Long Distance Migration of Beluga (*Huso huso*) and Stellate Sturgeon (*Acipenser stellatus*) in Lower Danube River in Relation with Iron Gate II Dam

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Abstract

Construction of the dams in Lower Danube River (LDR- rkm 0 Sulina – rkm 1075 Bazias) without fish passages, as well as illegal fishery and river bottom modification due to navigation had negative impact on sturgeon's populations. Beluga Sturgeon, Stellate Sturgeon and Russian Sturgeon still migrate to spawn in LDR but there is lack of information relating to sturgeons long distance migration in this area. Tagging with Vemco V16 TP acoustic tags, equipped with temperature and depth sensors involved 36 adult Beluga and 44 Stellate Sturgeons provide new data about sturgeon migration. Their migrations are monitored by VR2W receivers, deployed on between rkm 71 and rkm 864. Analysis of data showed that 17% of Beluga and 30% of Stellate Sturgeon never recorded and 30% and 11% of Beluga and Stellate Sturgeon recorded in period more than 30 days after tagging. Only 5% of Beluga and 7% of Stellate Sturgeon have been recorded after a period of more than 1 year. During 2013-2016 4 adult Beluga and 1 adult Stellate Sturgeon were recorded in the IGII Dam area. Results of this investigation showed that sturgeons still approached the IG2 dam and construction of fish passage on this dam is needed.

Keywords: *acoustic telemetry, sturgeon, migration*

INTRODUCTION

Sturgeons (Acipenseridae) are considered some of the most at-risk freshwater species due to overfishing, habitat degradation, and pollution (Billard, and Lecointre, 2001). Human impact on Danube River last century caused major impact on its morphology and biodiversity. One of the most affected species is migratory fishes and particularly the sturgeons. Black Sea is still home of sturgeons with Danube River supporting the largest populations (Nelson *et al.*, 2013). Compared to other rivers flowing into the Black Sea, Danube River has the greatest sturgeon species richness (Hensel, and Holcik, 1997).

Danube River still has three native diadromous sturgeon species: Beluga (*Huso huso*), Russian Sturgeon (*Acipenser gueldenstaedtii*) and Stellate Sturgeon (*Acipenser stellatus*), and one native riverine potomadromous species, the Sterlet (*Acipenser ruthenus*) (Bacalbasa-Dobrovici, 1997). Ship Sturgeon (*Acipenser nudipectus*) and European Atlantic Sturgeon (*Acipenser sturio*) which were recorded in Danube River in the past are probably extirpated nowadays (Kynrad *et al.*, 2002). All sturgeon species in the area possess high conservation status according to IUCN – Critically Endangered, except Sterlet, which is considered Vulnerable.

Observations of sturgeon species and sturgeon trade were made in Romania at Iron Gates area since 18th century (Marsigli, 1726), revealing the value of this species for the local fishermen at that times. More data were collected at the beginning of 20th century, when the naturalist Grigore Antipa studied the sturgeon fisheries of Saint George Danube's branch (Antipa, 1909). Sturgeon fishing was a common occupation for the inhabitants of the Danube River banks since prehistoric times. Many sturgeon remains were found at settlements in the Iron Gates area (Bartosiewicz & Bonsall 2004). Sturgeons were caught during their migration using methods such as stretched hooks lines, trammel nets and even harpoons when they swam in the upper layers of the water (Seeley, 1886).

In the past, before Danube River was dammed, the sturgeons were able to migrate upstream as far as Komarno (Danube River, rkm 1810) (Bloesch, 2006) and until the XIX century Beluga Sturgeon moved upstream as far as Germany. Beluga Sturgeon (*H. huso*) have two migration periods, one in fall from late August to November and one in spring which could start in January depending on the water temperature and ended in May. Spawning takes place during the spring migration when sturgeon females lay eggs at depths of 8 - 20 meters and water temperatures of 8 - 16 °C, usually on clay, gravel or sand substrate (Dinu, 2010). Similar to Beluga Sturgeon, Stellate Sturgeon have two periods of migration, one in fall which starts in August and continues until October (Bănărescu, 1964) and the second one in spring, during March - April, when they spawn at the water temperatures of 8 - 11°C on clay or sand substrate (Otel, 2007). The Beluga and Stellate Sturgeon used to spawn further upstream in Danube River, therefore constructions of dams had a significant impact over the natural reproduction of these species (Holcik, 1989). From five native species of sturgeons in Slovakia until the beginning of 20th century only the Sterlet and small resident population of Russian Sturgeon remained nowadays (Holcik *et al.*, 2006).

