

Chapter 26

Danube Sturgeons: Past and Future



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26.1 Introduction

Sturgeons are an ancient order of fish (Acipenseriformes), dating back in their occurrence to over 200 million years ago. The order comprises two families (Acipenseridae and Polyodontidae) and 27 species. Their natural range is restricted to the northern hemisphere. Sturgeons exhibit a very long life cycle (maximum lifespan up to over 150 years, depending on species). They are late-maturing species, and many grow to very large sizes (up to 6–7 m long). Most of the sturgeon species are anadromous. There are also potamodromous (landlocked) species and forms, spending their entire life cycle in freshwater (Fig. 26.1).

Within their natural range, sturgeons can be considered one of the best indicators for riverine ecosystem health, and their significant decline over the past century poses one of the ultimate challenges for river basin management. Worldwide, many sturgeon species are already considered extinct, highly endangered, or vulnerable, as they are extremely sensitive to a broad selection of anthropogenic impacts. Due to their highly valued caviar and meat, they were heavily overfished in the past, a pressure still continuing up to the present day. Because of their long generation intervals of up to 20 years and their irregular spawning patterns of 2–7 years, this family is extremely sensitive to overexploitation, and the recovery of stocks needs long time periods.

The life cycle of sturgeons includes long spawning migration, ranging between several hundred and several thousand kilometers. Obstacles within the river systems they use, therefore, pose a serious additional threat to sturgeon stocks by preventing them from reaching their spawning grounds. Furthermore, juveniles and spawned

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507



Fig. 26.1 A sterlet (*Acipenser ruthenus*), a pure freshwater sturgeon species, native in the Pontocaspian region. Sturgeons are unique with regard to external appearance and their traits

adults need a wide selection of habitats within the river and have to have the ability to migrate downstream after spawning.

While overexploitation and migration barriers are considered responsible for the diminishing stocks worldwide, additional threats cannot be overlooked. As sturgeons can produce fertile offspring through interspecific hybridization, the introduction of nonnative sturgeon species or genotypes can lead to an outbreeding depression of native stocks, as already to some extent described in Ludwig et al. (2009). Due to their longevity and their benthic habitat, sturgeons are also sensitive to pollution and the effects of accumulated heavy metals in the sediments, which may lead to organ dysfunctions, especially affecting the gonads and reducing fertility (Jarić et al. 2011; Poleksic et al. 2010).

Considering all of these different impacts, it becomes obvious why sturgeons pose such a difficult challenge for management. In the case of the Danube, this challenge is even further complicated, since the Danube is the most international river system worldwide, extending into territories of 19 countries (ICPDR 2015), with sturgeon stocks also using the coastal areas of three additional countries in the Black Sea Region.

26.2 Sturgeon Stocks in the Danube River Basin: A Historic View of Their Development up to the Present

Six sturgeon species are native in the Danube River Basin (Holčík 1989). In the past their stocks played an important economical role as a food resource for the human population in the Danube River Basin (Schmall and Friedrich 2014), and they might even be one driver for early human settlements in the Danube River Basin (Balon 1968). Fisheries for sturgeons are well documented since 3500 BCE (Hochleithner and Gessner 2012; Kirschbaum 2010). Intensive exploitation of sturgeon stocks

continued well into the Middle Ages, with the construction of traps and so-called “sturgeon” fences, covering the whole river width as a highly effective method for catching whole migration runs (Schmall and Friedrich 2014). In the early modern times at the beginning of the eighteenth century, the stocks were already so damaged that catching large sturgeons in the Upper Danube and the upstream part of the Middle Danube was considered extraordinary by the inhabitants along the shores of the Danube. Such rare, large sturgeons were reserved for aristocrats and clergy (Balon 1968; Fitzinger and Heckel 1836). Fish market data from the year 1548 suggest a prodigious abundance of sturgeon, e.g., 50,000 kg of fresh sturgeons sold on some days in the Viennese fish market (Krisch 1900). Therefore, large, highly fecund sturgeons became exceptional catches in these Danube reaches within only two centuries (Heckel and Kner 1858; Schmall and Friedrich 2014, Fig. 26.2).

