HELCOM Action Plan for the

Protection and Recovery of the Baltic Sturgeon

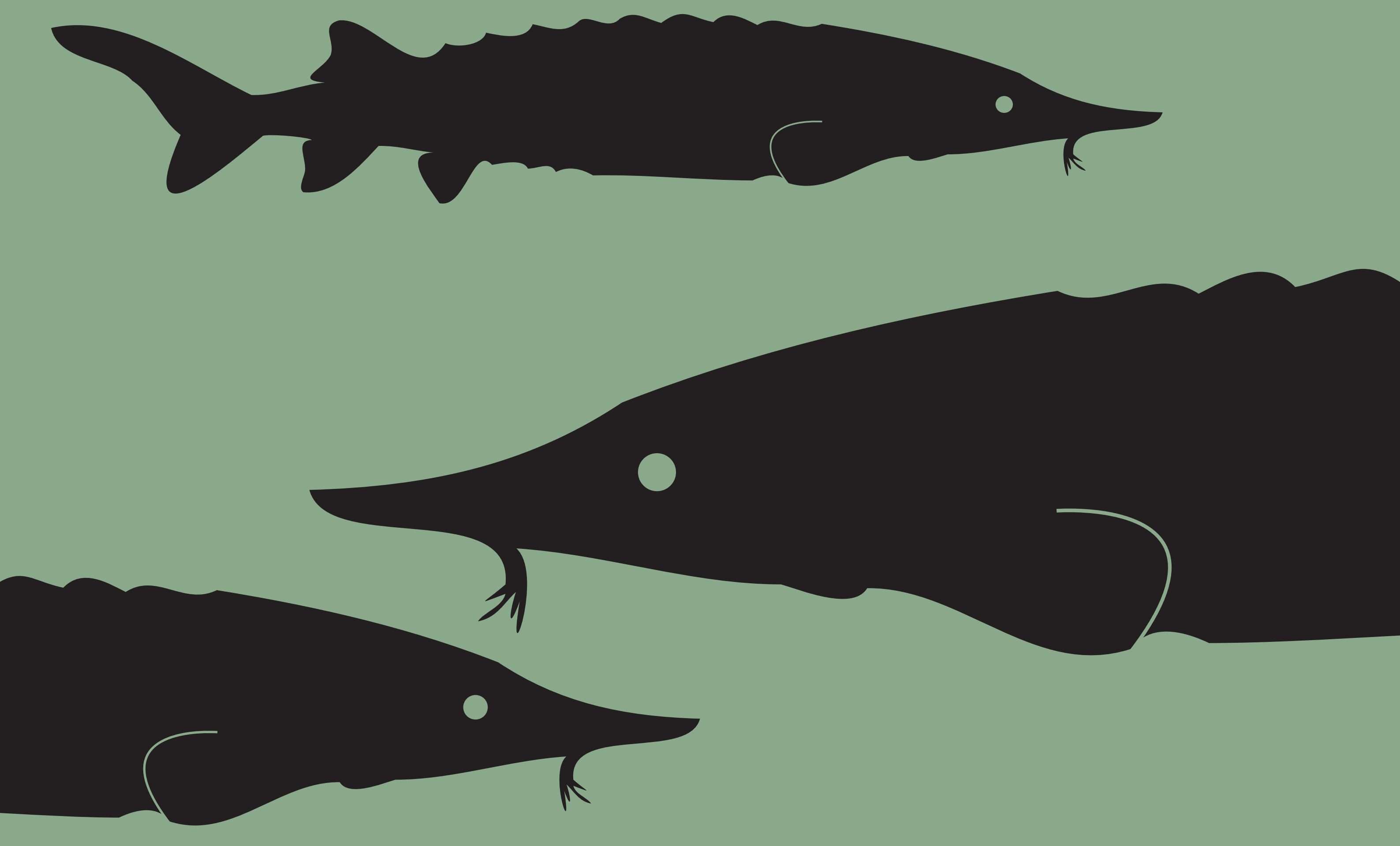
(Acipenser oxyrinchus)

for the period of 2019–2029

Baltic Marine Environment
Protection Commission

Biodiversity

BSEP n°168



This Action Plan was drafted and compiled by the members of the HELCOM Project Group on Baltic sturgeon restoration (now HELCOM Expert Group on Sturgeon Remediation – EG STUR) in response to a request by HELCOM Habitat (now HELCOM State & Conservation) in 2014 to provide a harmonized outline for the restoration works to bring back the locally extinct Baltic sturgeon (*A. oxyrinchus*). The Action Plan was adopted by the 40th Meeting of the Helsinki Commission (HELCOM 40-2019).

Published by:
Helsinki Commission – HELCOM
Katajanokanlaituri 6 B
00160 Helsinki, Finland

www.helcom.fi

This document is part of the flagship publication series of HELCOM, the Baltic Sea Environment Proceedings (BSEP) that have been running since the entry into force of the first Helsinki Convention in 1980. This document has been approved for publication by the members of the Helsinki Commission. Information and views expressed in this publication are the authors' own and might vary from those of the Helsinki Commission or its members.

For bibliographic purposes this document should be cited as:
"HELCOM/Gessner *et al.* (2019). HELCOM Action Plan for the protection and recovery of Baltic sturgeon *Acipenser oxyrinchus oxyrinchus* in the Baltic Sea area. Baltic Sea Environment Proceedings n°168"

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ISSN 0357-2994

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The PG for the restoration of the Baltic Sea sturgeon was temporarily supported by Marco Millardi (PhD) from the HELCOM Secretariat.

Executive summary

The Baltic sturgeon was an integral part of the Baltic fauna until the middle of the 20th century. The species is an anadromous, migratory fish spending most of its life in marine waters while returning to its native river for reproduction. Populations of the species have dramatically decreased during the last centuries. Subsequently, the species became extinct in the Baltic range states during the second half of the 20th century. Besides anthropogenic changes to rivers such as channelization (associated to habitat loss and reduced river productivity and diversity), the construction of hydrodams (which block the upstream migration to spawning sites and in cases where upstream migration is possible impact the downstream migration of adults and juveniles), and pollution (with major impacts mostly on the early life phases), overfishing has been identified to be the key impact that caused the dramatic decline of the population in the Baltic Sea area.

