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IDENTIFICATION OF STURGEON BEHAVIOR IN DIFFERENT HYDROMORPHODYNAMIC CONDITIONS RESULTING FROM THE IMPLEMENTATION OF HYDROTECHNICAL ARRANGEMENTS

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Abstract

The aim of this research was to evaluate the results obtained by ultrasonic tagging of sturgeon species and to collect field data for the period 2019-2021. Thus, an analysis was made of the information collected from the beginning of the period and also will be presented the migration capacity of sturgeons in the area of hydrotechnical arrangements and the possibility of passing areas in different hydromorphodynamic conditions highlighted by collecting bathymetry data. This research aims to present the situation of sturgeon species tagged with ultrasonic transmitters since the beginning of the study, both in terms of evolution by species, their migration capacity in the area of hydrotechnical arrangements and the identification of potential swimming speeds taking into account the feeding and rest periods, respectively. At the same time, in addition to the results proposed in the study, an assessment was made of the pressures that may adversely affect the conservation status of sturgeon species and the proposed measures.

***Keywords**: Sturgeon; Bathymetry; Migration; Ultrasonic; Tagging*

Introduction

Over the last decade, sturgeon populations are threatened by a drastic decline due to human impacts like exploitation, poaching, dam constructions, habitat destruction, water pollution [1-3]. Consequently, due to anthropogenic factors reported that have affected the populations, at the European scale, sturgeon species have been listed on the International Union for Conservation of Nature Red List of Threatened Species (IUCN, 2020), Appendix II of the Convention on International Trade in Endangered Species (Convention on International Trade in Endangered Species (CITES, 2020), Food and Agriculture Organization (FAO), the Natura 2000 list, the CMS – Bonn Convention (Convention on the Conservation of Migratory Species

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of Wild Animals) and the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats).

The hydrotechnical development of the Danube on Romanian territory began with the construction of the Iron Gates I dam in 1964 together with Yugoslavia (Serbia), and the second dam, Iron Gates II, was commissioned in 1984. Bacalbașa-Dobrovici, carries out the first research on the assessment of the impact of the Danube hydrotechnical development on sturgeon species in 1989 and 1991 [4-5]. His two studies assessed the status of sturgeon catches from 1955 to 1993 in order to determine the effects of damming the Danube on the evolution of sturgeon populations. His two studies assessed the status of sturgeon catches from 1955 to 1993 in order to determine the effects of the damming of the Danube on the evolution of sturgeon populations. The decline of these species has been observed, especially after 1973, but if we look at the analysis of the evolution of catches by Oțel V., in his paper published in 2007, the alarming situation of the decline of sturgeon catches appears with the year 1940, thus leading to the conclusion that the two hydropower plants were not the main cause of the decline [6]. However, it is very true that this decline in sturgeon populations in the lower Danube without measures to improve the conservation status of the species could lead to their extinction in the future. Another particularly important aspect that may have affected the migration of Anadromous fish species is the river regularization works carried out by Austria since 1875 by creating a unique channel in the Vienna area, which led to major changes in the river profile, slopes and sediment transport as well as water flow [7, 8].

Research on the analysis of sturgeon catches continues, and after the data published by Bacalbașa-Dobrovici, new data appear in 2004 when Ciolac publishes the paper "Study of migratory sturgeon catches in Romanian side of Danube River. Migration of fishes in Romanian Danube River", in which he makes a percentage analysis of sturgeon species caught in the period 1992-2001, in order to observe the long-term effects of the two hydropower plants [9]. It was therefore observed that the Russian sturgeon is the species with the lowest catches, at the opposite pole are the catches of the stellate species. From these data it can be concluded that the nuthatch is the most endangered species in terms of species extinction, which is also confirmed by research conducted by INCDPM Bucharest [10].

As far as the protection of sturgeons in Romania is concerned, an important aspect for their conservation is mainly represented by the cooperation of state institutions to issue legislation to compensate for their decline. These actions to protect sturgeon species by banning commercial fishing started as early as 2006 (Orders 330/2006; 1302/2012 and 545/715/2016) [11-13], with a new order currently under discussion for implementation.

However, INCDPM Bucharest experts have concluded that over more than 10 years of sturgeon monitoring by ultrasonic telemetry and the use of monitoring systems such as DKTB and DKMR-01T patented at OSIM by INCDPM Bucharest experts, the greatest pressure on ultrasonically tagged sturgeon and others is exerted by illegal fishing or poaching. INCDPM Bucharest has made all the necessary efforts to carry out scientific fishing of sturgeon species in compliance with the legislation in force, obtaining all the necessary authorizations and approvals from the authorities responsible for the management of fish resources and environmental protection in Romania.