Dredging activity were documented since the 14th century in Austria, and a large regulation plan on Danube basin were executed between 1870 and 1875 (Winiwarter *et al.*, 2013) with the main aim to improve navigation on the Danube River. The discussion between Serbia and Romania

concerning damming gorges area of Danube River started after 1945 result in construction of Iron Gate I Dam, at river km 943, which was put into operation in 1972 (Aaron, 1996), followed by the construction of Iron Gate II Dam, at river km 864, which was put into operation in 1984 (Corda, 1988). The presence of Beluga Sturgeon in the upper parts of Danube River was relatively common before the damming of the Iron Gate gorges (Bartosiewicz, and Bonsall, 2004). After the construction of Iron Gate II Dam, a study to evaluate the construction impact on sturgeon migration in the 864 rkm stretch between the Iron Gate II Dam and Black Sea was performed in the period 1985-1986 (Bratislava report 1987). The study was conducted by analyzing the fish catches in Danube River and a total of 92 adult sturgeons have been captured in 1985 and 1986: 29 Beluga Sturgeons (171 - 270 cm / 40-137 kg), 23 Russian Sturgeons (38-150 cm / 2,5 - 13,5 kg) and 40 Stellate Sturgeons (80-140 cm / 3,5 - 8 kg). Political changes in the 1990's in Eastern Europe opened the access to new modern techniques in tracking fish and resulted in the first telemetry study on sturgeon migration in Lower Danube River (rkm 0 to rkm 1075). This first study was conducted in 1998, when anadromous sturgeon species were tagged and tracked in Lower Danube River using acoustic tags (Kynard *et al.*, 2002). More telemetry studies were conducted after 2009 connected with sustainable tourism (Oddmund *et al.*, 2011), impact of navigation construction projects (Deak *et al.*, 2014), and fish passage studies (Bruijne, 2014; Bloesch, and Jones, 2016). In November 2013 for the first time Vemco VR2W acoustic receivers were installed in the Iron Gate II dam area between rkm 847 and rkm 864. Using the receivers installed previously in 2011 between rkm 71 and rkm 348 (Figure 1) it was possible to collect new sturgeon migration data studying such a large sector of Danube River. In 2014 another receiver has been installed near the town of Rousse at rkm 495. The installation of more receivers in the river sector between rkm 847 and rkm 864 was performed in 2015 and allowed monitoring of sturgeons in the IG II area.

The main goal of this study is to analyse data collected from receivers installed in the period 2011-2015 to track tagged Beluga and Stellate Sturgeons during their downstream (d/s) and upstream (u/s) migration between rkm 71 and

Figure 1. Location with VR2W receiver installed in first 864 kilometres of Lower Danube River (Here it will be good to illustrate that the receiver near Russe is at the right bank of the river)

rkm 864. The efficiency of tagging of Beluga and Stellate Sturgeon by Vemco V16 TP acoustic tags for monitoring of their migration has been also performed. Additionally, this study provide data about sturgeon migration routes, swimming speed, depths and distances covered during the spawning migration, and sturgeon behaviour in relation to the IG II Dam.

MATERIALS AND METHODS

Equipment

Danube River is second largest river in Europe, and does not fulfill conditions to use radio telemetry equipment due to its depth, width and high turbidity. Acoustic tags (V16TP) and receivers (VR2W) produced by Vemco have been used during the study. The detection range for V16TP acoustic tags (at high power) is about 400 meters at rkm 300, and increasing up to 1000 meters at river km 860, downstream of the Dam. This difference in detection ranges is caused by the turbidity which is higher at rkm 300 than the turbidity from rkm 860, where the Dam retains most of the sediment in the lake formed upstream (Project - Fish behaviour preparatory study at Iron Gate Hydropower dams and reservoirs, 2013).