Today, there are five primary key areas that have the potential to adversely affect survival, reproductive efficiency and return of the species (ranked in order of importance):

— Mortality caused by accidental catch (by-catch) and illegal fishing (poaching). Minimizing these losses is critical to the survival of the very limited number of individuals in the rivers and coastal waters that result from the ongoing recovery actions; hindering successful repopulation of the species in the river catchments;

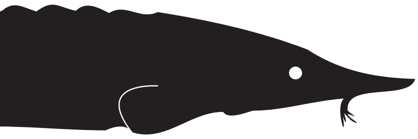
— Drastic changes of hydrologic and hydrodynamic regimes in rivers and estuaries (i.e. sand and gravel extraction, dyking and channelization, hydrodams, with associated impacts upon sediment transport) are greatly affecting spawning and nursery habitats and can block migration to spawning sites;

— Anthropogenic environmental pollution, e.g. from contaminants, pesticide use, agricultural practices, eutrophication and increased thermal pollution, can drastically affect reproductive success;

— The introduction of allochthonous (sturgeon) species which have escaped from aquaculture or which are deliberately introduced represent potential dangers such as interspecific competition, disease transfer, and the risk of hybridization affecting efforts to reestablish a viable population of Baltic sturgeon, particularly if such introductions are not reduced to negligible levels.

— Additionally, climate change has the potential to impact future performance of the species by increasing water temperature, altering faunal composition, water discharge volume, and changing seasonal water flows.

Restoration attempts for the Baltic sturgeon have been carried out since 1996, temporarily supported by a respective HELCOM project. Today they focus on the species *Acipenser oxyrinchus* which populated the Baltic Sea and its tributaries for more than 1500 years (Ludwig *et al.* 2002). Previously it was commonly believed that the sturgeon inhabiting the Baltic Sea would belong to the same species known as European sturgeon (*A. sturio*). Genetic investigations have shown the close similarity of the historic Baltic sturgeon populations with the northernmost populations of *A. oxyrinchus* in North America, which have led to their utilization as donor populations. The recovery measures which are under way in the southern Baltic Sea states will require decades before self-sustaining populations can be expected to become effective. HELCOM and the Baltic Sea states have committed themselves e.g. in the Baltic Sea Action Plan (BSAP) to support the re-introduction of Baltic sturgeon to its potential spawning rivers and in key areas of its former natural range. If successful, these measures would also make an important contribution to protecting and maintaining biodiversity.



However, despite the ongoing re-introduction measures (such as the establishment of *ex situ* stocks and the subsequent releases of juvenile sturgeons) the situation with no remaining functional population in the Baltic Sea area is still dramatic. This Action Plan aims to prevent the Baltic sturgeon (*A. oxyrinchus*) from full extinction, and in the mid-term, to re-establish viable populations of the Baltic sturgeon in its historic range. It further suggests effective protection measures and can therefore guide HELCOM and the Baltic Sea States to meet their commitments arising from the BSAP and other international agreements or provisions (e.g. PAN-EUROPEAN ACTION PLAN FOR STURGEONS 2018).

The implementation of the Action Plan is a long-term task which necessitates long-term funding. Close cooperation among all involved States and stakeholders will be essential to bring the plan to life. For this purpose it is recommended to elaborate catchment-specific management plans.

A multi-task approach offers the best option to rescue and recover the species and re-establish several of its populations. It is suggested that: a) a consistent and massively supported *ex situ* conservation program is carried out, taking advantage of the specimens already secured, b) an *in situ* conservation program will be enforced in order to prevent further loss of the remaining specimens c) a strategic (long-term) monitoring program for population development and habitat use is launched to make adaptive management effective, d) the results be used to set up a program on habitat protection and rehabilitation in order to ensure that spawning and nursery sites meet the needs of the species and are accessible for the respective life cycle stages.

Therefore, concerted actions from the Baltic Sea States most preferably at HELCOM level are urgently required to improve the conditions under which the species can recover within two generation periods. Only a successful implementation of this Action Plan will revive the Baltic sturgeon in most of the historic sturgeon rivers and the Baltic Sea from near extinction to a self-sustaining population level. As such it supports and gives guidance to HELCOM Contracting States to fulfill the aims of the BSAP, obligations under the Bern and Bonn Conventions, CBD targets, and for EU Member States, the Habitats Directive and the Water Framework Directive.

Contents

1. Introduction

The ecosystem of the Baltic Sea region is affected by strong anthropogenic impacts at all levels. The development over the past 400 years has massively changed the terrestrial ecosystems, the rivers as well as the marine and coastal ecosystems in the catchment area. In order to mitigate these impacts and to allow a transition to a sustainable use of natural resources, massive efforts have to be undertaken. An enclosed sea like the Baltic Sea is surrounded by many countries which causes numerous problems with regard to the management of human activities. HELCOM has been instrumental in setting common targets for national developments in this field. Also, the political changes that led to an expansion of the EU have considerably supported the harmonization process in the past. With the adoption of the HELCOM Baltic Sturgeon Action Plan, the countries surrounding the Baltic Sea have adopted another ambitious step towards more sustainability.

Sturgeons have been a significant element of the fish fauna of many HELCOM member states. They have been reproducing in all of the larger river systems of the southern Baltic and populated the whole Baltic Sea. Their economic value and their vulnerability to overfishing and habitat alterations made them one of the first species to be impacted by the economic development in the region. By 1900 most of the previously abundant population was diminished and by 1970 the species was considered functionally extinct.

