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Management approaches and aquaculture of sturgeons in the Lower Danube region countries

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Summary

This paper presents the status and trends in management of sturgeon species and the development of sturgeon aquaculture in the Lower Danube countries: Romania, Bulgaria, Serbia, Ukraine and Moldova. Sturgeon fishery moratoria and aquaculture development represent first steps in the Lower Danube countries to combat extirpation. Supportive stocking was used as a compensation for the impact of sturgeon fishery and dam construction, but these efforts unfortunately lacked adequate cooperation and coordination between and among region countries. Unsolved problems remain, such as the presence of illegal sturgeon fishery, water pollution, habitat destruction and fragmentation. Construction of fish passes and habitat restoration project developments are two key issues that have yet to be tackled in the Lower Danube region.

Introduction

Six sturgeon species originally inhabited the Danube River: beluga (*Huso huso*), Russian sturgeon (*Acipenser gueldenstaedtii*), ship sturgeon (*Acipenser nudiventris*), stellate sturgeon (*Acipenser stellatus*), European sturgeon (*Acipenser sturio*) and sterlet (*Acipenser ruthenus*). However, the European sturgeon is now considered extinct in the Danube, with the ship sturgeon facing possible extinction in the near future (Jarić et al., 2009). Populations of the other four sturgeon species are also experiencing severe decline (Lenhardt et al., 2006).

The sturgeon life cycle (i.e. long life span, late maturity, intermittent spawning and lengthy migratory movements) makes them very susceptible to key negative human impacts – the long-term unsustainable fishery levels (both legal and illegal) induced by the high demand for caviar, followed by a further increase in the number of fishermen and greater equipment efficiency, water pollution, as well as habitat destruction and fragmentation (Jager, 2001; Lenhardt et al., 2006; Hubenova et al., 2009). According to Vassilev (2006) construction of the Iron Gate I dam in 1972 (rkm 942) and Iron Gate II dam in 1984 (rkm 863) obstructed sturgeon migration to the Middle and Upper Danube, confining their migration routes to only the Lower Danube Region (LDR). In compensation for this decline, more than 1 000 000 larvae, fingerlings and juveniles of Russian and stellate sturgeon, and lesser amounts of beluga and sterlet have been released in the Lower Danube. However, these stocking activities are still considered to be insufficient (Vassilev, 2006). As the final predators in aquatic trophic chains, sturgeons are highly exposed to high levels of pollutant bioaccumulation in sediments (Poleksić et al., 2010). Their susceptibility to environmental contaminants comes from the high lipid content in their bodies and their specific life history, such as an extended time to maturity, prominent longevity and benthivorous diet (Kruse and Scarnecchia, 2002; Stanic et al., 2006; Webb et al., 2006). Pollution has been recognised as one of the key threats to survival of the sturgeon species (Williot et al., 2002; Agusa et al., 2004; Pikitch et al., 2005). It is believed that the main threat to sturgeons in the Upper Danube comes from habitat degradation, in the Middle Danube from the disruption of their migration routes by dam construction, whereas pollution and over-fishing are the major threats in the Lower Danube and the Black Sea (Bloesch, 2006). Political, social and economic changes in the LDR have also influenced sturgeon fisheries by the lack of strict fishing controls, which has resulted in increased pressure on sturgeons (Nikčević et al., 2004).

Importance of sturgeon species was recognized by a number of international conventions, agreements and initiatives, such as Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), Food and Agriculture Organization (FAO), TRAFFIC, WWF, the Natura 2000 list, the CMS – Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals), and the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats). One of the most radical attempts made to date to preserve sturgeons in the Lower Danube River was the announcement of moratoria on sturgeon catch in 2006. In April 2006, Romania banned sturgeon fishing for 10 years; 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.

The main aim of this study was to present and evaluate the status of sturgeon stocks in various countries in the LDR, as well as the ongoing and planned management activities and projects. The data presented could be of importance for both scientists and fishery managers.