In recent times along the Upper Danube, only very small numbers of one freshwater, sturgeon species, the sterlet (*Acipenser ruthenus*), can still be found. Most sterlet stocks nowadays must be actively sustained by stocking, and the self-sustaining, reproducing stock is considered to be lower than 1000 specimens (Wolfram and Mikschi 2007; Friedrich 2013). This stock is still threatened by habitat degradation and the introduction of allochthonous sturgeon genotypes and species (Friedrich et al. 2014). In the Middle Danube, this species is more numerous but also had a sharp decline after the destruction of an important spawning habitat during the construction of Gabčíkovo Dam (Guti 2008).

The potamodromous ship sturgeon (*Acipenser nudiventris*) is considered functionally extinct (Reinartz and Slavcheva 2016) as only very few single specimens were caught within the last decade in the Middle Danube. There is no program for controlled propagation of the Danube stock, as no brood stock is available. There is an ongoing discussion about a resident form of the Russian sturgeon in the Middle Danube (Heckel and Kner 1858; Holčík et al. 1981; Hensel and Holčík 1997). If such a form existed, it would probably be already extinct, as catches within the last 20 years (Guti 2008) are more likely to be fish that have escaped from hatcheries, rather than indicators of a relict population.

The Russian sturgeon (*Acipenser gueldenstaedtii*), the stellate sturgeon (*Acipenser stellatus*), and the beluga sturgeon (*Huso huso*) are now restricted to the lower part of the Danube, as the construction of the Djerdap I and II dams at the Iron Gate in 1972 and 1984 blocks upstream migration. Within the Danube two different migration types are known to exist for, at least, the beluga sturgeon and the Russian sturgeon. The vernal form migrates and spawns in spring, and the hiemal form migrates during the fall, overwinters in the river, and finally migrates further upstream to spawn during the following spring (Khodorevskaya et al. 2009). All three species are also highly endangered, in particular the long-distance migratory hiemal forms.

Fisheries were regulated and enforced in communist times in the Lower Danube. Post-communism severe poaching and unregulated fisheries increased dramatically in several Lower Danube countries. Although a total ban was implemented by 2005 through the Romanian government for a time period of 10 years and Bulgaria following shortly thereafter, illegal fishery and poaching still pose a very high pressure on such low stocks. An extension of the ban for another 5 years was agreed