Figure 1: *Acipenser oxyrinchus* from the Saint John River © G. v. Rykevoorstell

Since 1996 HELCOM and its Contracting Parties are jointly working for the target to reestablish the Baltic sturgeon in its historic range. Since 2002 new scientific results have largely promoted the process and have sped up the *ex situ* measures considered essential for the long-term establishment of self-sustaining populations in the wild. Since 2005 experimental releases of *A. oxyrinchus* have been taking place in an attempt to develop the methodology for large scale reintroduction measures (Gessner *et al.* 2010). Starting with Germany and Poland, the activities after 2010 have been joint by the Baltic States and the Russian Federation (Gushchin *et al.* 2007, 2013; Kolman *et al.* 2012, 2016; Purvina and Medne, 2018). Today, the previous range countries in the southern Baltic are collaborating towards the reestablishment of the species through the development of release strategies and habitat improvements as well as through measures to increase compliance in the fishery to prevent bycatch mortality. These attempts are to be harmonized in this Action Plan as a joint outline of the up to date knowledge as an expression of a joint perspective on the future measures to be taken to render the activities to a success.

The development of a Baltic Sea Sturgeon Action Plan has been one part of the HELCOM project "HELCOM Sturgeon Remediation" approved by the 39th Meeting of the HELCOM Heads of Delegation (HOD 39/2012), held in Helsinki, Finland, on 3 to 4 December 2012. This decision was a consequent follow up of the Baltic Sea Action Plan which states that Contracting Parties should "By 2015, have the re-introduction program for Baltic sturgeon in place, and as a long term goal, after their successful re-introduction has been attained to have best natural reproduction, and populations within safe genetic limits in each potential river."

Based upon the international Action Plan for the Protection and restoration of its sister species *Acipenser sturio*, under the Bern Convention (Rosenthal *et al.* 2008), the Action Plan for the Baltic sturgeon contains the background, the approach and detailed suggestions on measures to be taken to address sturgeon restoration as well as criteria for its evaluation (indicators, milestones etc.). It also comprises information and documentations about the past distribution, the historic population structure, as well as the history of the decline of Baltic Sea sturgeon, based on an extensive literature review. Finally, it also reports the past and current conservation status in the HELCOM countries.

The recovery strategy outlined in this Action Plan is based upon suggested measures, monitoring plans and guidelines developed during the years of cooperation among HELCOM Contracting Parties involved in the Baltic Sea sturgeon project and additional multilateral cooperation.

The recovery actions for the restoration of Baltic Sea sturgeon are to be adapted to the national situation in each of the Contracting States, but will have to follow a common strategic approach. The need for transnational coordination between HELCOM countries in order to develop effective management is especially pressing for sturgeon recovery, both because sturgeons are wide ranging not being restricted to a single jurisdiction, but also since sturgeon rivers are long and large, often representing country borders (e.g. Oder and Narva rivers) or flowing through more than one country. It is thus necessary to coordinate breeding, reintroduction and monitoring efforts between countries focusing on river basins, rather than national borders. Moreover, once young sturgeons migrate to the sea, they effectively spread throughout the whole Baltic Sea, as proven by the recapture of marked individuals from pilot projects. These individuals were recaptured hundreds of kilometers from their release point. Thus, measures that address the potential threats to the conservation objectives need to be undertaken at a larger, regional or even supra regional scale in order to be effective. The Action Plan addresses this issue by coordinating the efforts of all countries interested in sturgeon restoration.

Detailed information concerning the current state of habitats, the measures planned or currently in place that could affect sturgeon and the potential for collaboration with fisheries and other stakeholders was collected on a national basis to ensure relevance and applicability.

The Action Plan provides also an example for the implementation of conservation actions in other geographical regions of Europe. Species such as Baltic sturgeon which are in unfavorable conservation status and prioritized under the Habitats Directive are a focus of multi annual work plan. The need for similar actions has also been highlighted within the framework of the Convention on Biological Diversity, the Bern Convention, the Pan-European Action Plan for Sturgeons 2018, the EU Biodiversity Strategy 2020 (COM(2011) 244, especially actions 3b, 7b, 14a, 14b and 18b), and the EU strategy for the Baltic Sea Region Priority Area Bio(as proven by the EUSBSR support for the Project Group). Descriptors of good environmental status 1 and 4, listed in Annex I of the EU Marine strategy framework directive (MSFD, 2008/56/EC) are also clearly linked to the aims of this Action Plan.

The implementation of the HELCOM Baltic Sea Sturgeon Action Plan (BSSAP) will provide the main outline for restoration actions to be followed. Essential measures comprise the broodstock maintenance, reproduction and selected rearing actions. Based upon the results of these measures, it is necessary to continue the monitoring of the ecological status of the habitats and the Baltic sturgeon population development.

1.1. Objectives

This Action Plan covers a period of 10 years. Its main purpose is to ensure that the recovery measures are based on common principles and state of knowledge, pursue the same targets and utilize harmonized methodology to allow the comparison of results. It also outlines challenges for future work as well as potential benefits that result from its successful implementation.

Sturgeon remediation is far from being a recovery measure for a single species. The complex life cycle, its long life span, late maturity and the utilization of diverse habitats in this diadromous species render it both an indicator and an umbrella species for the quality of habitats as well as the effectiveness of management for sustainability while also delaying the timeframe for the remediation measures to decades rather than years which imposes massive challenges to secure funding throughout the process. Taking the responsibility for such a long-lasting effort also clearly reflects the dimension in which HELCOM and its member states operate. As such this AP is more than a handbook for the recovery of a species, but rather a compendium of future actions to be taken in order to reverse the significant alterations and functionality losses in the ecosystems addressed along with measures to reestablish the respective populations. These actions are summarized under seven objectives which can be grouped into three main categories.

Category 1: *ex situ* protection
- **Objective 1:** Actively support the recovery of the target populations to initiate a positive population trend.

Category 2: *in situ* protection
- **Objective 2:** Protect the populations under recovery from accidental and directed removal of individuals
- **Objective 3:** Protect and restore the sturgeon habitats where available/necessary
- **Objective 4:** Secure or facilitate sturgeon migration in all target rivers

Category 3: Administrative prerequisites and outreach
- **Objective 5:** Increase public, administrative and political awareness on sturgeon conservation
- **Objective 6:** Set proper financial and legal prerequisites for sturgeon restoration
- **Objective 7:** Monitor and evaluate Action Plan implementation to allow adaptive management

2. Description of the species

The Baltic sturgeon represents a close zoo-geographical linkage between North America and the Baltic Sea. As confirmed in 2002 only (Ludwig *et al.* 2002), the Baltic sturgeon is a representative of the northernmost populations of the American Atlantic sturgeon (*A. oxyrinchus*) and not a subspecies of *A. sturio* as previously hypothesized (Artyukhin & Vecsei 1999). The systematic consequences of which are still not fully resolved. This change in species assignment is still evident in national and European (EU) legislations where *A. sturio* is listed as the only native and protected species. In the following chapter, the differences between the two species and their characteristics are described in order to facilitate the differentiation also between them and numerous introduced sturgeon species that have been stocked or resulted from accidental escapement from fish farms over the past 50 years.

