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5. Fish movement in relation to water temperature fluctuations in the Lower Danube River Iron Gate II dam area

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Abstract: Water temperature plays an important role in the fish life cycle, and have a direct impact over fish species movement behavior, migration, feeding and reproduction. The impact might be different between the rivers because of hydro morphological factors that are specific for each watercourse (sediments, water conductivity, turbidity, total suspended solids etc.). The study focuses on 3 fish species, Vimba bream (*Vimba vimba*), Common nase (*Chondrostoma nasus*), Common barbel (*Barbus barbus*). Total number of 43 specimens from these three fish species were caught, tagged and released in Danube River upstream and downstream the Iron Gates II dam and tracked using acoustic telemetry equipment. The fish movement was followed for eight months, from September 2019 to April 2020. In this time period, data from 26 Vimba bream, 13 Common nase and 4 Common barbel movement were collected. Acoustic telemetry data was used to evaluate fish movement in relation with the water temperature variation of the Danube River. In all three species studied, was revealed a decrease in the number of detections in the moment when the water temperature drop below 12 °C, and a increase in the number of detections in the spring when the water temperature reach 8 °C.
Keywords: acoustic telemetry, fish, movement behavior

INTRODUCTION

The Danube River is the second longest river in the Europe (2860 km) after the Volga.It crosses 10 countries and 4 capitals and has an average multi-annual flow of 6500 m^3/s before to split in three branches and flow in the Black Sea (Gâştescu 1990,Driga 2004, Gâştescu 2008; Dávid and Madudová 2019). Maximum discharges in lower Danube River is recorded during high spring waters and sometimes occur in summer (Diaconu 1963).To regulate the water flow in Lower Danube River, improve navigation and provide electricity, two large dams were built, one at 943 river kilometer (rkm) (Iron Gate I dam) in 1972 and one at rkm 862 + 800 (Iron Gate II dam) in 1986.

The Iron Gate II dam (IG II) is located on the main branch of the Danube River (Figure 1) and has two turbines in Serbia on the right bank, a 34 m width navigation lock, 7 spillway spans and 16 more turbines in the main section of the dam close to left bank (8 in Romania and 8 in Serbia) (Comoglio 2011, Hidroelectrica 2000).On the secondary Gogosu branch, on the Romanian river bank, at rkm 875, the dam has 7 more spillway gates and two additional turbines (Corda 1988).

Damming is known to have a direct or indirect impact over riverine ecosystems, caused by changing in sediment loads and nutrient cycles upstream and downstream the dam area (Humborget al. 1997; Friedlet al. 2004). These changes of the Danube River water level and flow induced by damming may have a long-term effect over properties and natural cycles of the river (Stratimirovic et al. 2021).

Water temperature have high impact over fish movement behavior, especially because the fish are poikilothermic and their activity is directly dependent on water temperature changes (Jonsson 1991; Nonsson 1991; Lenhardt et al. 2021). Water temperature is known to be an important factor indetermining the timing for starting upstream migration in migratory fish species, an essential factor in species survival(Näslund1991). In addition, global temperature changes has become a growing

concern because may have a major impact over fresh water fish populations with unknown potential implications (Morgan et al. 2001; Walberg 2011).