Experimental

Materials

In order to monitor sturgeon specimens, the experts use a set of materials specific to this operation, some of which are also patented as inventions at OSIM. Thus, a list of the materials used will be detailed below.

i) VEMCO ultrasonic tags:

V16TP-6X, large tag usable on individuals of the species Acipenser gueldenstaedtii, respectively Huso huso

V16TP-4X, small tag usable for individuals of the species Acipenser ruthenus and Acipenser stellatus respectively

These tags have been designed to transmit signals to VR2W underwater receiving stations, which are programmed to record the transmitted acoustic signals at 69 kHz wavelengths. Battery life is approximately 15 months and data download are via Bluetooth connection.

(ii) VR2W type submersible station used to receive acoustic signals relating to the depth and temperature of the individuals detected.

iii) Remote monitoring system for ichthyofauna, in particular sturgeons under different hydrological conditions, DKMR01-T. This system consists of the following components: warning light (1), floating tank made of sheet metal, filled with expanded polystyrene and polyurethane foam (2), connection system between tank and protection pipe, made of cast iron (3), metal protection covers with special closing system (4), protection pipe with slots for water passage (5), ultrasonic signal receiving station (6). This station has proven to be reliable, ensuring continuous monitoring of sturgeon species and obtaining a series of results unique at national and world level in terms of migration routes of ultrasonically tagged sturgeons, identification of the swimming capacity of sturgeons in areas where hydro-technical works have been installed, identification of the time required for juveniles to cover the distance to the entrance to the Black Sea.

iv) The monitoring system for ichthyofauna, especially sturgeons, using ultrasonic tag remote sensing under different hydrological conditions, DKTB. This system consists of the following components: warning light (1), metal protective cover with special closing system (2), protective pipe with slits for water passage (3), slits allowing water penetration and circulation (4), handle for handling the system (5), water level and quality monitoring equipment (6), ultrasonic receiving equipment (VR2W station) (7), shore anchoring pole (8), shore system fixing cable (9). This monitoring system has been developed in order to be able to simultaneously monitor the migration path of sturgeons with water level and turbidity in areas where there is a risk of anthropogenic impact (Fig. 1).

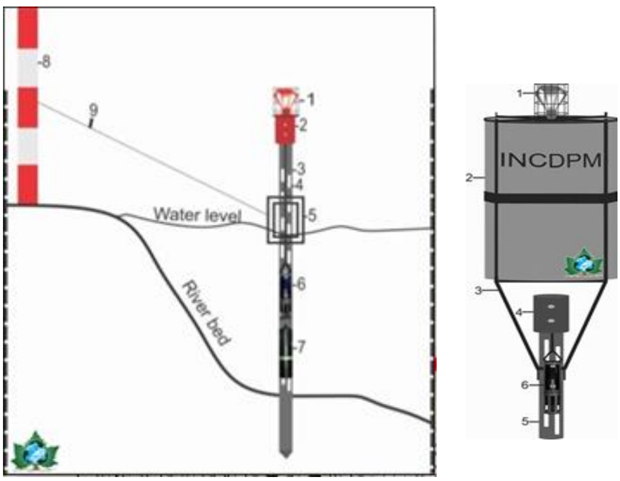

Fig. 1. Monitoring systems. A. DKTB fixed monitoring system.
B. DKMR-01T floating monitoring system

v) T-bar anti-poaching tag

vi) Tagging instruments: surgical kit, tweezers, betadine, Surgibond, dressings, suture thread, stretcher, electronic scale, basin

vii) Boats

viii) VR100 mobile acoustic telemetry receiver
ix) GETAC field laptop
x) Oximeter
xi) Eppendorf tubes
xii) Single Beam and Multibeam equipment
Methods