Installing the receivers

The VR2W acoustic receivers were installed using different methods: (i) anchored to a fixed structure as concrete walls, piles of the Iron Gate Dam or pontoons, (ii) anchored on the bottom of the river with long ropes and recovered using GPS location, (iii) installed on buoys anchored in the

river. The receivers were installed in 3 different periods, started in 2011 when first receivers for tracking adult sturgeons were installed between rkm 71 and rkm 348. During 2013 - 2014, the receiver installation was extended up to rkm 864 when six more VR2W receivers were installed downstream of Iron Gate II dam in locations ensuring adequate recording of sturgeons arriving in front of the main Hydro Power Plant (HPP) (Figure 1). The receivers were installed at (1) Turbine No. 1 left bank, (2) mouth of Gogoșu branch (rkm 860), (3) the Romanian ship lock located on the secondary Gogoșu branch, (4) and one more downstream at rkm 847 (Pristol village). Two receivers were installed upstream on the Gogoșu branch at km 10, (5) close to the two turbines which are on Gogoșu branch, and (6) close to the Gogoșu Spillway (Figure 1). In 2014 - 2015 five more receivers were added in IG II area (Figure 2) to cover both banks of the river downstream the Dam: 3 near Romanian bank (1 RO, 2 RO, 3 RO) and 2 near island in Serbian part of the Danube River (1RS, 2 RS). One more receiver was installed at Rousse at rkm 500 on Bulgarian Danube River right bank (Figure 1).

Capturing the fish

Special trammel nets, crafted by local fishermen were used to capture live adult sturgeons. Local fishermen were also sub-contracted by DDNI (Danube Delta National Institute) to capture sturgeons with special fishing license issued by National Agency for Fisheries and Aquaculture Bucharest (NAFA). The trammel nets

Figure 2. Acoustic receivers installed downstream Iron Gate II dam in 2015

Figure 3. Total lengths of captured Beluga and Stellate Sturgeons

for sturgeons have 140 – 170 mm mesh size with 200 m length and 2.5 m height. Fishing was done in the 1- 3 km long drive sectors on the Borcea branch (at km 30, km 50) and Danube River km 800 – 863. The fishing was performed during the night when the nets were drifting in the river for 1 - 2 hour each, period of time was depending of the water velocity. Since 2011 there were 44 wild adult Stellate Sturgeons captured and tagged, with 75 - 135 cm total length and 36 wild adult Beluga Sturgeon captured with 191 – 255 cm total length (Figure 3).

Tagging method

Sturgeons are among the largest fish species, which migrate in the fresh waters for spawning. Spending most of their life in the salt waters of Black Sea, they return to Danube River to spawn, when they reach sexual maturity. They return to their natal river at the age of 5 to 7 years in the case of the Stellate Sturgeon, and 10 to 15 years in the case of the Beluga Sturgeon. Tagging and

manipulation of adult sturgeons is difficult due to their size. For reducing the handling and stress, the sturgeons were kept in the river all the time and tagged using the method described by *Iani et al.*, (2017). The fish was locally anesthetized with lidocaine and for total anaesthesia was used an electro narcosis device (Figure 4). The tagged sturgeon recovered rapidly as soon as the electro-narcosis device is stopped.

This method has been used to avoid the long-term manipulation and removal of sturgeon from the river. Chemical anaesthesia was used in the past, but this method needs a long period of manipulation and recovery and was replaced by electronarcosis to reduce the stress on sturgeons. The captured sturgeons were tagged with Vemco V16 TP acoustic tags, equipped with temperature and depth sensors, with an estimated battery life of 7 – 8 years. The tags were programmed to transmit signals in two different steps: Step 1 – 300 days at high power 15 - 45 seconds delay and

Figure 4. Tagging sturgeons directly in the river

Figure 5. Proportion of Beluga and Stellate Sturgeons recorded in different time periods after tagging: 1. never recorded after tagging; 2. recorded in period less than 10 days after tagging; 3. recorded in period less than 20 days after tagging; 4. recorded in period less than 30 days after tagging; 5. recorded in period more than 30 days after tagging; 6. recorded in period more than 1 year after tagging.

Step 2 – the rest of battery life at low power and 30 - 90 seconds delay.