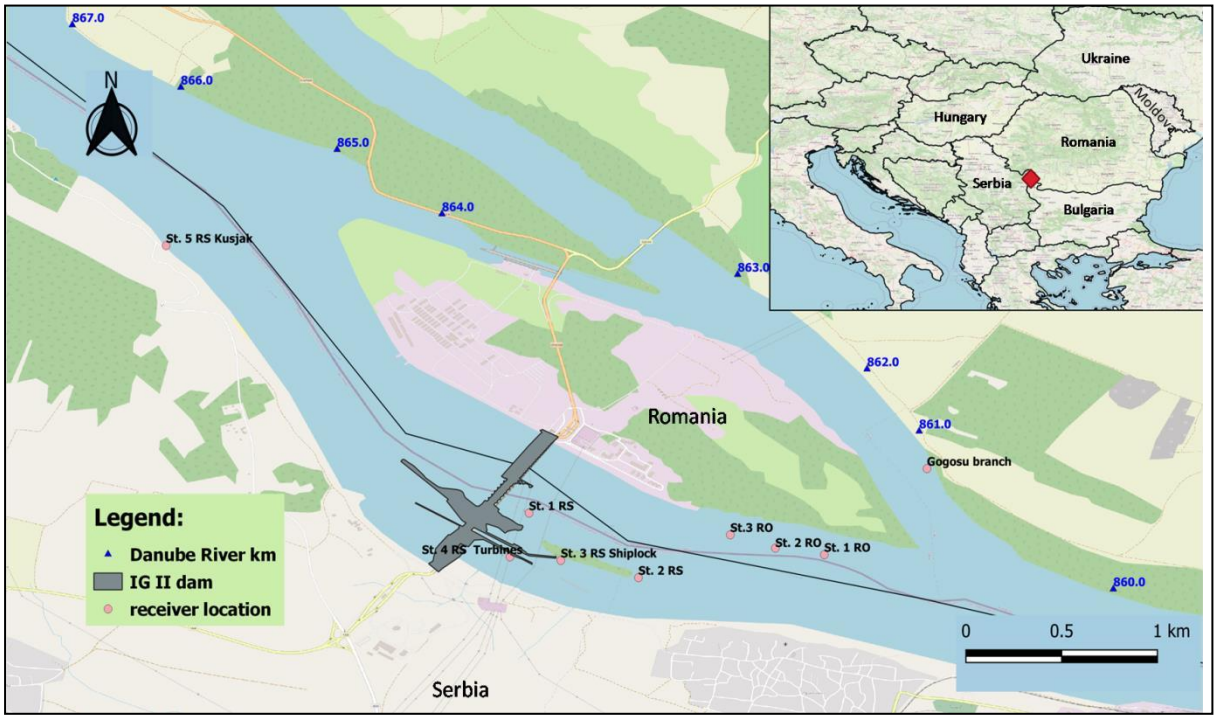

Figure 1: Iron Gate II dam with receivers installed downstream and upstream the dam

MATERIALS AND METHODS

The fish have been caught since September 2019 during the evening using drift nets at river km 860 on the right bank and overnight using fix nets(mesh size of 40 and 50 mm, height of 2 m and a length of 30 m), at rkm 854 left bank.

The fish were tagged using acoustic tag that were surgically implanted into fish abdomen. Before the surgery the fish was anesthetized using an anesthetic prepared from clove oil and 96% ethanol (Ross &Ross2008, Økland et al. 2012).

The tagging was done on the river bank, in order to reduce the time spent in captivity and scale down the stress caused by catching, captivity and tagging.VemcoV9PandV13P acoustic tags with pressure sensor were used for tagging the fish (Fig. 2).

Both tags type had a min. delay of 40sec. and max delay of 80sec. After tagging and recovery from anesthesia,22 fish (3 Barbel, 12 Nase, 7 Vimba) were released downstream the dam at rkm 860 and 21 fish (1 Barbel, 1 Nase, 19 Vimba) were released upstream of the dam atrkm866.

The fish were recorded by 18 VR2Wreceivers,10 installed downstream the Iron Gate II dam and 8 installed in the lake upstream the dam (Fig. 1). The receivers were installed attaching them to the concrete structures of the dam (ship lock) or using special buoys connected to a 90 kg concrete anchor by a 10mmsteel hawser (Fig. 2).

Figure 2: Equipmentused for fish tagging (9 mm & 13 mm Vemco tags) - left;VR2W receiver - middle; buoy used to install receivers in the river downstream the dam – right

Water temperature data was obtained from Lower Danube River Navigation Administration (Gruia measuring station, at 851 rkm, Fig. 3). Based on the water temperature fluctuation and fish data between1st Sepember 2019 and 30th April 2020, eight month span was divided into shorter periods with a similar water temperature range (Fig. 3, 4, 5 &6).