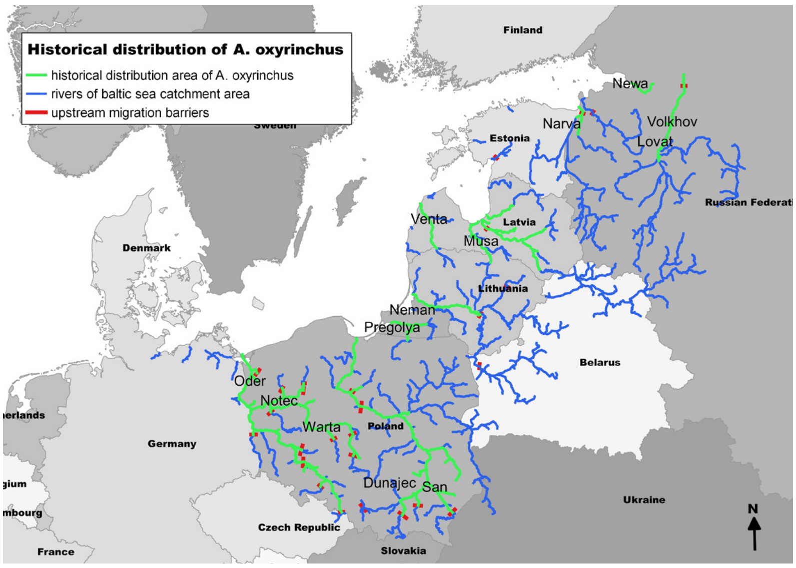


Figure 2: Baltic Sea area and historic reproduction rivers of *A. oxyrinchus*

In the following the majority of the information that is available for the species has been generated in North America. This information is applied also for the Baltic Sea area. In those cases where deviating information for the Baltic Sea exists it is specifically pointed out. As such "American Atlantic sturgeon" is used in those cases which refer to North America specifically; *A. oxyrinchus* in cases that make reference to the species regardless of its range; and "Baltic sturgeon" in cases which refer to the Baltic Sea area solely. For the purpose of the AP as well as for all further use in publications or information material we recommend using the term Baltic sturgeon whenever the species in the Baltic Sea area is addressed to avoid unnecessary confusion among readers.

2.1. Zoogeography

Acipenser oxyrinchus is described in two valid subspecies. The American Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus* occurs along the Atlantic coast of North America from Saint John, Florida to the Saint Lawrence River in Canada including the coastal waters of Newfoundland. The species is segregated into four distinct population segments (DPS) which vary in haplotype from south to North (Waldmann *et al.* 2002). The Northern Populations, inhabiting the Hudson and the rivers north up to the Saint Lawrence River including the Connecticut, the Kennebec, the Saint John, eventually the Miramichi and the Saint Lawrence rivers (Wirgin *et al.* 2000). Their haplotype is shared with the Baltic sturgeon indicating that population foundation has been based upon the northernmost population. The second subspecies is the Gulf sturgeon (*A. oxyrinchus desotoi*) that inhabits the tributaries to the Gulf of Mexico from Florida to Texas.

While the type specimen of Linnaeus remains unknown and the description being rather general, the first description of the Baltic sturgeon and its similarities to the American Atlantic sturgeon dates back to Thikhi (1929). The issue was reflected in various publications (Magnin 1963, Debus 1999, Gröger & Debus 2000, Arthyukin & Vecsei 2000) but did not result in any further actions. Only the genetic identification of museum specimen and excavation material by Ludwig *et al.* (2002) resulted in a public recognition of the presence of two species of sturgeons in the North and

Baltic Seas since the Middle Ages or even earlier (Popovic *et al.* 2014) and the resulting adaptation of the ongoing restoration plans. Most recently, the history of the American Atlantic sturgeon in Europe was expanded by a systematic analysis of the remains in excavation samples that date back to 1500 B.C. and which provide evidence that *A. oxyrinchus* was widespread also in the Eastern Atlantic and North Sea and tributaries at that time (Nikulina & Schmölcke 2017). Obviously, *A. oxyrinchus* was present in these waters since the end of the ice age and was replaced by the expansion of the European sturgeon from the Mediterranean and the Iberian Peninsula. In the Baltic, *A. oxyrinchus* remained the only sturgeon species that was extirpated in the late 19th and early 20th century.

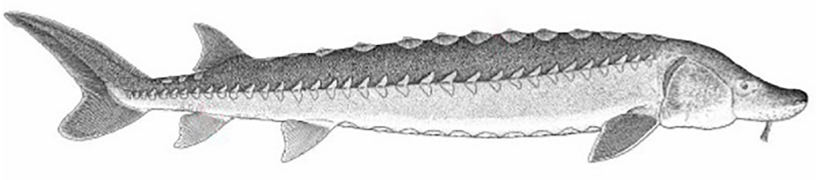


Figure 3: *A. oxyrinchus* total length 268 cm, last catch in the Baltic Sea, 1996, on Saareema Island, Estonia (Drawing © by Paul Vecsei)