Materials and methods

Assessed data was obtained from both scientific and official sources and mostly related to the catch, aquaculture and conservation activities in the LDR countries. The Action Plan for the conservation of sturgeons (*Acipenseridae*) in the Danube River Basin (DSAP) was the key document that comprised the most important conservation and restoration activities. The document compared national action plans from LDR countries in order to estimate management priorities of each country and the feasibility of their described objectives.

It was difficult to collect data about activities over the past few years. One reason for the lack of published papers in recent years could be the imposed fishing moratoria and consequent lack of data regarding legal/reported catch. Unfortunately, habitat restoration activities, which are the most important and urgent conservation objective in the LDR, have not yet been applied in practice. In total, 42 published sources and personal communications were used in this study, as well as those from the authors' own observations.

It was difficult to assess the actual sturgeon catch in the Lower Danube due to the presence of illegal and unreported fishery, which can "represent" as much as half the total catch (and up to 90% of sturgeon catch) in the region, as claimed by Bacalbasa-Dobrovici and Patriche (1999 cit. in Reinartz, 2002). Current sturgeon catch is even more difficult to assess, due to imposed fishing moratoria in the LDR countries.

Results and discussion

Convention on International Trade in Endangered Species of Wild Flora and Fauna had an important role in cooperation initiation, with the goal to collect data on catch and trade of sturgeon species and their products and to stimulate establishment of conservation measures and cooperation among LDR countries. Countries in the LDR have submitted annual reports on sturgeon catch, national administrative management and conservation frameworks, scientific activities, supportive stocking and trade with sturgeon species and their by-products. As of 2006 sturgeon data has been more difficult to collect because of fishery moratoria. In 2009, no information on trade in sturgeons was received by the CITES Secretariat from the Range States, which have the highest volumes of trade; reports were submitted only by Hungary, the Republic of Moldova, and Serbia.

The following chapters present the status of sturgeon species as well as the past and ongoing management activities in each LDR country, and discuss the progress made since the adoption of the DSAP.

Serbia

Beluga, Russian and stellate sturgeon presence in Serbia is limited to only 17.8 km of the Danube River, downstream from the Iron Gate Dam II. With the exception of sterlet, which is still the object of small-scale fishery in Serbia, catch of other sturgeon species is prohibited. The Serbian sterlet population is still considered to be under significant pressure from commercial fishery, however due to illegal fishing practices, the catch also comprises subadults. In May 2006, there were reported occurrences of the North American paddlefish (*Polyodon spathula* Walbaum, 1792) in the Serbian part of the Danube River, which were probably escapees from Romanian aquaculture facilities (Hegediš et al., 2006) at times of flooding.

Even prior to the 2006 moratorium the Russian sturgeon, Atlantic sturgeon and stellate sturgeon were all fully protected by the Decree on Natural Rarities Protection, which established the prohibition of any activity endangering wild species and their habitats. In Serbia sturgeons are protected and regulated by the Law on Fishery, the Law on Environmental Protection, as well as other decrees, decisions and orders. Stipulations in these decrees have been amended recently with regard to particular sturgeon species. The decree on control of utilization and trade of wild flora and fauna has been also updated, which establishes closed seasons and minimal landing sizes for particular fish species; capture of beluga, ship sturgeon, Russian sturgeon, stellate sturgeon and European sturgeon is completely forbidden. Minimal landing size for sterlet is 40 cm standard length, with a closed season lasting from March 1 to May 31.

In accordance with the sturgeon fishery moratorium in Serbia, there was no reported beluga fishery since 2006. Preceding the moratoria, reported beluga catch was always below the allowed annual amounts established by CITES (Table 1). The meat was mostly for private consumption by the fishermen, while caviar was used for the commercial trade. There is some evidence that there was illegal catch in Serbia in the last few years, but a reliable estimate is difficult (CITES, 2009).