The sturgeons are caught by deep-sea gillnets by fishermen authorised to do so under the scientific fishing permit issued by the National Fisheries and Aquaculture Authority. Thus, the caught fish are brought to the shore and placed in a containment tube. Prior to the operation, biometric measurements are taken to determine length and weight and a DNA sample is taken from the anal and dorsal fins for laboratory analysis (minimally invasive method). After that, an abdominal local anesthesia will be performed, where an incision will be made beforehand, the ultrasonic tag will be inserted, and the incision will be closed using a needle and suture. Once the incision closure operation is completed, the area is again disinfected with a solution and a specially designed tissue adhesive is applied to create a film that does not allow water to penetrate and infect the area during the post-operative period. At the same time, once the internal tagging procedure has been completed, an anti-poaching T-bar tag is applied to the tail of the specimen, on which the contact details of the institution are noted, so that incidental catches can be reported, thus attempting to reduce poaching. After ultrasonic tagging, the sturgeon is released into the wild and monitored using the DKTB and DKMR-01T migration monitoring systems which are downloaded via Bluetooth connection. In addition to these systems positioned at key points, additional monitoring is also carried out using a VR100 mobile receiver capable of detecting sturgeons in real time. This research also examined the possibility of passage of sturgeon tagged with ultrasonic transmitters in areas where hydrotechnical works were carried out to facilitate navigation, leading to the modification of the water course on a certain section by changing the morphology and flow dynamics. Thus, in order to characterize the area where hydrotechnical constructions have been implemented, it is specified that one of the most recent installations was carried out in the period 2013-2017 on the Bala branch of the Danube consisting in the construction of a bottom sill aimed at redistributing the flows so that minimum navigation conditions can be ensured on the Old Danube even during dry periods.

Thus, in order to identify the behaviour of sturgeons during migrations in the lower Danube under different hydromophodynamic conditions, it was necessary to carry out sets of singlebeam and multibeam bathymetry measurements, so that a characterization of the conditions of some areas of interest could be made (behaviour in the bottom sill area, behaviour in habitats suitable for feeding, wintering or even breeding sturgeons).

Results and discussion

The scientific fishing was carried out mainly on the Borcea branch of the Danube between km 60-0 by 3 boats in the period 2019-2020, respectively 5 boats in 2021, catching a total of 281 specimens of sturgeon (Fig. 2) belonging belonging to the 4 species that are still found within Lower Danube: *Acipenser ruthenus*, *Acipenser stellatus*, *Acipenser gueldensteadtii* and *Huso huso*, respectively 2 specimens considered hybrids between the species *Acipenser stellatus* * Acipenser ruthenus*.

Following the research, the following results were obtained regarding the statistics of the species captured, tagged and monitored on the Lower Danube Course:

a. the most dominant species is *Acipenser stellatus*;

b.a significant increase has been observed in the last 3 years in catches of *Acipenser gueldenstaedtii*, which leads us to believe that in the case of this species the repopulation program was a success, but we cannot say for sure without basis for future in-depth studies;

c. In the case of *Huso huso*, the lower percentage of catches was mainly due to the issuance of the scientific fishing authorization which was usually carried out after the third month of the year, from which we conclude that the peak migration of this species.