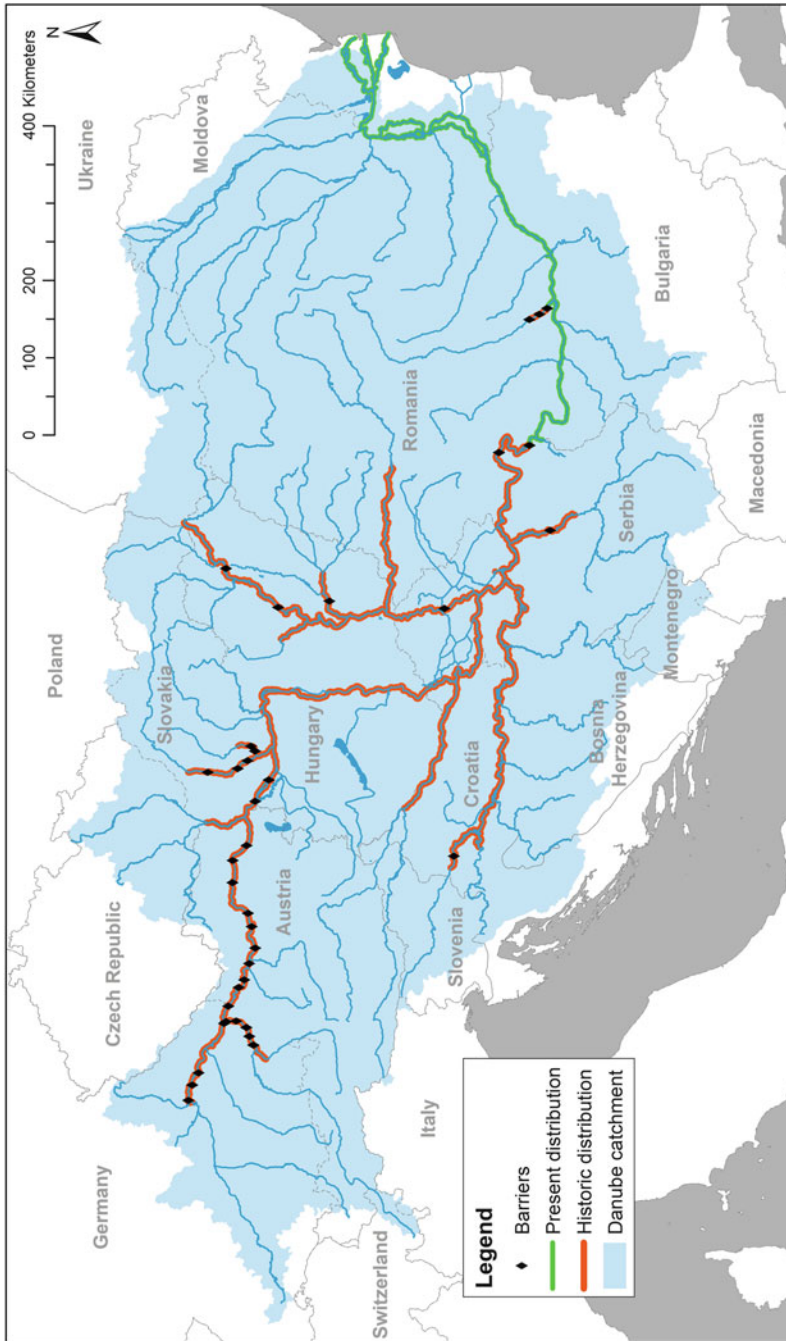


Fig. 26.2 Present and past distribution of anadromous sturgeons in the Danube River Basin

upon in 2015 after long discussions; however, due to their long generation intervals, it is obvious that a recovery of the stocks cannot be accomplished within this short time frame. For all three species, controlled propagation and stocking programs are carried out in the Lower Danube. These species can also be found in hatcheries and aquaculture facilities all over Europe. However, in most cases it is not clear whether the fish belong to Danubian or Caspian genotypes. Consequently, introduction of these fish into natural water bodies has to be considered as a potential risk to the autochthonous species.

Another sturgeon species, the common European sturgeon (*Acipenser sturio*), occurred historically only in the Lower Danube but is considered extinct in the Black Sea Basin (Bacalbasa-Dobrivici and Holčík 2000), its only remaining stock living in the Garonne-Dordogne-Gironde River Basin and, following reintroduction efforts, in the Rhine and Elbe Rivers (Gessner et al. 2010).

26.3 Integrated Approach for Sturgeon Restoration in the Danube River Basin: Sturgeon 2020

In 2005 the *Action plan for conservation of sturgeons (Acipenseridae) in the Danube River Basin* (SAP) was developed under the umbrella of the “Bern Convention” to foster sturgeon conservation (Bloesch et al. 2005). The plan was designed after existing action plans for *A. sturio* in France and Germany, which have been extended and updated over the years (Gessner et al. 2010; Rosenthal et al. 2009).

Although ratified by all Danube countries, the SAP was never truly implemented on a transnational level, with a few exceptions for stand-alone projects, e.g., for the sterlet in Bavaria (Reinartz 2008), despite being supported by a wide range of protective international legislation:

- CITES—Convention on International Trade with Endangered Species
- Bern Convention
- CMS—Convention on the Conservation of Migratory Species of Wild Animals
- CBD—Convention on Biological Diversity
- Ramsar Convention
- BSC—Black Sea Convention on the Protection of the Black Sea
- EU environmental directives
- WFD—Water Framework Directive
- Governmental and nongovernmental organizations (ICPDR, International Commission for Protection of the Danube River; IAD, International Association for Danube Research; WWF, World Wide Fund For Nature; WSCS, World Sturgeon Conservation Society)