RESULTS AND DISCUSSIONS

From 36 Beluga and 44 Stellate Sturgeons tracked during the field work, about 17 % of Beluga and 30% of Stellate Sturgeons never been recorded again and about 5 % of Beluga and 7 % of Stellate Sturgeons have been recorded again in the period of more than 1 year after the tagging (Figure 5). The main difference between the two species is in the higher detected percent of never recaptured Stellate Sturgeons 30% against 17 % for Beluga. It is interesting that the percent of tagged fish recaptured after more than 30 days is much higher for Beluga (30%) than for the Stellate Sturgeon (11%). The higher percentage of Beluga Sturgeons never recorded after tagging (24%) compared with the Stellate Sturgeon (17%) may be caused by the fact that the larger Beluga Sturgeons are recaptured easier by the poachers. For example on 19th November 2011 a tag used for

tagging a Beluga Sturgeon was recovered from a plastic bottle which was floating on Borcea branch km 42.

Beluga Sturgeon

During 2013 and 2016, four Beluga Sturgeons and one Stellate Sturgeon were recorded in the Iron Gate II Dam area (rkm 847 – rkm 864) of which two Beluga Sturgeons and the Stellate Sturgeon were recorded very close to the Dam. One Beluga Sturgeon with TL 200 cm, approximate weight 40 kg, which was tagged in the fall of 2013 (Table 1, fish no. 1) arrive in the area of the IG II Dam on 2 April 2014 swimming in the range of 9.6 – 10.9 m depth, and after 6 days it moved downstream on 8 April with swimming depth in the range of 7.3 - 10 m (Figure 6).

On 6 April 2014 the same Beluga Sturgeon was captured by a fisherman early in the morning and released at rkm 860 at 10:15 AM (GMT+2) and recorded in the same day at 8 PM by the receiver installed at the mouth of Gogosu branch, jumping

Figure 6. Beluga Sturgeon swimming depths recorded at Danube rkm 847 (Table 1 fish no. 1)

Figure 7. Beluga Sturgeon jumping behavior recorded downstream the Dam on 6th April 2014 and mobile tracking detection recorded on 7th April at 800 m downstream IG2 Dam (left)

Figure 8. Beluga Sturgeon swimming depths recorded in 2012 and 2014 (Table 1 fish no. 2)

on the surface of the water (Figure 7). Next day after release on 7th April 2014 it was recorded again using mobile Vemco receiver VR100 at about 800 meters downstream of IG II Dam close to the left bank at the depth of 6.2 meters (Figure 7). It moved further downstream on 8 April and it has travelled 747 km for the same number of days (18 days), as it was migrating upstream. The same fish has been recorded for the last time on 26 April 2014 at rkm 100 (water temp. 14.6°C) swimming at 1.1 - 1.8 meters water depth.

Second Beluga Sturgeon tagged in 2013 was recorded for the first time in the same year on 1 December at rkm 100. After two years on 15 November 2015 it was recorded at rkm 500 moving upstream (Table 1, fish no. 4). Eight days later the same fish was recorded between 23 November and 05 December 2015 at the IG II Dam by the receivers installed close to both Romanian and Serbian banks. Later it migrated 577 km downstream between rkm 847 and rkm 270 in 8

Figure 9. Recorded swimming depths of Beluga Sturgeons (Fish no. 1,2,3,4 in Table 1)

Figure 10. Stellate Sturgeon swimming depths recorded in the IG II Dam area (Table 1 fish no. 5)

days (Table 1, fish no. 4). It was recorded for the last time on 20 February 2016 at rkm 71.

These two Beluga Sturgeons are examples for fish recorded by manual tracking or by the receivers installed at 800 m downstream the IG2 II Dam. Some Beluga Sturgeon recorded in the IG II area (rkm 847 – rkm 864) like Beluga male tagged in 2012 (Table 1 fish no. 2) were recorded just by the receiver installed at rkm 847 (Figure 8) and not recorded at all by receivers installed close to the Dam.

The Beluga Sturgeon swimming depths analysis based on 4 specimens, that have reached the Danube River sector located downstream of the IG II Dam reveal recorded swimming depths between 1 and 18 m. The most common swimming depths, recorded for upstream migration were in the interval of 8 to 12 m, and for downstream migration in the interval of 7 to 11 m (Figure 9).

Beluga Sturgeon showed 10 times depth less than 0.5 m and in accordance with work of Dunbar (2015) that water depths less than a half meter identified as possible jumping events, we

recognized them as possible jumping activities of beluga sturgeon. One of this Beluga Sturgeon approaches to surface and jumping presented on Figure 7.