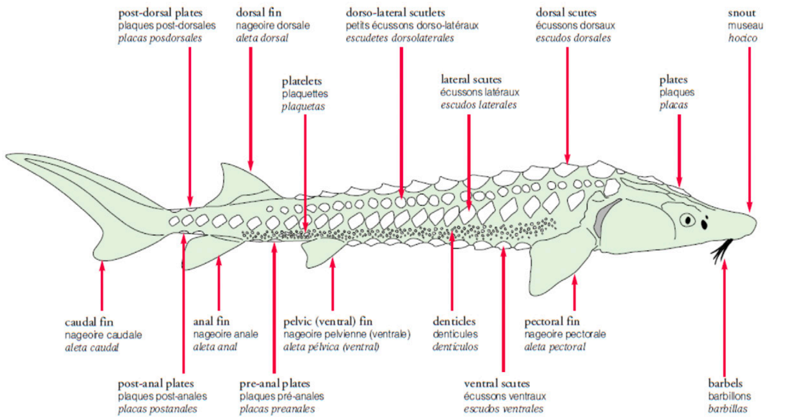


Figure 4: Sturgeon gross morphology and description of main characteristics used to discriminate the species of the family (© ECC 2001)

2.2. Morphology

Body with 5 rows of scutes; SD 7-16, SL 24-35, SV 6-14. Scutes are tubercular in surface structure, highest point of body not at first dorsal scute (which is not the largest) but midway along the dorsal scutes; skin covered with rhombic platelets between rows of scutes, post-dorsal and/or post-anal plates present, bony plates present on left and right side of anal-fin base, poD 3-9, poA 3-9, prA 2-6.

Snout long but becoming increasingly more blunt with age. Snout equipped with four rounded barbels midway between mouth and tip of snout. Snout conical with rounded edges and white rim and a dark pigmented notch on ventral side of snout tip. The mouth is small and oriented horizontally, and opens downward, lower lip is interrupted; BrSp 15-27. The spiracle is present.

The dorsal fin is short and steep, with 38-46 soft rays. The anal fin has 23-30 soft rays. The fins possess a white band along the margins.

2.3. Meristics

The snout is long and wide, becoming increasingly blunt with age. Its length ranges from 30-60% of the head length, and averaging 8-10% of the total length. The head length reaches 24-33% of the fork length. The barbels are located midway between the mouth and tip of the snout or in juveniles slightly closer to the mouth.

2.3.1 Peculiarities

The fulcrum of the caudal fin is longer than the base of the anal fin. The dorsal fin is short and steep. The bony scutes are of alveolar structure and the dentricles between rows of scutes are rhombic.

2.3.2 Coloration

The colour of the back is grey-brown to blue-black, the sides are lighter, and the belly is grey-white. The lateral scutes are lighter than the surrounding skin. The snout and the fins display white margins.

2.3.3 Differentiation from other species in the region

In their natural range in Europe only *A. sturio* is partially sympatric with *A. oxyrinchus*, overlapping in their marine range. Nevertheless, since the late 1980s a variety of exotic sturgeon species and their hybrids have been introduced to Europe mainly for aquaculture purposes, but also in an attempt to increase fisheries yield (Yegelsky & Stepanova 1972), or for recreational purposes (angling, aquarium trade). Since the early 1990 an increasing number of sturgeon species occurs in the inland as well as the coastal waters (Gessner *et al.* 1999, Arndt *et al.* 2000, 2002). Due to the fact that both endemic sturgeon species depend upon reestablishment measures, the interference of non-indigenous species is especially critical. In order to allow the removal of non-indigenous sturgeon species, secure characteristics that are applicable in the field, have to be used. As such it seems easiest to generate common features that distinguish both *A. oxyrinchus* and *A. sturio* from all the other species to ensure the easy recognition of the native species.

A combination of only few characteristics would be optimal to ensure an easy and applicable determination. As such the candidate features would comprise: As to be seen from Table 1, a set of markers for the general discrimination of the native species from the introduced ones is not available. For this reason it is suggested to utilize two alternative characteristics A) the presence/absence of bony plates along and around the anal fin, and B) the shape of the dorsal fin, being short and revealing a clear convex curvature, which in combination with the position of the barbels and the shape of the interdentricles (between the five rows of scutes) allow a simple and quick identification of the native species (Figure 5). In addition, if still indecisive, the bony scutes are lighter than body, not forming a lateral band, dentricles NOT star shaped but rhombic, barbels round and of even length, located at midpoint between tip of snout and upper lip.

Table 1: Overview of the main morphological features of different sturgeon species potentially occurring in the Baltic Sea catchments.

Species	DF	AF	DS	LS	VS	GR	poD	poA	prA
Acipenser baerii	30-56	17-33	10-20	32-62	7-16	20-49	0	0	1-3
Acipenser brevirostrum	30-42	19-22	7-13	21-35	6-11	22-29	1-3	1-2	2-3
Acipenser gueldenstaedtii	27-51	16-35	5-19	21-50	6-14	15-36	0-2	1-2	1-3
Acipenser mikadoi	36-40	25-29	8-10	26-36	6-8	18-20	1-2	1-2	2-3
Acipenser naccarii	36-48	24-31	9-21	29-46	8-13	30-35	3-9	1-9	1-3
Acipenser nudiventris	39-57	17-37	11-26	33-74	11-17	24-45	0	0	0-3
Acipenser oxyrinchus	38-46	23-30	7-16	24-35	6-14	15-27	3-9	3-9	2-6
Acipenser persicus	27-51	16-35	7-19	23-50	7-13	15-31	0-2	1-2	1-2
Acipenser ruthenus	32-49	16-34	11-18	56-71	10-20	11-27	0	0	1-4
Acipenser schrenckii	38-53	20-32	11-17	32-47	7-9	36-45	6-8	6-8	3-6
Acipenser stellatus	40-54	22-35	9-16	26-43	9-14	24-29	0	0	1-5
Acipenser sturio	30-50	22-33	9-16	24-40	8-15	15-29	3-9	3-5	2-6
Acipenser transmontanus	42-52	25-31	11-14	36-48	9-12	34-36	0	0	6-9
Huso dauricus	43-57	26-35	10-16	32-46	7-13	16-23	1-3	1-3	2-6
Huso huso	48-81	22-41	9-17	28-60	7-14	17-36	0	0	0-3

Abbreviations
DF – dorsal fin rays, **AF** – anal fin rays, **DS** – dorsal scutes, **LS** – lateral scutes, **VS** – ventral scutes, **GR** – gill rakers, **poD** – plates between dorsal and caudal fins, **poA** – plates between anal and caudal fins, **prA** – plates between anus and anal fin, **AL** – average length (cm), **ML** – maximum length (cm)