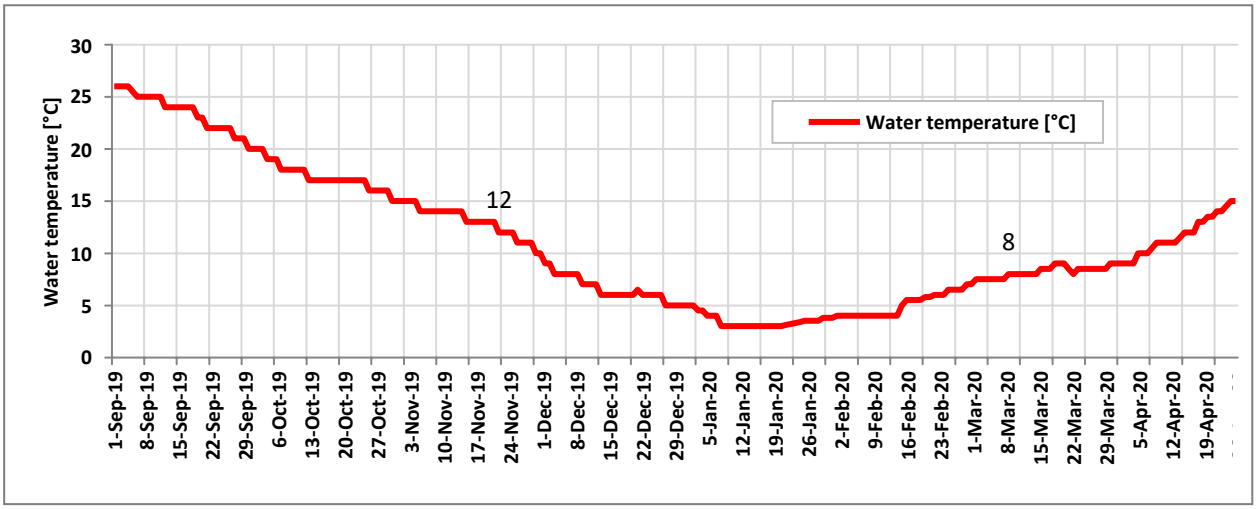

Figure3: Water temperature variation at rkm 851 between1st September 2019 and 30th April 2020

RESULTS AND DISCUSSION

There were 26 Vimba bream tagged with acoustic tags that has a max. total length of 58 cm / 1.1 kg and a min. total length of 28.5 cm and 0.19 kg. The vimba specimens were recorded by all 18 acoustic receivers installed and had a total of 137149detections. The nase specimens were recorded by 13 installed receivers with a total of 28813 detections and the barbel specimens were recorded by 11 receivers with a number of 6978 detection recorded.

Vimba bream (*Vimba vimba*)

The first Vimba bream was detected between 13 - 27 October 2019,26 fish(24% of total detections) were recorded at a water temperature of 17 °C (Fig. 4).The number of detections remained high until their number started to decrease more significantly with the decline of the water temperature to 12 °C. This decrease in detections was stabilized at the water temperature of 7 °C. The low number of detections is associated with a reduced fish movement caused by low water temperatures. Most likely the presence of recordings in the temperature range 7 - 3 °C can be associated with vimba overwintering behavior. After that there were some increase in the number of detection, in the second part of January 2020. Then the number of detections started again to rise in the first part of the March at the water temperature of 8 °C, when this trend has a steady increase (Fig. 4).The 0.6 % of total detections took place between 13-18April2020when only one specimen was recorded at a water temperature of 11 °C.