There were no recent supportive stocking activities regarding sturgeons in Serbia. There is currently only one aquaculture facility, situated in Kusjak ('Feniks') near the Iron Gate II dam, where beluga and Russian sturgeon are being reared (Fig. 1). This facility has beluga juveniles imported from Bulgaria and Romania. At present, there are 400 beluga specimens and approximately 600 Russian sturgeon in this fish farm. In 2009, average size of beluga in this facility was around 150 cm length and 10–15 kg, and the Russian sturgeons were approximately 80 cm long, and weighing approximately 4–8 kg. Thus far, there was no export of fish produced in this facility.

While research efforts focusing on Danube sturgeon populations in Serbia are still insufficient, there has been certain progress during the last few years. Research activities have been mostly oriented to the issues of sturgeon genetics, toxicology, and population structure and viability. In a project funded by the Ministry of Environment and Spatial Planning of the Republic Serbia, national standardization of methods for genetic research has taken place (Lenhardt et al., 2008a; Cvijanović et al., 2009). Genetic research of sturgeons is still largely underdeveloped in Serbia. One ongoing study of sterlet populations aims to assess their genetic population structure, extent of genetic diversity loss, as well as at the effect of dam construction on population fragmentation. Morphological assessment by Ognjanović et al. (2008) of sterlet populations in the middle course of the Danube River supported the theory of the existence of two sterlet morphs.

Within the project 'Sustainable use of sterlet and development of sterlet aquaculture in Serbia and Hungary', conducted in 2007 and 2008 by the Institute for Multidisciplinary Research, Belgrade, in cooperation with the Research Institute for Fisheries, Aquaculture and Irrigation in Szarvas, Hungary, the status of the sterlet population, age structure, and heavy metal accumulation in different tissues as well as their histopathology were performed along with the investigation of new possibilities in wild stock management and aquacul-

Table 1
Annual beluga catch quota in the Serbian part of the Danube River and realized amounts of the catch and caviar trade

Year	Prescribed catch quota (kg)	Realized catch (kg)	Prescribed caviar quota (kg)	Realized caviar trade (kg)
2003	8500	894	700	88.52
2004	8500	1683	700	176.61
2005	3500	1834.83	595	95.73

Fig. 1. Locations of sturgeon aquaculture facilities and supportive stocking activities in the Lower Danube Region

ture. Project results have shown that the Danube sterlet population is exposed to heavy metals both directly from water and sediment and indirectly through the food chain, and a significant presence of sublethal histopathological changes most pronounced in the liver and skin (Lenhardt et al., 2008b; Poleksić et al., 2010) was also detected.

Statistical tests applied to sighting records of European and ship sturgeon confirmed that European sturgeon can be considered extinct in the Danube River, while ship sturgeon could still be present, but with possibly imminent extinction (Jarić et al., 2009). According to the study by Lenhardt et al. (2006), estimated extinction of Russian sturgeon is predicted at around mid-century, and beluga at mid-millennium. In a study by Jarić et al. (2010), a population viability analysis of the six Danube sturgeon species was developed in order to assess their population status, future risk of extinction and to determine the most suitable conservation and management measures. The study revealed a large sensitivity of Danube sturgeon populations to changes in natural mortality, fecundity, age at maturity and spawning frequency, and confirmed that sturgeons are highly susceptible to even moderate levels of commercial fishery, with their recovery being a multi-decadal affair. Stocking with juveniles was shown to produce a lag in population recovery, which was proportional to the time stocked individuals needed to reach maturity (Jarić et al., 2010).

A national action plan for the management of sturgeons in Serbia was developed in 2005 (Lenhardt et al., 2005). However, while habitat restoration was emphasized in the document as one of the key objectives in accordance with DSAP, it appears that only a negotiation level has thus far been attained.

Republic of Moldova

The only available data on sturgeons in Moldova are related to beluga, which are rarely found in the Dniester River. The specimens were registered during spring and summer months, with weights up to 100 kg (CITES, 2009). Beluga is a protected species and included in the Red Book of the Republic of Moldova as endangered (EN), as well as in the list of protected species within the law on the animal kingdom. It is also protected by the laws on natural areas, fishing and fisheries resources of the state, as well as by the code on administrative contraventions (CITES, 2009). A fishing moratorium has thus far only been imposed for beluga. Illegal catches have not been registered by authorized ecological inspections (CITES, 2009) in the past few years.