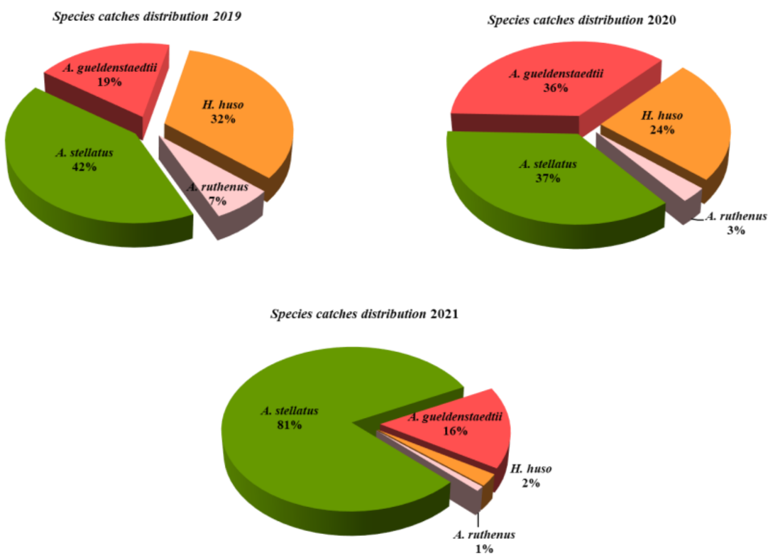

Fig. 2. Species catches distribution in 2019-2021 period

Also, the processing of bathymetric data on water flow rates and velocities recorded at the time of passage of sturgeon tagged with ultrasonic transmitters over the "bottom threshold" showed that they were able to cope with these water flow velocities by passing the risk zone and continuing their migration to spawning habitats. It thus appears that these species are capable of considerable effort to perform their most important biological function, namely reproduction. Following the processing of data collected in the period 2019-2021, in the area of the hydrotechnical installations, 24 individuals tagged with ultrasonic transmitters, of different lengths and weights, were identified and managed to overcome the area by swimming against the water current, migrating towards the Old Danube River km 348. Thus, the sturgeons IOSIN 4S33 (*Acipenser gueldenstaedtii*) and IOSIN3S15 (*Acipenser stellatus*) will be described behaviourally. Thus, the average speeds recorded at the time of sturgeon passage ranged from a minimum of 2.17m/s to a maximum of 2.64m/s. At the same time, the flow rates were also recorded on the dates when sturgeon migrated into the area of interest and exceeded a minimum of 2501m^3/s and a maximum of 4272m^3/s by swimming against the current. With regard to the swimming speed of individuals that migrated upstream to the spawning habitats by swimming against the current, data processing was carried out for two individuals of different species: *Acipenser gueldenstaedtii* and *Acipenser stellatus*. According to the data obtained, different values of sturgeon swimming speeds are indicated (Fig. 3), which can be defined according to the species and their current needs (feeding, resting, area survey):

a. the swimming speeds analysed for the *A. gueldenstaedtii* specimen indicated that the specimen migrated upstream with a maximum speed of 0.64m/s, its migration being generally characterised by swimming speeds of less than 0.3m/s, indicating that the sturgeon exhibited habitat-seeking behaviour in the area;

b. as in the case of the species *A. gueldenstaedtii* and *A. stellatus*, the sturgeon showed similar behaviour with a maximum upstream speed of 0.87m/s;

In order to characterize the Bala bottom sill area, bathymetric measurements were carried out annually during 2019-2020 in order to carry out a concrete assessment. Thus, it is indicated to us that this area as a result of the implementation of the hydrotechnical works of the "bottom sill" type is in a complex process of deposition and erosion caused by water currents. At the same time, behind the two thresholds, we can see the two pits formed as a result of erosion, pits that may represent resting areas for sturgeon specimens that swim against the current over the construction. These holes thus facilitate the passage of sturgeons as they are characterised by lower velocities in the riverbed area.

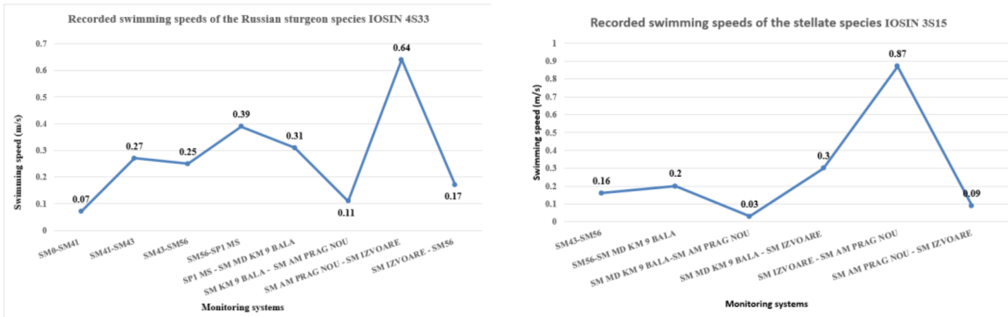

Fig. 3. Diagram of swimming speeds recorded in two specimens of sturgeons that crossed the bottom threshold Bala

It was also found that behind the bottom sills, two "pits" with large depths have been created, which can be considered good resting areas for sturgeon migrating upstream to spawning habitats (Fig. 4). These 'pits' attenuate the velocity of water flow in the deeper areas, which may provide good resting conditions for sturgeon species.

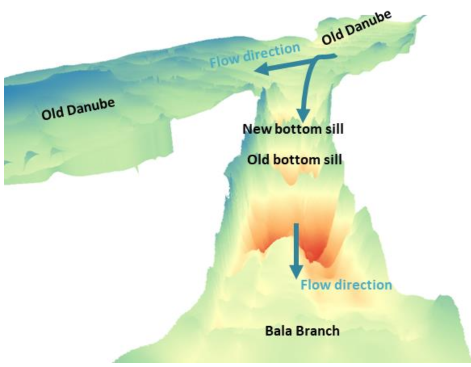

Fig. 4. Riverbed morphology in the area of the bottom sills on the Bala branch

Conclusions

During the research period from 2019-2021, scientific fishing activities were carried out on the Borcea branch of the Danube between river km 60-0, with a total of 281 sturgeons of the 4 species still found in the lower Danube River being caught, tagged, released and monitored. Fishing and catching of sturgeons were carried out in accordance with the legislation in force on scientific fishing, involving experienced fishermen verified and approved by the National Agency for Fisheries and Aquaculture.

