundated ponds. During 14 years, 1076 pike were captured at nine sites. The fish appeared in large numbers in years when the average water level was high in spring ($R = 0.738$, $P < 0.01$, $n = 14$). During the study, there were two periods when there were no pike, either in the river or in the inundated ponds. Furthermore, observation showed that prey fish might also affect the presence or absence of pike in late spring in the study area.

Key words: water level, Spearman correlation, river, inundated ponds, Pike, *Esox lucius*, »Gornje Podunavlje«

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Rad govori o periodičkom, no nepravilnom pojavljivanju štuka (*Esox lucius* L.) u rijeci Dunavu i njenim naplavljenim barama. Tijekom 14 godina na 9 lokaliteta ulovljeno je 1076 štuka. Ribe su se u velikom broju javljale u godinama kad je prosječna razina vode bila visoka u proljeće ($R = 0.738$, $P < 0.01$, $n = 14$). Tijekom istraživanja postojala su dva razdoblja kada štuka nije bilo ni u rijeci niti u naplavljenim barama. Osim toga primijećeno je da riblji plijen također može utjecati na prisutnost ili odsutnost štuka na istraživanom području tijekom kasnog proljeća.

Ključne riječi: razina vode, Spearmanova korelacija, rijeka, naplavljene bare, štuka, *Esox lucius*, »Gornje Podunavlje«

INTRODUCTION

The pike (*Esox lucius*) is a top freshwater predator that feeds mainly on fish. It is common in lakes, slow flowing rivers and inundated ponds in the arctic and temperate zones of the northern hemisphere (DIANA *et al.*, 1977; RAAT, 1988). Pike are described as keystone predators of fresh waters and through this function they play an important role in the aquatic ecosystem. Through their predation they are able to control the prey fish community composition (PREJS *et al.*, 1994; BERG *et al.*, 1997).

Furthermore, the pike is an important target species for recreational anglers (PIERCE *et al.*, 1995; ARLINGHAUS & MEHNER, 2004).

The appearance of fish in the Danube River is strongly connected to their migration and to the floodplain areas (CIOLAC, 2004). They come to certain parts of the Danube because of spawning or food supply (CIOLAC, 2004). We do not know much about the appearance of pike in parts of Danube River, and about their spatial movements. Such studies have been much more common in lakes and ponds than in rivers (CHAPMAN & MACKAY, 1984; MASTERS, 2005; ARLINGHAUS, 2008; KOBLER *et al.*, 2008). Their appearance and movements differin still water and in rivers (MANN 1980; BURKHOLDER & BERNARD, 1994; GERLIER & LUQUET, 1999; KOBLER *et al.*, 2008). The distance of pike movement varies. Investigations done on the River Ill in France mention a movement range between 400–12,260 m (GERLIER & LUQUET, 1999), while English studies done in the River Frome give a maximum movement of 3 km in the study area, while only a few pike dispersed more widely (MANN, 1980). In both studies there are static and mobile specimens in the pike population, a number of individuals staying within a range of movement, but some of them making much longer journeys (MANN, 1980; GERLIER & LUQUET, 1999). BURKHOLDER & BERNARD (1994) showed that pike are disposed to make movements longer than 100 km during their migration between summer and winter locations. Studies showed that pike from rivers have extensive movements with mean upstream spawning migrations in the Ourthe and Ambléve rivers (OVIDIO & PHILIPPART, 2002).

The aim of this study was to i) present the number of pike captured per year of observation and ii) exhibit the appearance of pike in correlation with water levels in the Danube River and its floodplain area in the Gornje Podunavlje Special Nature Reserve, Serbia.

STUDY AREA AND METHODS

Study area

The study was performed in and along the Danube River (in the text: the river) and its ponds in the floodplain area on the territory of the Gornje Podunavlje Special Nature Reserve (SNR) (central coordinate: E18°58′; N45°37′) in northwest Voyvodina (N Serbia) – between 1,366 and 1,433 river km. Pike were captured at nine sites: five in the river and four in ponds (Fig. 1). In this region the average width of the river is about 750 m with a water level of 450 cm measured in Apatin (NW Voyvodina), with average depth of 15 m (range: 2.2–32 m). The river meanders and creates canals and many ponds. Ponds were formed from former arms of the river and some of them were established through excavation when soil and clay were needed for the building of dams. The ponds are often surrounded by trees, mainly with willow (*Salix*). The banks are mainly overgrown with grass, sedge (*Poaceae)* and blackberry (*Rubus*).

On the territory of the Gornje Podunavlje SNR the descent of the river is between 4–6 cm/km which means that it has a slow current velocity. Algal vegetation is very poor but it is rich in zoo- and phytoplankton, and primitive algae. In the ponds there are many emerged and submersed vascular plant species (Tab. 1.).