To address dramatic declines in Danube sturgeon populations (IUCN 2010), in 2012 the Danube Sturgeon Task Force (DSTF) was established as a network of dedicated volunteers from scientific, governmental, and nongovernmental organizations. The aim

was to develop a fully transboundary, overall strategy that would foster synergies between existing organizations to support the conservation of the native sturgeon species in the Danube River Basin and Black Sea. Therefore, the SAP was updated and streamlined into the program “Sturgeon 2020” (Sandu et al. 2013), with support of the EUSDR (European Strategy for the Danube Region). “Sturgeon 2020” aims to foster sturgeon conservation according to the EUSDR target “to ensure viable populations of sturgeon and other indigenous fish species by 2020.” It is considered to be a living document since sturgeon conservation depends on long-term commitments by all countries in the Danube River Basin and along the Black Sea, and it requires transnational cooperation between stakeholders, governments, scientists, local communities, and NGOs (Sandu et al. 2013).

A range of different priorities with adjacent, necessary measures have been developed to address the high heterogeneity of different conditions and human impacts within the Danube River Basin and the Black Sea Region (Sandu et al. 2013). Actions envisaged within “Sturgeon 2020” are grouped into six interconnected key topics:

- (1) Acquiring political support for sturgeon conservation
- (2) Capacity building and law enforcement
- (3) In situ conservation
- (4) Ex situ conservation
- (5) Socioeconomic measures in support of sturgeon conservation
- (6) Raising public awareness

The six main actions of “Sturgeon 2020” can be sorted into different groups (e.g., No. 1, acquiring political support, and No. 6, raising public awareness). These are supporting actions, which focus on raising funds, long-term governmental commitment, and political support necessary for the implementation of concrete conservation actions and projects, also to be backed up by matching legislation.

One of the crucial steps for the conservation of sturgeons is to implement mechanisms that help to control and stop poaching in the Lower Danube countries and the Black Sea. As the stocks are still declining and in a critical condition, especially for the Russian sturgeon, as well as the long-distance migrating forms, illegal harvest is still one of the major threats for sturgeons in the Danube River Basin. Actions No. 2 (capacity building and law enforcement) and No. 5 (socioeconomic measures in support of sturgeon conservation) are intended to tackle this problem at both ends. It is necessary to build up the capacities for law enforcement and to design structures to control and combat illegal, unregulated, and undocumented fisheries, as well as illegal and mislabeled trade of sturgeons and their products. A recent study by WWF showed many irregularities in the caviar trade within the Danube River Basin (Jahrl 2013). Therefore, international and national legislation have to be harmonized to give a solid and consistent basis for transboundary enforcement. This process needs to be sustained continuously to overcome the inertia from different interests of various stakeholders as was seen with the tedious process of persuasion for the prolongation of the fishery ban in Romania.

However, due to the difficult economic situation in the Danube Delta, legislation and enforcement alone may only reduce poaching. To totally stop illegal fishery, local

communities must be helped to find or develop alternative ways of income. Sturgeon fisheries represented a vital income source for many communities in this area. Even with intensified enforcement, the current fishing bans cannot prevent poaching if they are not accompanied by appropriate compensation measures for local fishermen. Therefore, a two-step effort is necessary. Before increasing any enforcement, first, we must increase awareness of local fishermen to the actual situation of sturgeon stocks in the Danube River and the consequences of ongoing poaching. Poaching will perpetuate the current decline, denying coming generations' access to this resource and preventing reestablishment of a sustainable fishery in the future.

A project by the WWF called "Joint actions to raise awareness on over-exploitation of Danube sturgeons in Romania and Bulgaria," which was funded by the European Commission under the LIFE program (L'Instrument Financier pour l'Environnement), acted as a pioneer for the development of communication and dissemination channels between fishing communities in Romania and Bulgaria and stakeholders working on the conservation of the Danube sturgeons. It also included measures that targeted education of enforcement agencies, as well as actions No. 1 and No. 6 so as to raise public awareness and gain political support for sturgeon conservation. The project ran from 2012 to 2015, and a successor was submitted and granted for the 2016 LIFE period. The second step, to generate alternate ways of income for local communities, has to be politically addressed but can be developed with strong support from other stakeholders of sturgeon conservation. Ideas range from ecotourism to the establishment of sturgeon aquacultures to provide sturgeon products without compromising wild stocks. They even embrace the use of local community knowledge on sturgeon ecology and include them actively in monitoring actions for conservation purposes. However, such innovations would need tight guidance by conservational institutions in order to minimize fraudulent actions that actually sustain poaching while masquerading as conservation.