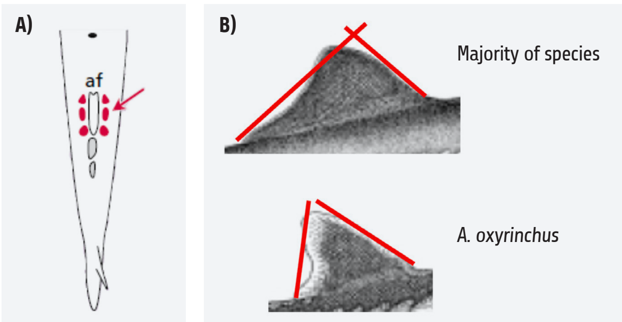


Figure 5: Key characteristics for the discrimination of *A. oxyrinchus* from introduced species: **A)** bony plates adjacent to anal fin base present, pre-anal plates >2, post-anal plates present, **B)** dorsal fin short and steep with expressed curvature (© ECC 2001)

2.4. Genetics

2.4.1 mt DNA

Detailed studies of the mitochondrial haplotypes were carried out for Atlantic and European sturgeons during last decade (Ong *et al.* 1996, Stabile *et al.* 1996, Waldman *et al.* 1996a, Waldman *et al.* 1996b, Wirgin *et al.* 2000, Ludwig *et al.* 2002, Ludwig *et al.* 2008, Panagiotopoulou *et al.* 2014, Popović *et al.* 2014). These studies were based on a highly variable part of the d-loop. More detailed investigations based on mitochondrial DNA control sequences including nearly all populations of Atlantic sturgeon along the American East Coast found no separation between populations inhabiting formerly glaciated versus non-glaciated North American Atlantic Coast rivers (Wirgin *et al.* 2000). Notably, haplotype diversity was greater for specimens from non-glaciated drainages. Northern rivers (north of the Hudson) were dominated by only two mitochondrial haplotypes (A and B). Three additional haplotypes occurred less frequently (A1, B1 and R) (Wirgin *et al.* 2000).

The low haplotype variability in northern populations contrasts with the high level of diversity in southern populations. Wirgin *et al.* (2000) discussed founder effects as a potential explanation for restricted haplotype diversity in the northernmost populations. Northern rivers were either colonized exclusively by haplotype A females, or the less common haplotypes were lost by genetic drift. This strong focus on one clade of haplotypes could reflect either a more recent colonization and/or a selective cold-adapted advantage to northern climatic conditions. Nevertheless, studies of Baltic sturgeon specimens produced a clear separation relative to North Sea specimens (Birstein *et al.* 1998), as well as evidence for the presence of an American Atlantic sturgeon population in the Baltic Sea since the early Middle Ages (Ludwig *et al.* 2002).

In the Baltic, only one mitochondrial haplotype (North American haplotype A) has been observed. Possibly, founder specimens had only haplotype A. Alternatively other haplotypes may have been lost by genetic drift depending on their rareness. A selective advantage linked to haplotype A may have supported the shift from European sturgeon to North American Atlantic sturgeon in the Baltic Sea, the easternmost (coldest) part of the former distribution area of European sturgeon.

Because of the results of the genetic research on the population structure of the North American Atlantic sturgeon and the comparison with the historic Baltic sturgeon populations (Ludwig *et al.* 2002, Ludwig *et al.* 2008, Popović *et al.* 2014) the broodstock development focuses on fish from northern rivers of the Atlantic Seaboard of North America. The collection of spawners and subadults from the St. Lawrence and St. John rivers utilizes fish from commercial fisheries. A third potentially suitable donor population is the one originating in the Kennebec River. However, a fisheries ban imposed in 1997 (St Pierre 1996) excludes the supply of wild-caught Atlantic sturgeon from the United States. Furthermore, according to recent data, the population size is too low to allow the safe utilization of Kennebec River fish for the remediation program.

2.4.2 Microsatellites

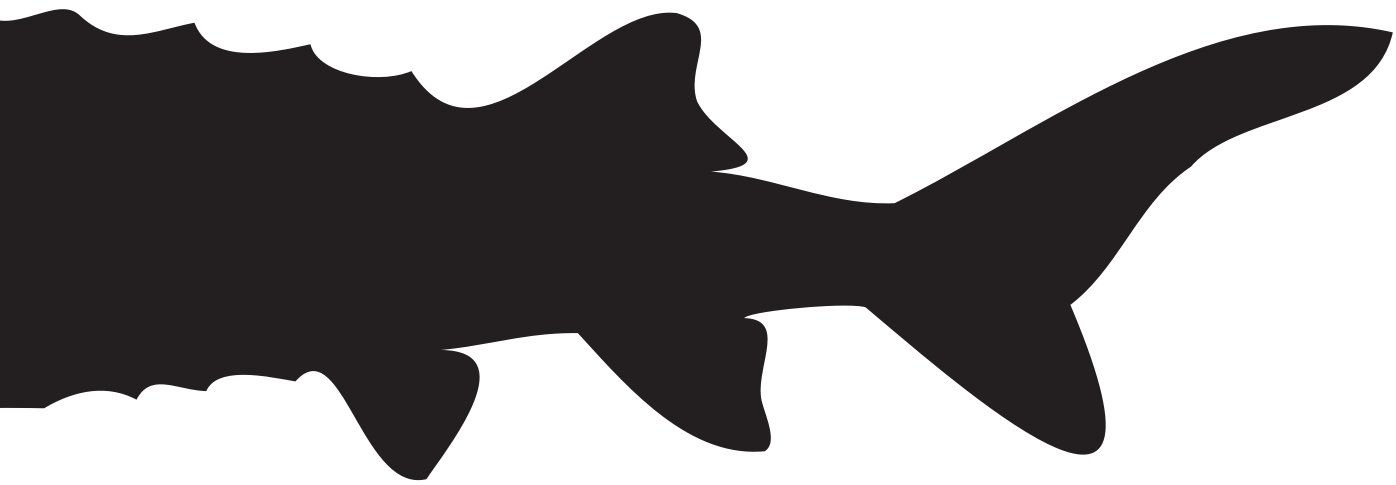
Intra- and interpopulation studies of nuclear markers are very rare for European sturgeon populations. So far, only the Gironde population has been screened, revealing a high level of homozygosity (Ludwig *et al.* 2004). Nevertheless, three consistent differences in the flanking sequences of the microsatellite locus Aox-23 (King *et al.* 2001) were found distinguishing Atlantic sturgeon from European sturgeon (see Table 2). All archived specimens of the Baltic sturgeon with mitochondrial haplotype A carried North American Atlantic sturgeon nuclear genotypes, whereas all other archived specimens had European sturgeon nuclear genotypes. Nuclear sequences revealed no evidence of interspecific hybridisation.