There is a fully established production complex in Moldova, Aquatir Ltd. in Tiraspol, for growing sturgeons in a recirculation system (Fig. 1). The complex has the capacity to produce 5 tonnes (t) of caviar per year, 80–100 t of marketed fish, and approximately 500 000 fry. This facility employs novel methods and technologies, with good standards of aquaculture production. The facility acquired 800 beluga from Russia in 2006, 1262 in 2007, and 1500 specimens in 2008. The plan is to achieve 13 800 kg of beluga meat by 2012, with an initial caviar production of about 480 kg planned for 2014 (CITES, 2009).

Romania

From 1990 to 2000, sturgeon fishery in Romania was almost completely lacking in government control. In the past few years the situation has improved significantly, with much effort being made on the national level; together with the adaptive management under CITES regulation, a regional strategy has been established. Development of the database with records of all sturgeons legally captured in Romania has resulted in the largest number of individual data on sturgeons acquired so far: 717 specimens recorded in 2003, 863 in 2004, and 535 in 2005 (Suciu, 2008b). A strong indicator of the detrimental effects of fishing was the lack of adult sturgeons migrating in the river to spawn. As a result, commercial sturgeon fishing was banned for a 10-year period. In the Romanian government order issued regarding sturgeon preservation, trade in wild sturgeons captured on Romanian territory is forbidden. Any sturgeons captured accidentally must be released in their natural environment, regardless of their condition (Smederevac, 2007).

A system monitoring the abundance of young-of-the-year (YOY) sturgeons in the Danube River was established by 2007 (Paraschiv et al., 2006). Juveniles were raised and tagged; seven tagged stellate sturgeons stocked in December 2006 were recaptured in the Danube (Suciu et al., 2007) in June and July 2007. The six Romanian aquaculture facilities are in Tămădău Mare, Tulcea, Olt County, Galati, Constanta, and Periprava (Northern Dobrogea). They mostly deal with the production of stellate sturgeon, Russian sturgeon, beluga and sterlet (Fig. 1).

As of 2007, capture of adult sturgeons is allowed only with special permits for artificial reproduction, and all specimens must be tagged and consequently released (Suciu et al., 2007). In May 2007, the first sperm bank was established. To conserve their genetic diversity, hatcheries participating in the programme must use at least 14 stellate sturgeons, nine Russian sturgeons and seven beluga specimens, the minimum effective number of breeding individuals for artificial propagation (Suciu, 2008a). According to the data available on the website of the Danube Delta National Institute (DDNI, 2009), 172 fish were captured as a broodfish in 2007 and an additional 188 in 2008, with males being more numerous in catch in both years. A stocking programme has been implemented since 2006 (Suciu, 2008b).

Recent research activities regarding sturgeons began at the end of May 2009, when satellite transmitters were placed in the first sturgeon in the Danube River (Fougner, 2009). This is a cooperative project between researchers from the Norwegian

Institute for Water Research (NIVA) and the Norwegian University of Science and Technology (NTNU), together with Danube Delta Institute as a local partner. The aim of the project is to investigate sturgeon biology and to help socio-economic development in the Romania and Bulgaria by innovation and transfer of technology. At present, five sturgeon specimens have been successfully tagged with satellite transmitters. Tagged sturgeons will be tracked over the next 2 years on their migration routes in the Danube River and the Black Sea.

While habitat restoration is included as an objective in the Romanian national sturgeon management plan (2006), there were no habitat restoration activities conducted thus far in Romania (Suciu R., 2010 personal communication).

Bulgaria

During the last decade, published data regarding sturgeons in Bulgaria has been reviewed by Vassilev (2003) regarding spawning sites, and by Vassilev and Pehlivanov (2003) regarding structural changes in sturgeon catch. In recent years, after the sturgeon fishing moratorium proclamation, only Hubenova et al. (2009) have made an assessment on the status of sturgeon stocks in Bulgaria.