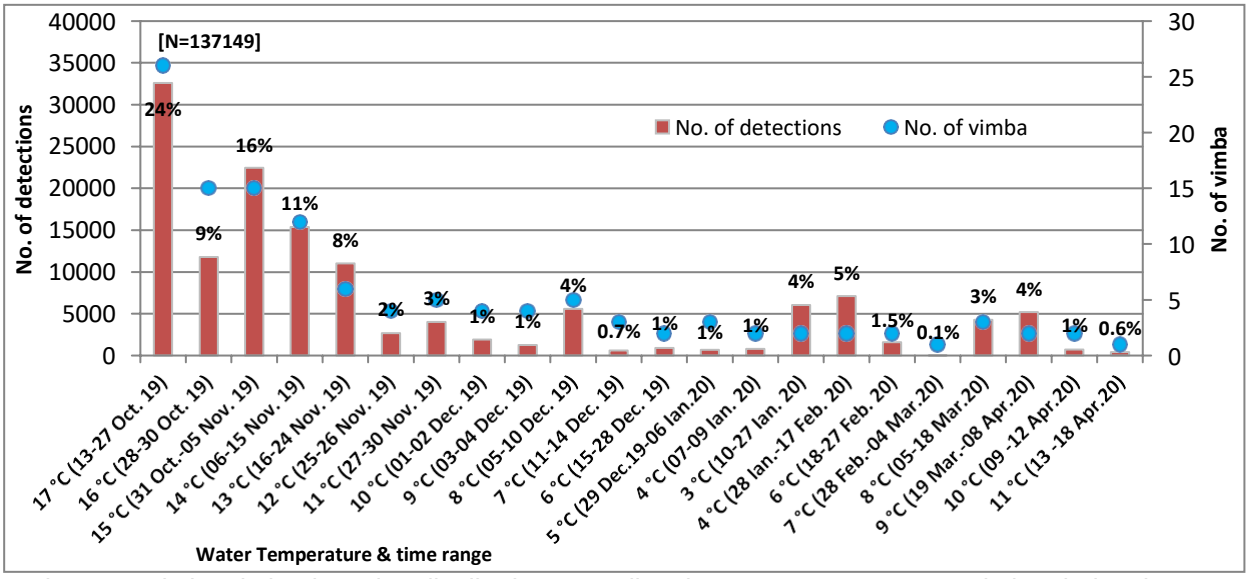

Figure 4: *Vimba vimba* detection distribution according the water temperature variation during the period from13thSepember. 2019 and 30th April 2020

Common nase (*Chondrostoma nasus*)

There were 26 Common nase tagged with acoustic tags that has a max. total length of 41.5 cm / 0.8 kg and a min. total length of 28.5 cm and 0.19 kg. The number of detections of Common nase in September and first part of October was direct correlated with the small number of tagged fish. A higher number of detections was at a water temperature of 17 °C (32% of the total number of detections) (Fig. 5).The number of detections remained high until the water temperature was around 13 °C. When the water temperature dropped below 12 °C, the number of detections decreased and remained lower. A new increase in the number of detections was observed at the water temperature of 8 °C, the period associated with the end of the overwintering period. The 15% of Common nase total detections were recorded at, water temperature of 9 °C (Fig. 5).

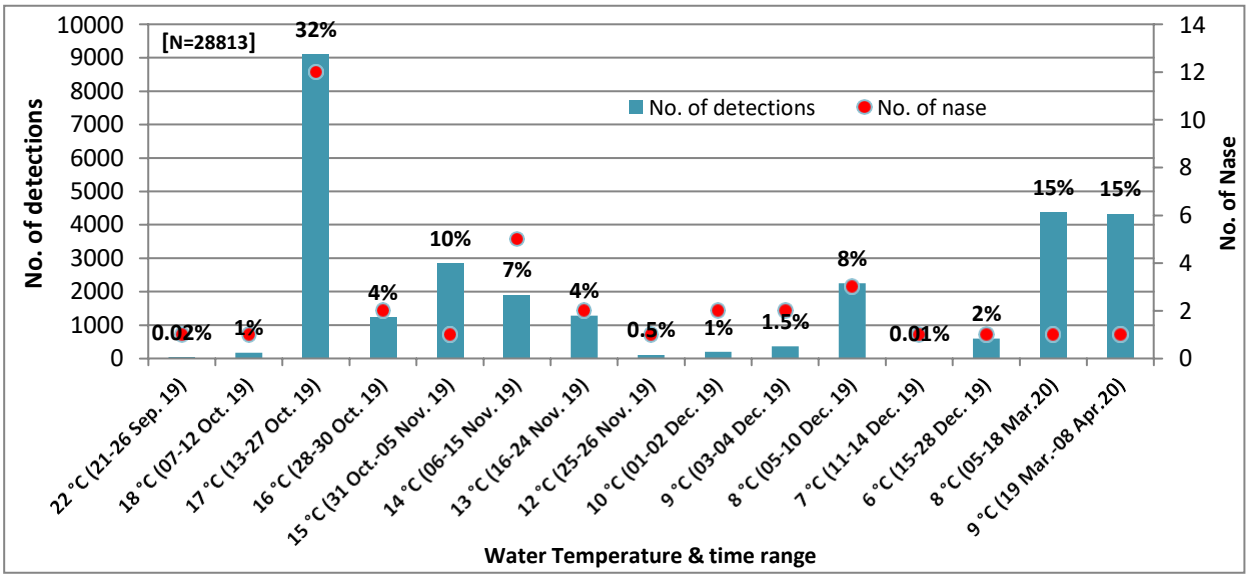

Figure 5: Common nase detection distribution according to the water temperature variation during the 1st September 2019 and 30th April 2020

Common barbel (*Barbusbarbus*)

There were 26 Common barbel tagged with acoustic tags that has a max. total length of 49.3 cm / 1.12 kg and a min. total length of 33 cm and 0.34 kg. The Common barbel specimens recorded by receivers installed in the Danube River had detections at the water temperature of 22 °C until the water temperature reached 13 °C. As well as Vimba bream and Common nase, the number of detections / the Common barbel movements had decreased significantly with the water temperature decrease below 12 °C. The 0.5% of total detections of Common barbel tagged was recorded in April at a water temperature of 10 °C (Fig. 6).The small number of recordings at a temperature of 10 °C may be caused by more intense spring migration due to rising water temperatures, which led to movements outside the detection area of the installed receivers.