Actions for in situ conservation target the preservation of the complete sturgeon life cycle as well as protection of its genetic diversity in its natural habitat. To meet such conservation targets, it is necessary to identify, protect, and restore the life cycle and habitats of sturgeons on the Danube River in order to prevent additional habitat alterations and to mitigate existing deficiencies. The major problem in this regard is the present lack of knowledge on habitat use, migration patterns, spawning site selection, and other autoecological traits of this family. These deficiencies make further research with standardized methodologies indispensable. Several local-scale projects currently address this field (e.g., Friedrich et al. 2016; Hontz et al. 2012; Ratschan et al. 2014; Suciú et al. 2015), but the research horizon must be extended to include more Danube stretches (Table 26.1). "Sturgeon 2020" recommends the establishment of a standardized monitoring network, working with the same predefined protocols, which would then be able to document changes in population dynamics as well as in habitat conditions. This could be the basis of an adaptive monitoring plan, with regard to ex situ (see Chap. 27) fishery regulations and actual habitat restoration and reconstruction.

Aside from fundamental research on population dynamics and in situ habitat actions, further observations are necessary to focus on migration and overcoming barriers. Facilitation of fish migration at the two Djerdap dams at the Iron Gates

Table 26.1 Prioritized measures for in situ conservation of sturgeons in the DRB

Species	Species-specific and region-specific requirements			
	Upper Danube	Middle Danube	Lower Danube	Black Sea
<i>Acipenser gueldenstaedtii</i>		Iron Gate dam passage upstream/downstream, reintroduction	Population analysis, autoecology research, applied in situ measures	Population analysis, autoecology research, applied in situ measures
<i>Acipenser nudiventris</i>		Population analysis, applied in situ measures		
<i>Acipenser ruthenus</i>	Population analysis, autoecology research, applied in situ measures	Population analysis, autoecology research, applied in situ measures	Population analysis, autoecology research, applied in situ measures	
<i>Acipenser stellatus</i>		Iron Gate dam passage upstream/downstream, reintroduction	Population analysis, autoecology research, applied in situ measures	Population analysis, autoecology research, applied in situ measures
<i>Acipenser sturio</i>		<i>Reintroduction</i>	<i>Reintroduction</i>	<i>Reintroduction</i>
<i>Huso huso</i>		Iron Gate dam passage upstream/downstream, reintroduction	Population analysis, autoecology research, applied in situ measures	Population analysis, autoecology research, applied in situ measures

High priority in bold, medium priority in regular, least priority in italic (after Sandu et al. 2013)

would reopen over 1000 river kilometers of habitat and is one of the key priorities for sturgeon conservation in the Danube River Basin. A scoping mission by the FAO and the ICPDR (Comoglio 2011) led to a pre-feasibility study on flow velocities and sturgeon behavior downstream of the Iron Gate II Dam (Suciu et al. 2015). This project should be accompanied by further studies in the near future on turbine passage and sturgeon behavior on approach to the dam, leading to follow-up studies for both upstream and downstream migration facilities for juveniles and adults.

The construction of fish passages at the Iron Gates is slowly promoted. However, there is ongoing, intense debate about the construction of a submerged sill 550 km downstream. In its original execution, this sill sets up extremely high flow velocities that strongly hamper sturgeon migration or disrupt it entirely (Bloesch 2016). Acoustic telemetry showed that out of 315 tagged individuals, only 10 could pass the unfinished sill (Déak and Matei 2015). Such a tiny fraction cannot maintain a sturgeon population, especially given the other two passages at the Iron Gate dams in the future. As a result of this controversial situation, the construction of the sill has been stopped, and alternatives including decommission of overvalued, built constructions have to be discussed (Bloesch 2016). While in situ conservation of

sturgeon populations is the overall goal, in the short- and midterm, accompanying ex situ actions (No. 4) are necessary.