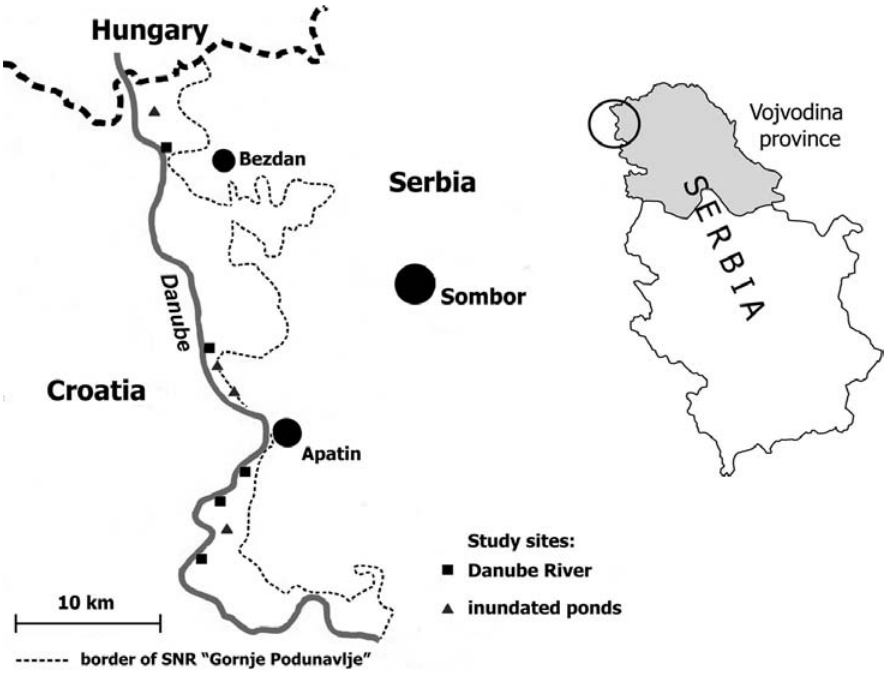

Fig. 1. Locations where pike (*Esox lucius*) were captured in Gornje Podunavlje SNR, northwest Serbia.

Methods

Pike were captured from the beginning of June until mid of November over 14 years (1995–2008). The total number of visits was 297, average per year 21 (range: 15–30). The study sites were visited in the morning, and the time of catching per day varied from 3 to 6 hours. Angling rods and natural baits or lures were used to collect pike. The pike were measured with a precise scale and ruler. Only fork length of each individual was taken into consideration. The length of the fishes was measured to a precision of 1 cm, and the weight to a precision of 50 g. Mean length and weight was calculated as the arithmetic mean of all fish lengths and weights.

Tab. 1. Main characteristics of the locations on the Danube River and in flood ponds where pike (*Esox lucius*) were captured.

Water body	Depth of sites where pikes appeared	Ground	Aquatic vegetation (dominant species)	Hiding places for pike
Danube River	1.5–4.5 m (mean: 3 m) at water level of 100 cm, Apatin	sand, clay, mud, rock	–	dead trees, dimples, rocks
Inundated ponds	0.8–2.5 m (mean: 1.65 m)	mud, sand	seaweed species, *Trapa natans*, *Nymphoides peltata*	dead trees, dimples, living and dead seaweed vegetation

Tab. 2. Spearman correlation between number of pike and mean water level in the four spring months.

	Number of specimens	R	*P*	*n*
Danube River and inundated ponds (SUM)	1,076	0.738	*<0.01*	*14*
Danube River	722	0.642	*<0.05*	*14*
Inundated ponds	354	0.639	*<0.05*	*14*

R: correlation value; *P*: value of significance; *n*: number of years studied;

In this study the mean water levels of four spring months (March, April, May and June) were used as a key factor. I used the data measured in Apatin at the hydrologic station (value given in cm). In the mentioned four spring months the water level mostly varies between 250 and 750 cm. During summer and early autumn the water level is mostly low or very low with a range between 50 and 200 cm.

The main question of this paper is: does the appearance of pikes in the investigated area correlate with the average water level during these four months? Our question was tested with a non-parametric test – Spearman rank correlation (PODANI, 1997)

RESULTS

During the 14 years a total of 1076 pike were captured with a mean length of 42.9±7.48 cm (SD range 30–96 cm) and a mean weight of 847.8±725.64 g, (SD range 250–6900 g).

The appearance of large numbers of pike depends on high water level in spring months. There was a significant positive correlation between the number of captured pike and the average water level in the four spring months (Tab. 2).