Stellate Sturgeon

One of the Stellate Sturgeons tagged in spring 2014 continued its journey upstream swimming at 4.5 -7 meters water depth (Figure 10) and get to Iron Gate Dam area on 25 June 2014 (Danube River km 847, water temp 23.1°C) (Table 1, fish no. 5). It spent 11 days in the area and even gets close to the Turbine no. 1 ($\approx$ rkm 864) on the left bank of Danube River (Figure 2). This Stellate Sturgeon was recorded 42 times (temperature and depth detections) in 49 minutes by the receiver installed at the Turbine no. 1 at the Romanian side (left river bank). The turbine was not working at that time due to repairs that took place during 2014. This was possible because water level was very low and very few turbines of all sixteen were working at that moment (150 cm water level at Gruia rkm 851 in 5 July 2014), compared with the water

Figure 11. Recorded swimming depths of Stellate Sturgeons no. 5 table 1

level of 729 cm recorded on 23 May 2014 at Gruia /rkm 851. Next day on 06 July the same Stellate Sturgeon was recorded for the last time swimming downstream at rkm 847 (Figure 10).

Stellate Sturgeon swimming depths, recorded from the specimens that have reached close to the IG II Dam reveal recorded swimming depths between 2 and 11 m. The swimming depths recorded during the upstream migration were in the interval between 2.9 to 7 m, and for downstream migration most of the recorded swimming depths were in the interval between 2.3 to 7 m (Figure 11).

¹Borcea branch km 42 located on Danube River km 300; ²Caleia branch km 9.5 located on Danube River km 195; ³Borcea branch km 15 located on Danube River km 270, ⁴Unknown exact day of tagging, the sturgeons were tagged into a ROMOMED project

Although, there are more than 40 years since the first dam was constructed on Lower Danube River, the Beluga Sturgeon and Stellate Sturgeon are still present at Iron Gate Dam. Due to homing instinct the sturgeons migrate 864 km from the sea trying to get upstream the dam. The homing instinct has been observed in migratory fish species (Andrew *et al.*, 2015) and proved in Gulf sturgeon (*Acipenser oxyrinchus*) which had a high homing fidelity (Stabile *et al.*, 1996). Soon after the Iron Gate II Dam was constructed, agglomerations of sturgeons were recorded downstream of the Dam (Bratislava report 1987), but the number of sturgeon that reaches the downstream area of Iron Gate II Dam decreased constantly (Paraschiv *et al.*, 2007). Beluga and Stellate Sturgeons which are detected close to the Iron Gate II Dam reveal that the sturgeon generations used to migrate

in the Middle Danube River (rkm 1075 – rkm 1800) are not completely lost. When the sturgeon gets to Iron Gate II Dam they are attracted by the water flow of the Dam and try to get closer to it. The 10 km long Gogosu branch most of the times has a low water level, and it is not used by the sturgeons due to this reason. The fisherman report that in the years with high water level in Danube River, the Spillways from Gogosu branch are opened to release water from the lake which attracts the sturgeons to join this branch. Acoustic telemetry proved to be a good method for tracking sturgeons in deep and turbid waters as in Danube River. Using acoustic telemetry equipment more spawning grounds can be identified by tracking sturgeons between Black Sea and Iron Gate II Dam. Few spawning grounds were identified and studied before between rkm 100 and rkm 310 (Holostenco *et al.*, 2013; Suciu *et al.*, 2005) and in Bulgarian river stretch (Vassilev, 2003). The spawning grounds used by the adult sturgeon and nursery grounds of juvenile migratory sturgeons in Danube River need to be identified and studied in order to find solutions for reducing the sturgeon habitat degradation, caused by dragging, pollution or other human factors. The installation of the receivers in the river stretch between rkm 847 and rkm 864 allowed collection of data which confirmed that Beluga and Stellate Sturgeons still reaching the IG II Dam area. All the collected data will be used for a better understanding of sturgeon migration and behaviour in order to design and build fish passage facilities (Comoglio, 2011) at IG II Dam, and also to identify new spawning sites in LDR, which should be protected during planned dredging work that will be performed for improving navigation between rkm 375 and