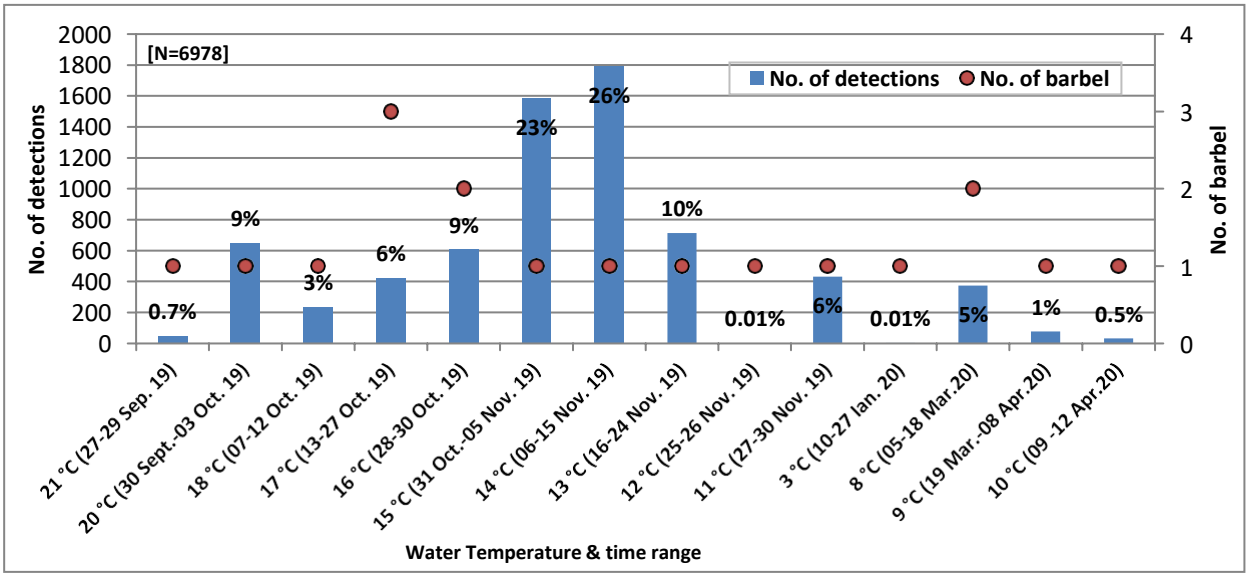

Figure 6: Barbus barbus detection distribution according to the water temperature variation during the 27thSeptember 2019 and 12th April 2020

According to literature Vimba bream movement in freshwater is more obtained in autumn and spring, indicating that the fish could stay during winter in brackish water areas, perhaps due to poor wintering conditions in the river (Tambets et al. 2018). Preferable spawning temperature of Common nase is between 8 and 12°C. which means that spawning season for this species would last from late March to late May (Keckeis et al. 1997). These findings correspond to our observation that even lower

temperatures below 10°C are not disturbing nase movement behavior because with these temperature we can expect start of the spawning migration patterns. While barbel species during autumn and winter have low rate of movement that is related to the reduction in metabolism and associated with low activity(Baras 1995).

CONCLUSIONS

In the eight months period observed in this study from beginning of September to end of April, covering 3 seasons and 3 different fish species in the lower Danube between Serbia and Romania seasonal variation in movements corresponding to Danube water temperature were shown. The Vimba specimens were the most sensitive to oscillations of the Danube water temperature. The intense movement behavior was between 17 °C - 13°C when over 60% of the total number of detections were recorded. The Nase and barbel specimens were less sensitive to water temperature oscillations, but the common for all 3 analyzed species are high rate of detections in October. The interval with the lowest number of detections was in the water temperature range of 7 °C to 3 °C and it is associated with overwintering period. These findings are important for better fisheries management and monitoring plans.

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