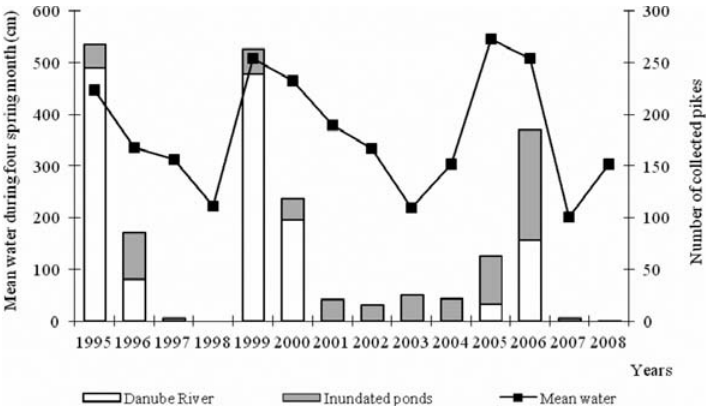

Fig. 2. Changes in the mean water level in the four spring months and the number of pike over 14 years on the Danube River and in flood ponds.

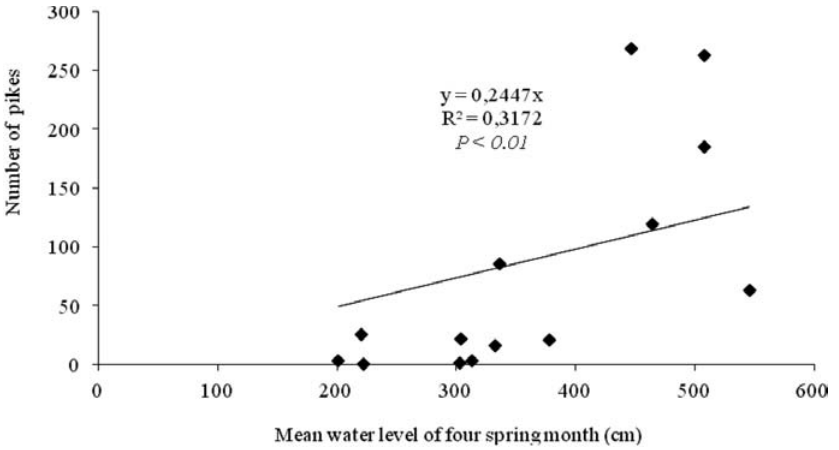

Fig. 3. Appearance of pike in relation to mean water level.

However, the average spring water level was higher than 350 cm in 2000, 2001 and 2005 and yet pike did not appear in large number. In 1996, they appeared in quite large number although the average water level in spring was only 336 cm (Fig. 2). There were two periods (1997–1998; 2007–2008) during these 14 years in which there no pike were caught, either in the river or in the ponds (Fig. 2). Between 2001 and 2004, pike appeared only in ponds. In these years the average water level in spring varied from 220 (2003) to 378 cm (2001) (Fig. 2).

Average spring water level between 200 and 400 cm did mainly result in the appearance of pike, but in a very low number, while average water level between 400 and 600 cm mostly resulted in the appearance of a large number of pike (Fig. 3).

DISCUSSION

This study showed in general that pike do not appear every year in large numbers in the studied part of the Danube River and ponds. Their appearance per year is irregular because it depends upon the height of the average spring water level. It is very important that the flow reaches and holds an adequately high water level in the floodplain area of the river for a longer period of time (*pers. obs.*). Constant and prolonged (min. 1–2 months) duration of the high water level in spring is important because only then do pike and other fish species use the inundated areas for spawning. In some years the water level was not high enough at the beginning of March when pike spawn. The high water usually came later, nevertheless pikes appeared. There were also exceptions in their appearance, for example in 1996, when there was no high water in spring but they appeared in large numbers. Results also showed that high water level did not result in a high number of pike. I presume that average water height in spring is not the only factor responsible for the appearance of pikes. The prey fish resource is also an important parameter. A long--term study done in the United Kingdom reported that change in prey fish abundance affects the population of pikes (WINFIELD *et al.*, 2008). Low food availability

in a habitat could lead to cannibalism which is common behaviour among pikes (RUTZ, 1996), and over the long term could destabilise the population. In our regions the prey fish are mostly represented by the carp family (*Cyprinidae*). Their spawning starts in the beginning of April and lasts until the end of June. This moment is important for pikes, because after the exhausting reproduction period, a lot of energy must be compensated for and spawning cyprinids are an easy prey in late spring.

According to my observations, most of the pike left the studied parts of the Danube River at the end of October or by beginning of November (temperature of the water is then about 10 °C), probably to their wintering habitats. Other studies also showed that pikes have different winter and summer habitats. Studies about habitat choice in mid-summer and mid-winter were done on lakes where pikes selected different habitats for summer and winter (KOBLER *et al.*, 2008). In the winter season pikes choose habitats closer to shore, but in summer they select positively submerged macrophyte beds (KOBLER *et al.*, 2008). During the spawning period in early spring pike mainly inhabit shallow water habitats with rich aquatic vegetation (NILSSON, 2006). The ponds in the floodplain area of the Danube River are also water habitats with rich submerged vegetation and I presume that they make excellent spawning sites.

According to the results of this study the high water level in the spring plays an important role in the appearance of pike in the studied part of the Danube River and its floodplain area. Furthermore, I presume that prey fish abundance in late spring can also be an important factor that keeps pike in the study site.

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