Commercial sturgeon fishing was a traditional activity in Bulgaria. Most of the catch used to come from the Danube River, with only 10% from the Black Sea (Hubenova et al., 2009). Populations of Russian sturgeon, stellate sturgeon, beluga and sterlet are now critically depleted in Bulgarian waters. An analysis of 80 years of sturgeon fishery in Bulgaria shows that the annual catch has decreased from 51 t at the beginning of the 20th century to 43.3 t by 1970, decreasing further from 26 t during 1995–2001 to 15.7 t in 2002–2005. The ratio of different species in the catch has also changed: whereas in the 1940s Russian and stellate sturgeons were dominant species, sterlet became dominant in the 1960s and 1970s and beluga during the period 1995–2005. Changes in the catch structure were the first signal of the disturbance in sturgeon stocks. According to Hubenova et al. (2009), all sturgeon populations in Bulgaria have decreased drastically, with the ship sturgeon and European sturgeon apparently extinct.

In 2003, the Ministry of the Environment and Waters introduced a regulation concerning caviar export. Every caviar-exporting company had to compensate the catch with adequate re-stocking activities. Supportive stocking activities have been regularly conducted since 1998. In the period 1998–2005, more than 711 000 sturgeons were released into the Danube River. Of the total fish stocked, 94.5% were Russian sturgeon, while beluga comprised 5% and sterlet 0.3%. For 1 kg of caviar exported, the minimum prescribed number of fish for stocking was 30 and the maximum 120. The only choice was whether to stock with beluga and ⁄ or Russian sturgeon. Between 2006 and 2008, CITES export quotas for Bulgaria were not issued, and exporters were no longer obliged to conduct stocking activities in the Danube River. Consequently, only 2000 Russian sturgeons were released, with weights of around 5 g each.

According to the National Program for the Support of the Stable Growth of Fish Resources established in 2008, the Danube River was supposed to be stocked in 2009 with 30 000 Russian sturgeon and 20 000 Beluga specimens of Danube origin (Hubenova et al., 2009). A requirement is that stocking has to be performed using younger fish of proven Danube origin, which had not always been taken into consideration in supportive stocking. In recent years, supportive stocking has been performed using both native and hybrid species. There is also a need for supportive stocking programmes that would focus on the two extinct or probably extinct species, the ship and the European sturgeons.

There are five officially registered fish farms in Bulgaria: one in Plovdiv, the 'Beluga' enterprise in Vidin, 'Esetra Commerce Ltd.' in Kardjali, 'Aquamash Ltd.' cage farming facility in Kardzali and the 'Perpen Chobanov' enterprise in village Boljartsi (Fig. 1). The amount of market size sturgeons produced in aquaculture in Bulgaria was estimated to be nearly 900 t for the period from 2002 to 2007. Bulgarian producers were importing fertilized eggs from Russia, but now the stocking material originates from sexually mature brood-stock specimens (Hubenova et al., 2009). Russian sturgeon is the main object of aquaculture, while the beluga, stellate sturgeon and sterlet have been reared in smaller quantities. The total biomass of fish from all sturgeon farms in Bulgaria has been about 80 t. The total amount of caviar produced from aquaculture in Bulgaria is 2–2.5 t. As of 2003, the paddlefish (*Polyodon spathula* Walbaum, 1792) also began to be introduced in Bulgarian aquaculture.

Regarding the legislation framework in Bulgaria, there have been two new orders issued since 2006 that are related to the management of sturgeon stocks. Orders by the Minister of Agriculture and Forestry and by the Minister of Environmental Protection and Water prohibit sturgeon catch in the Bulgarian Black Sea territory, while the Order by the Minister of Agriculture and Food imposes annual moratoria on sturgeon catch in the Bulgarian section of the Danube River. As stated by Hubenova et al. (2009), the means used by Bulgarian authorities have not led to the desired outcome, the main reason being the delay in the implementation of the measures. For example, the Fishing Licensing System for the collection of data for the Danube River and Black Sea fisheries was initially established in 1995. The Action Plan for sturgeons in the Bulgarian part of the Danube River and the Black Sea was developed in 2004 (Raikova et al., 2004). Although habitat restoration is one of the main objectives of the Action Plan, no sturgeon habitat restoration activities were thus far conducted in Bulgaria (Vassilev M., 2010, personal communication).