Table 1. Beluga and Stellate Sturgeon migration recorded in Lower Danube River

Crt. No.	Species	Year of tagging	Location of tagging	Danube River km & Date of recording	Water temp. °C	Short migration description
1	<i>Huso huso</i>	November ⁴ 2013	Borcea branch ≈Danube rkm 300	rkm 100 18,19, 22, 24 and 26 Nov. 2013	11.9	It moved (d/s) after tagging; returning next year in the spring, swimming 747 km (u/s) in 18 days, swimming d/s (747 km in 18 days).
				rkm 100 1 Dec. 2013	7.5	
				rkm 100 15 Mar. 2014	12.4	
				rkm 847 02 April 2014	13.3	
				rkm 860 05 April 2014	13.2	
				rkm 863 07 April 2014	13.2	
				rkm 847 08 April 2014	14.6	
2	<i>Huso huso</i>	24 May 2012	Borcea branch ≈Danube rkm 300	rkm 100 26 April 2014		It moves (d/s) after tagging and exit the Danube River, it returns to the river in 2014 fall; wintering in the River upstream km 100, continue migration during 2015.
				rkm 300 ¹ 25 May 2012	19.1	
				rkm 195 ² 28 May 2012	18.3	
				rkm 100 29 May 2012	18.2	
				rkm 100 01 Nov. 2014	11.2	
				rkm 847 07 Apr. 2015	9.6	
				rkm 847 08 Apr. 2015	9.7	
3	<i>Huso huso</i>	09 November 2011	Borcea branch ≈Danube rkm 300	rkm 847 26 Apr. 2015	13.9	It moved d/s after tagging leaving the Danube River. It is recorded 5 years latter at rkm 847 on 19 th April 2016. On 12 May 2016 was recorded last time at rkm 100/ water temperature 16.3 °C.
				rkm 847 27 Apr. 2015	13.9	
				rkm 300 11 Nov 2011	10	
				rkm 187 14 Nov 2011	8.5	
				rkm 181 14 Nov 2011	8.5	
				rkm 100 17 Nov 2011	7.7	
				rkm 100 18 Nov 2011	7.7	
4	<i>2.Huso huso</i>	November ⁴ 2013	Borcea Branch	rkm 847- 19, 22, 24, 25, 27, 28, 29 Apr 2016	15.4- -15.8	After tagging moved d/s rkm 100; returned u/s 2 year latter in fall of 2015 and arriving in Nov.; D/s the Dam it is recorded by the receivers installed on the 2 and 3 left bank and receivers 1 and 2 right bank. It moves d/s and it is recorded last time in 2015 at rkm 270 on 14 Dec. It is recoded again in 2016 at rkm 71 on 20 Feb.
				rkm 100 12 May 2016	16.3	
				rkm 100 01 Dec. 2013	7.8	
				rkm 500 15 Nov. 2015	11.8	
				St. 3 RO 23 Nov. 2015	10.2	
				St. 1 RS 23 Nov. 2015	10.4	
				St. 1 RS 05 Dec. 2015	8.2	
				St. 3 RO 05 Dec. 2015	8.2	
				St. 2 RO 05 Dec. 2015	8.2	
				St. 1 RS 05 Dec. 2015	8	
5	<i>Acipenser stellatus</i>	May ⁴ 2014	Borcea branch	St. 2 RS 05 Dec. 2015	7.8	It moves u/s and d/s between rkm 847 & 860, on the left bank, it reaches close to the dam (Turbine no.1 Ro), and left the area on 6 th July.
				Rkm 847 06 Dec. 2015	7.8	
				rkm 270 ³ 14 Dec. 2015	6.9	
				rkm 71 20 Feb. 2016	6.4	
				rkm 847 25 June 2014	23.1	
				rkm 860 26 June 2014	22.6	
				rkm 847 26 June 2014	22.8	
				rkm 864 05 July 2014	23.2	
				rkm 847 06 July 2014	23.5	

rkm 863 according to EU Strategy for the Danube Region (EU Strategy 2014).