Table 2: Genetic differences between *A. sturio* and *A. oxyrinchus* (data reviewed in Ludwig *et al.* 2002). More than 10% sequence divergence was observed between *A. o. oxyrinchus* and *A. sturio* within partial mitochondrial DNA (d-loop) sequences; while three diagnostic nuclear substitutions were found in the flanking sequences of the microsatellite locus Aox-23.

	Sequence differences	
	Mitochondrial DNA	Nuclear DNA
	D-Loop	Aox-23
	11111122 2333444445777813446700 8256013457456377294805	 355 934
A. sturio (North Sea)	ACGTACCATCTACACCCTGAAT	CGA
A. oxyrinchus (North America)	GTCACTGCCTCTTGTATCATCA	TAT
A. oxyrinchus (Baltic Sea)	GTCACTGCCTCTTGTATCATCA	TAT

2.5. Characterization of broodstock and offspring

To verify the polymorphism of the future brood stock and to select specimens which should be included into the brood stock as a basis for future stocking of Baltic rivers, genetic analyses of fishes used for reproduction in Canada as well as their progeny were performed. Profiles of eight microsatellites were obtained for 323 specimens in total, comprising all batches of eggs hatched in Poland between 2004 and 2008. The results indicate that the polymorphism indices of fishes reared in the Baltic today are still lower than those calculated for the native population. This low polymorphism is based on the low number of parental fish used for spawning from the St. John River. The expected and observed heterozygosity values for Polish hatchery populations were 0.640 and 0.639, while for the St. John population they were 0.665 and 0.663. This result again indicates that the differences between the native St. John population and the broodstock reared in captivity are rather low (Popović *et al.* 2014). Ongoing research on the differences between the Canadian *A. oxyrinchus* populations and the current *ex situ* stock are commenced to obtain more insight into the population structure in the Canadian source populations which are considered to comprise three subpopulations and the representation of these subpopulations in the *ex situ* stock.



3. Life history and habitat links

Acipenser oxyrinchus is diadromous and utilizes a multitude of habitats throughout its life-cycle. The maximum lifespan is estimated to be 120 – 140 years of age with a maximum size of more than 5 meters and a body mass of more than 600kg. While reproducing in the gravely reaches of the rivers, where also the external embryonic development of the yolk sac larvae takes place, the later juvenile stages largely depend upon sections of the river with fine sediments and high invertebrate production. The transition to salt water is – in contrast to salmonids – a gradual process with increasing ability to regulate osmolality of the body. After spending up to 20 years in marine waters the now adult sturgeon returns to its natal river for the first reproduction in spring at high flow conditions. Following their first reproduction, sturgeons leave the river immediately after spawning but return repeatedly in 2 - 5 year intervals, being longer in females than in males, for spawning until the end of their lives. As such, old females are more fecund than their younger conspecifics with 5-15% of the bodyweight being laid down in eggs. The generation cycle of the species is long due to the late age at maturity and the long life expectancy, reaching more than 50 years.

Many details on the reproductive behaviour are known from the North American populations only which provide a plethora of data and therefore are utilized to summarize important aspects of the biology of the species.

3.1. Life-cycle

Juveniles remain in fresh- or slightly brackish water for the first year and then stay 2-6 years in brackish waters before moving into the sea. Young of the year occupy open sand to muddy habitat in deeper stretches of the river. Outmigration is interrupted and seasonal movements (summer) into the river for feeding are observed. Fish at sea usually feed and grow during winter.

In the ocean, long distance feeding migrations of up to 3,000 km have been reported from North America at depths to 150 m. Baltic sturgeon have been observed in the Bothnian Bay (Umea) near Bergen (Norway), and in the Gulf of Biscay (Loire River mouth, France) and near the coast of Gijón (Spain) (Arndt *et al.* 2011).

3.2. Diet

Aquatic insects polychaete and oligochaete worms are the most common items reported for juvenile *A. oxyrinchus* in fresh waters (Bogacka-Kapusta *et al.* 2011). The diet in estuarine and marine waters consists mainly of insect-larvae, worms (*Capitella, Clymenella, Glycinde, Limnodrilus, Nereis, Pherusa, Scolecolepides*), crustaceans (*Crangon, Gammarus, Gilvossius, Pinnixia, Squilla, Politolana, Upogebia*), molluscs and small fishes (*Ammodytes, Mallotus, Microgadus*). *A. oxyrinchus* is described as an adaptive feeder utilizing herring and capelin as a food source.

3.3. Size and growth

Atlantic sturgeon are reported in the 20th century to reach a maximum length of 4.3 m, a weight exceeding 370 kg, at an age of 60 years (Smith 1985). Since this observation originates from heavily exploited populations it is in line with historic records that maximum lengths of more than 5 m and weights exceeding 600 kg are probable (Jaric & Gessner 2013).

3.4. Sexual Maturity

Male *A. oxyrinchus* reach first sexual maturity at a minimum size of 1.2-1.6 m at ages 7-9 in the southern (Gulf of Mexico), 10-19 in the middle of its range, and 20-25 in the northern ranges (Canada) of the species. Females mature at a minimum length of 1.5-1.8 m between age 9-15 in the south, 15-24 in the centre and 24-30 in the northern part of the range. Males spawn in cycles of 1-4 years, females in cycles of 2-5 years. Spawning cycles depend upon energy supply and are shorter in the south.