Ukraine

Most fishery in the Ukraine is in the Black Sea; the side effect of this marine sturgeon fishery is that sturgeon subadults are commonly present in the catch (Vassilev, 2006). Unfortunately, no data is available for recent years. According to Vassilev (2006), the catch in the Ukraine at the end of 20th century was around 152 t and the three migratory species, beluga, Russian sturgeon and stellate sturgeon, were approximately equally present in the catch, with a slightly larger share of beluga. The amount of acquired caviar was around 12 t. The Ukraine is also not a signatory of the Regional Strategy for the Conservation and Sustainable Management of Sturgeon Populations of the N-W Black Sea and Lower Danube River in accordance with CITES. A sturgeon fishery moratorium is still not in practice.

Prodanov et al. (1997) have made an assessment of the Black Sea sturgeon stocks for the period from 1966 to 1992. The Dnieper River represents the major Russian sturgeon spawning grounds, while the stellate sturgeon and beluga mostly spawn in the Danube. After construction of the dam and canal system in the Dnieper River the spawning grounds became inaccessible, thus the Danube remains the only large river where this fish species continues to spawn. Prodanov et al. (1997) also made a forecast of the future state of sturgeon stocks in the Black Sea. According to their predictions, sturgeon species biomass will increase at the beginning of the 21st century as a result of additional reproduction at the Dnieper fishfarm. However, a number of prerequisite conditions must be met if these optimistic forecasts are to be realized: poaching must be significantly reduced in all Black Sea countries, both natural and artificial reproduction must be improved, and the problem of increased mortality of benthic organisms, which are important segment of their diet (e.g. molluscs, worms and crustaceans), has to be resolved (Prodanov et al., 1997).

Habitat restoration

Since spawning migration represents a key segment of sturgeon species life cycle, the availability and access of river and marine habitats is the major condition for the conservation and restoration of sturgeon biodiversity in the Danube River Basin (DSAP, 2006). With the aim of safeguarding and restoring sturgeon species in the European rivers, the Bern Convention adopted the DSAP in 2007. It contains the prerequisites for the development of the national plans in the member countries, as an implementation of international commitments on a national scale (Gessner et al., 2009). The DSAP presents objectives for securing Danube sturgeon populations, as well as measures for establishing sustainable management and restoration of natural habitats and migratory routes. From 12 prescribed objectives, four of them are related to habitat protection, management and restoration, including the reopening of migration routes.

Man-made river modifications have imposed habitat loss or degradation and disruption of spawning migration routes for sturgeon species. Building of canals, bank constructions, the disconnection of rivers from their floodplains, sand and gravel exploitation, and navigation all add to the general loss of sturgeon habitats (Bloesch, 2006). Construction of the Iron Gate dams, as well as canals, river banks, agriculture and aquaculture polders have led to changes in the Danube River hydrology, loss of spawning sites and resulted in the isolation of fragmented subpopulations, with inbreeding as a common negative factor. Effects of these anthropogenic activities also resulted in the loss or changes of invertebrate fauna used as a food for sturgeons, and the formation of silt instead of gravel and sand riverbeds, which are necessary for the natural spawning and development of sturgeon embryos (DSAP, 2006).

The sandy river bottom dominating the lower part of the Danube River is unsuitable for spawning because of the sturgeon preference of rocky substrate with crevices (Kynard et al., 2002), however the presence of captured juveniles in that area indicates that they represent important sturgeon nursery habitats. Rocky areas rarely occur downstream, and the major rocky areas do not occur until rkm 258 or further upstream. According to Vassilev (2003), the main beluga spawning sites were at depths of 9–22 m, on a gravel and coarse sandy substrate, with a strong, but 'soft' stream, situated between rkm 863 and 755. Sturgeons prefer a moderate water velocity for spawning (Kynard et al., 2002). In the Romanian part of the Danube River, according to Kynard et al. (2002), one of the preferred spawning locations is at rkm 258, however these stocks presumably spawned upstream; some stocks may have spawned (and may continue to spawn) downstream, as well as in the tributaries.