Nearly 40% of fish tagged by radio telemetry to study the seasonal movements of dorados (*Salminus brasiliensis*) in 400 km long section of the upper Uruguay River (Brazil) were never detected (Hahn *et al.*, 2011) which is higher than values obtained by this study for Beluga Sturgeon (17%) and Stellate Sturgeon (30%) which could be partly explained with better results obtained with acoustic than radio telemetry in large rivers. There are three possible reasons why fish were not

detected by any receivers: problems in the fixed stations or in mobile tracking, fish were captured by fishers and not reported, or transmitter failure (Hahn *et al.*, 2011). According to Winter (2000), the losses from harvesting by humans are often much higher than 30%, and the transmitter failure rate can approach 10%. In April 2006, Romania banned sturgeon fishing for 10 years in the Danube River while Serbia and Bulgaria followed the same plan as a part of requirements stipulated by the Regional Strategy for the Conservation and Sustainable Management of Sturgeon Populations

of the northwestern Black Sea and Lower Danube River in accordance with CITES (Smederevac-Lalić *et al.*, 2011). But illegal sturgeon fishery is still problem in Lower Danube Region (Smederevac-Lalić *et al.*, 2011), so, obtained percent of never detected specimens could be explained partly by illegal fishery. This is in accordance with findings of Kynrad *et al.*, (2002) when Stellate Sturgeon tag returns from the fishery of 38% in 1998 and 28% in 1999 (plus an unknown large unreported catch) indicate a high harvest rate.

Hahn *et al.*, (2011) showed that some specimens of *S. brasiliensis* during upstream migration moved at an average speed of 54.1 km d⁻¹ and the maximum speed detected in that study was 63.3 km d⁻¹, the largest recorded for the species to date. In this study Beluga Sturgeon had the same speed in upstream and downstream migration, 41.5 km d⁻¹ in case of the fish no.1 table 1 and between 57.5 and 72 km d⁻¹ in case of downstream movement of fish no. 3 and 4 tables 1.

Sturgeons usually occupied deeper habitats depending of what is available and they commonly found on depth between 12 and 18m but the most frequently available habitats are between 9 and 12m. Lake sturgeon (*Acipenser fulvescens*) is found at depths greater than 10 m in the Winnipeg River.

White*et al.*, (2002) show the depth preferences of Pallid Sturgeon, (*Scaphirhynchus albus*) (0.6 m - 7 m) and Shovelnose Sturgeon, (*Scaphirhynchus platyrhynchus*) (0.9 m - 8.8 m) which is smaller than the Beluga Sturgeons recorded depth in this study. Green sturgeon, *Acipenser medirostris*, preferred sites in the Rogue River which are greater than 5 meters deep (Erickson *et al.*, 2002). The white sturgeon, *Acipenser transmontanus*, preferred relatively moderate to high water depths in the range from 11 to 30m (Hatten *et al.*, 2009). The Beluga Sturgeon reveals a preference for deeper waters during upstream migration (8 m - 12 m) and for downstream migration (6 m -10 m). In case of the Stellate Sturgeon the biggest depth recorded was during stationary period when it was recorded close to the dam by the receiver installed at Romanian turbine no. 1 at the depths of 7 - 11 meters. Sturgeons also known to have the unusual activity of jump out of the water almost 2 meters without clear reasons (Thorn, and Falgiani, 2013). Sulak *et al.*, (2002) found that Gulf sturgeon (*Acipenser oxyrinchus desotoi*) in the Suwannee River (northwestern Florida) showed jumping

activities with producing specific sounds during this action and hypothesized that it is a form of group communication. According to mentioned investigation sturgeon spend during jumping activities about 7 second with 1-2 seconds in the air (usually 1.2 - 1.5 s). Watanabe *et al.*, (2008) explained occasional approaching of sturgeon to the surface by their necessity to gulp air and fill gas bladder. Work of Dunbar (2015) suggested also connection between gas bladder function and sturgeon jumping. In this investigation there were only 10 depths less than half meter from Beluga Sturgeon recorded on the receiver in the VR2W receiver (Figure 2).

CONCLUSION

In conclusion, this study give unique data relating to Beluga and Stellate Sturgeon migration at nearly 800 kilometre long sector of the Lower Danube River by use of acoustic telemetry. Data confirmed that these sturgeon species still approach IG II Dam and that construction of fish passages on IG I and IG II are urgently needed. This could open approximately additional 900 kilometres till Gabčíkovo dam for sturgeon migration.

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