In the area of the hydrotechnical works, 24 sturgeons tagged with ultrasonic transmitters were identified, which managed to swim against the current without any problems, migrating above the Izvoarele area (Old Danube River km 348).

The processing of the database yielded considerable results showing that during the monitoring period 2019-2021 the hydrotechnical work was overcome by swimming against the current by individuals belonging to the 4 sturgeon species that are still present in the Lower Danube River. It seems, therefore, that these species are capable of considerable effort to perform their most important biological function, namely reproduction.

However, the behaviour of these species at the time of the analysis was conditioned by the breeding season, which certifies the movement speeds as low, taking into account the need to identify suitable habitats to perform vital feeding and breeding functions. Thus, it can be pointed out that so far, the hydrotechnical work has not had a considerable impact on the migration capacity of sturgeon species, as they use the area both in upstream migrations to breeding habitats and downstream to Black Sea habitats.

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References

[1] T. Friedrich, *Danube Sturgeons: Past and Future*, **Riverine Ecosystem Management**, 2018, pp 507-518

[2] E. R. Misăilă, C. Misailă, G. Vasile, *Preliminary data on ecological plasticity in sturgeon fries,* **An. Şt. Univ. „Alexandru Ioan Cuza” Iaşi, s. Biologie Animală**, 53, 2007, pp. 269-275.

[3] G. Dumitru, E. Todirascu-Ciornea, I. Sandu, *Effect of glyphosate herbicide on some hematological and biochemical parameters in Carassius auratus L.*, **Revista de Chimie**, **70** (2), 2019, pp. 518-521.

[4] N. Bacalbaşa-Dobrovici, *The Danube River and its Fisheries, Dodge*, D.P. (Ed.) in: **Proceedings of the International Large River Symposium**, (Editor: D.P. Dodge), Can. Publ. Fish. Aquat. Sci., 1989, 106: 455-468

[5] N. Bacalbaşa-Dobrovici, *Statut de differentes especes d'ésturgeons dans le Danube roumain*, **ACIPENSER**, (Editor: P. Williot), CEMAGREF Publ. Bordeaux, 1991, pp. 185-192.

[6] V. Oţel, **Atlasul peştilor din Rezervaţia Biosferei Delta Dunării,** Ed. Centrul de Informare Tehnologică Delta Dunării, Tulcea, România, 2007, pp. 148-264.

[7] F. Schiemer, *Conservation of biodiversity in floodplain rivers*, **Large Rivers**, 11, 1999, pp. 423-38.

[8] F. Schiemer, G. Guti, H. Keckeis and M. Staras, *River and its fish fauna: A review*, **Ecological status and problems of the Danube**, 2013, pp. 273-300.

[9] A. Ciolac, *Study of migratory sturgeon captures in Romanian side of Danube River. Migration of fishes in Romanian Danube River*, **Applied Ecology and Environmental Research,** 3(1), 2004, pp. 73-78.

[10] Gy. Deak, M. Raischi, A.M. Badilita, T. Danalache, A. Cristea, E. Holban, S. Zamfir, M.

Boboc, M. Matei, B. Uritescu, I. Boaja (Popescu), D. Stefan, G. Tudor, G. Badea, I. Gheorghe, G. Cornateanu, N. Raischi, M. Silion, *Action for preserving sturgeon species from Lower Danube River*, **International Warsaw Invention Show**, 09-11 october 2017, Varsovia, Polonia.
[11] G. Dumitru, E. Todirascu-Ciornea, L. Hritcu, I. G. Sandu, *Studies of some morphological and biochemical parameters concerning the health condition of some fish species from Prut River, Romania*, *Revista de Chimie*, **69**(5), 2018, pp. 1194-1199.
[12] * * *, Ordinul comun nr. 262/330/2006 privind conservarea populațiilor de sturioni din apele naturale și dezvoltarea acvaculturii de sturioni în România.
[13] * * *, Ordinul comun nr. 545/715/2016 privind măsurile de refacere și conservare a populațiilor de sturioni din habitatele piscicole.

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