Fragmentation of the Danube River through dam construction represents the main problem in this area as dams obstruct migration routes whereby sturgeon cannot reach their upstream spawning habitats. Reopening of fish migration routes through construction of fish passes represents a key issue (Pini Prato et al., 2009) that should be realized as soon as possible. Unfortunately such activities require significant funding and political will, as well as international understanding and cooperation. EU funds that could be used for habitat restoration measures do exist (Torkler, 2009), but they are not large enough to support all necessary activities. In developing countries, such as those in the LDR, energy production plays a dominant role in comparison to conservation-related issues. Power plant companies play significant roles in state policy and have an influence on the government. Iron Gate dams are one of the major hydropower producers in the region, thus compromises and understanding both play an important role in this process.

Considering the objectives of the DSAP, we can conclude that some LDR countries (Serbia, Romania and Bulgaria) have fulfilled the requirement to develop and adopt national action and management plans. These plans contain nearly all measures prescribed by the DSAP; the only objective not included in the national action plans was water quality and quantity, which must comply with the required conditions for healthy sturgeon populations throughout their life cycles (Objective 11, DSAP). Nevertheless, while such objectives were not defined by the national action plans, some efforts have been made (Lenhardt et al., 2008a). According to DSAP under the Bern Convention as well as the national action plans of the member states and regional countries, priority must be given to activities that would make the dams passable for sturgeons in the Lower Danube.

There are many good examples of the successful restoration of salmonid species; sturgeons, however, are unfortunately more vulnerable and complex. In the United States, there are positive examples of Atlantic sturgeon (*Acipenser oxyrhinchus oxyrhinchus*) restoration and management programmes. As presented by St. Pierre (2009), all fisheries were terminated in 2005; the ban is supposed to last until two generations of sturgeons have had an opportunity to spawn at least once, which will require 30–40 years of moratorium. These programmes also include fish passages at dams and the supportive stocking of waters with prespawned adults and ⁄ or hatchery-reared larvae above the dams. According to Ludwig (2009), many restoration projects were not successful because less-adapted fish had been released into local environments. There are still gaps in knowledge regarding successful breeding and rearing, as well as in successful management strategies of exploited populations (Williot et al., 2002; Bloesch, 2006).

The WWF is working together with the International Commission for the Protection of the Danube (ICPDR) and the governments of Serbia and Romania to examine options for making dams passable to sturgeon and other species (Hulea, 2010). However, development of infrastructure projects for the EU Trans-European Transport Networks is in the planning, which will threaten many of the Danube's last free-flowing sections and ecologically valuable areas. The first project for Romania is to increase navigation between Călăraşi and Brăila, which will cut the most important migration route for Danube sturgeons and destroy highly valuable nature areas. The Ukrainian government has begun construction of the navigation canal for large vessels through the Danube Delta. Despite protests and international conventions for nature conservation, the first phase of the project has already been implemented. Unfortunately, no environmental impact assessment of these projects has been conducted, which can compromise sustainable economic and environmental development throughout the Danube basin (Hulea, 2010).

According to Vassilev (2006), the basic problem on restoration and conservation of the sturgeons is connected with the obvious contradiction between their endangered status and their great economic value. Realization of the restoration projects on the national level require strong lobbying and regional coordination efforts. If the conservation and restoration activities in the Lower Danube countries are compared with the successful examples from other countries, it can be concluded that the sturgeon fishery moratoria and aquaculture development represent steps in a positive direction. However, unsolved problems remain, such as the presence of illegal sturgeon fishery and the lack of regional cooperation and development of multilateral supportive stocking programmes. Construction of fish passes and the development of habitat restoration projects remain the two key issues that have yet to be confronted in the Lower Danube region.

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Conflict of interests

The authors have declared no potential conflict of interests.

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