The main idea of ex situ is to establish captive, life cycle units, which should serve as living gene banks. By rearing juvenile fish in a hatchery outside of the river (“off-site”) and releasing them into the wild at a later stage, it is possible to stabilize and strengthen populations. However, ex situ measures are not a stand-alone activity, as they cannot be sustainable without in situ measures and therefore can only act as short- to midterm solutions until in situ habitats and populations are reestablished (Reinartz 2015). Conservation hatcheries always have to be linked with the natural population so as to maintain a natural gene pool and guarantee a broad genetic diversity, which is essential for long-term survival of species. Furthermore, seminatural conditions should be provided by the rearing facility to enable the sturgeons to adapt in the wild and to show homing behavior based on water chemistry, nutrition, flow velocities, temperatures, exposure to predators, etc. (Reinartz 2015; Friedrich et al. 2016).

A feasibility study for ex situ measures for Danube sturgeons (Reinartz 2015) and two hatchery manuals of the FAO (Chebanov et al. 2011; Chebanov and Galich 2011) provided the basis for two pilot projects to address the need for ex situ actions in two Danube sections. The LIFE project “LIFE- Sterlet: Restoration of sterlet populations in the Austrian Danube” targets ex situ actions for sterlet in the Upper Danube and applies a technique wherein eggs and juveniles will be reared under seminatural conditions in Danube water with natural diets. The juveniles will be released into suitable areas in several size classes and are partly tagged with external tags and hydroacoustic transmitters to supplement in situ research (Friedrich et al. 2016). In the Lower Danube, the project STURGENE evaluated different facilities for their suitability for two tasks: to keep wild brood stock and/or to raise juveniles for ex situ actions (Reinartz et al. 2016). This survey showed that there are few facilities available for either of the two tasks, and although some hatcheries can be adapted to fulfill at least the role to keep and spawn brood stock, it will be necessary to build new facilities to accomplish for both tasks. To minimize the risk to loose entire conservation units and genetic strains due to catastrophic events, it is necessary to spread them over different facilities (Friedrich et al. 2015). Both LIFE Sterlet and STURGENE are considered pilot projects, and the overall aim within “Sturgeon 2020” is to extend the measures taken within both projects to all species and areas within the Danube River Basin (Table 26.2). The next step is the development of an ex situ hatchery in the Lower Danube for the native species and the securing of funding for the construction and long-term operation of the facility.

26.4 Conclusions

Restoration of sturgeon stocks and habitats within the Danube River Basin can be considered a long-term multitask on a multinational level. The DSTF and its program “Sturgeon 2020,” with the support of the ICPDR, the EUSDR, and several ministries, could establish several projects for the conservation of sturgeons in a rather short time frame and within one defined framework, finally implementing the

Table 26.2 Prioritized measures for ex situ conservation of sturgeons in the DRB

Species	Species-specific and region-specific requirements			
	Upper Danube	Middle Danube	Lower Danube	Black Sea
<i>Acipenser gueldenstaedtii</i>		Ex situ measures (after restoration of river continuity at Iron Gate dams)	Rescue program, extensive ex situ measures	Rescue program, extensive ex situ measures
<i>Acipenser nudiventris</i>		Rescue program		
<i>Acipenser ruthenus</i>	Linking to in situ measures and population assessment	Linking to in situ measures and population assessment	Linking to in situ measures and population assessment	
<i>Acipenser stellatus</i>		Ex situ measures (after restoration of river continuity at Iron Gate dams)	Linking to in situ measures and population assessment	Linking to in situ measures and population assessment
<i>Acipenser sturio</i>		<i>Linking to recovery programs in Europe</i>	<i>Linking to recovery programs in Europe</i>	<i>Linking to recovery programs in Europe</i>
<i>Huso huso</i>		Ex situ measures (after restoration of river continuity at Iron Gate dams)	Extensive ex situ measures	Extensive ex situ measures

High priority in bold, medium priority in regular, least priority in italic (after Sandu et al. 2013)

first coordinated actions nearly 10 years after the formulation of the first sturgeon action plan in 2005. However, more political and financial support and coordination of efforts in the Danube River Basin are still necessary. Therefore, an international project under the name MEASURES was envisioned in 2016 to be submitted to the Danube Transnational Programme in order to strengthen the sturgeon network and to implement the next steps within Sturgeon 2020.

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