3.5. Spawning

3.5.1 Spawning season

Spawning migrations in the tributaries to the Baltic Sea were variable. Maximum upstream distances covered can be long (historically in Vistula and Oder River reaching up to 960 km) (Grabda 1968, Przybyl 1976) while in the majority of historic spawning rivers in Europe the spawning grounds are located within 100-300 km distance from sea. Migration takes place at a speed of 4-24 km/day.

The spawning season varies with latitude and depends upon water temperature and discharge. In the northern populations spawning starts in May and early June with a peak in July, at water temperatures of 13-22°C (Arndt *et al.* 2005). In most populations a substructure seems to exist that resembles the "races" as defined by Berg (1948) with fish moving into the rivers at different times of the year (spring and summer as well as fall) and migration distances that vary between the groups (long distance spring migrants, short distance summer and fall migrants) (Balazik *et al.* 2012, Smith *et al.* 2015, Farrae *et al.* 2017). Overwintering population segments have not yet been reported.

Spawning migrations take place in a single move in all of the species range (Dovel and Berggren 1983, Smith 1985, Gilbert & Moran 1989). Males reach the spawning sites up to 10 days before the females.

3.5.2 Reproduction

Gonado-somatic-index increases with age and varies between 4 and 12% (Van Eenennaam *et al.* 1996). Ripe eggs are 2.1-3.0 mm in diameter with an average mass of 12-16mg. Females spawn between hundreds of thousands to several million eggs depending on size of the female.

The spawning behavior seems to be similar throughout the populations. In the James River males tend to congregate 2–10 km below the spawning grounds, possibly waiting for females. When a female swims by males follow her to spawning grounds. At the spawning grounds males move under or behind the female and release milt while she releases eggs. After spawning females tend to drop down and stage in brackish environments before traveling to the ocean. As in A. fulvescens (Bruch *et al.* 2011) males drop down to staging areas and wait for the next spawning opportunity (Atlantic Sturgeon Review Team 2007).

3.6. Habitat requirements

Spawning takes place in well oxygenated water at elevated current velocities of 0.4-1.2 m/s over bedrock, cobble and gravel. Average water depths of spawning sites are variable but mainly are between 2 and 14 m. Typical spawning site morphology is described by Du *et al.* (2011) for A. sinensis but the basic principles are valid for *A. oxyrinchus*.

Homing fidelity was shown in A.o.*desotoi* to exceed 94% between neighboring systems based on genetic analysis (Stabile *et al.* 1996). Spawning immediately upstream of the brackish water front has been observed in the Saint John population (Arndt *et al.* 2005).

Spawning is described to take place on the descending limb of discharge at water temperatures of 13°C -22°C (var. authors).

3.7. Larval development

Egg development from fertilization to hatching at a water temperature of 20°C takes 55 - 90 hours. Upon hatch larval behaviour varies in accordance with the spawning sites used. In Saint John River, fish that spawn close to the brackish water wedge tend to avoid upswing upon hatch but utilize the incoming tide to migrate upstream for staging habitat. Fish that originate from river sections well above the tidal zone have larvae that emerge from the egg and swim up to leave the egg incubation site. Newly hatched larvae are 8 - 11 mm in length and 9 - 14 mg in weight. Prior to exogenous feed uptake the larvae utilize interstitial spaces in gravel and other shelter to complete embryogenesis. Exogenous feeding begins 8 - 11 days post-hatch, which is preceded by a marked increase in activity and motility (Gessner *et al.* 2006). The presence of gravel is essential to minimize stress during larval development as was shown by Gessner *et al.* (2006) and Mc Adam *et al.* (2011). Lack of substrate shortens the time until hatch and affects the body composition with regard to energy contents and PUFA contents. After 45 days the post larvae have completed metamorphosis and resemble the juvenile phenotype.

Young of the year (YOY) behavior, their movements, the habitat utilization, and foraging are insufficiently documented to date. Limited information on Hudson River YOY was gained from artificial stream studies that found they did not reinitiate a downstream dispersal prior to wintering, and they had a size-based foraging hierarchy, with only the largest fish obtaining optimal foraging positions (Kynard & Horgan 2002). While the density of YOY in the stream was highly artificial, the organization of the individuals into a feeding hierarchy suggests complex social organization may exist in the species and that the size dominance is used to keep fish spaced out on the rearing habitat (Atlantic Sturgeon Review Team 2007).

3.8. Juveniles and subadults

Habitat utilization of juveniles using telemetry and capture data was described by Hatin *et al.* (2007) in the St Lawrence River who found 0+ age Atlantic sturgeon predominantly over sandy substrates in exclusively freshwater habitats at 7.3 to 12.8 m (mean = 11.1 ± 1.8 m; n = 12) depths. The respective current velocities are 0.29 - 0.53 m s-1 (mean = 0.4 ± 0.1 m s-1_1; n = 10) at an average 13 – 16% salinity (Haley *et al.* 1996). In bays and mainstream river sections of the Hudson River, juveniles were found concentrated in deep water (mean 22.7 m) and were over mud (Haley *et al.* 1996). For overwintering juveniles migrated to deep river sections while during spring, they move upstream (Dovel & Berggren 1983, Smith 1985, Bain *et al.* 2000). Recent tracking studies of juveniles in a Maine estuary found juveniles foraged in the estuary during summer and fall but migrated out of the estuary in fall (Fernandes 2008). Juveniles remain upstream in fresh water or in low salinity areas of rivers during warm months (Hall *et al.* 1991, Collins *et al.* 2002) and migrate to more highly saline areas during cold months. These movements are observed in juveniles of 1–6 years, prior to leaving on their coastal foraging migration (Gilbert & Moran 1989). Hatin *et al.* (2002) describe the mean summertime home range for 2 year old juveniles in the St. Lawrence Estuary to be 4.5 - 2.7 km2 (1.3 ± 8.4 km2; n = 8) while core areas were less than 1 km2 in 6 – 10 m water depth in fresh water near the interface with salt water, with low flow over silt-clay substrate, reflecting foraging habitat (Hatin *et al.* 2007). This finding is attributed to the fact that one specific juvenile feeding ground was identified in the estuary where the juveniles concentrated. The universal applicability of this behavior is not yet known.

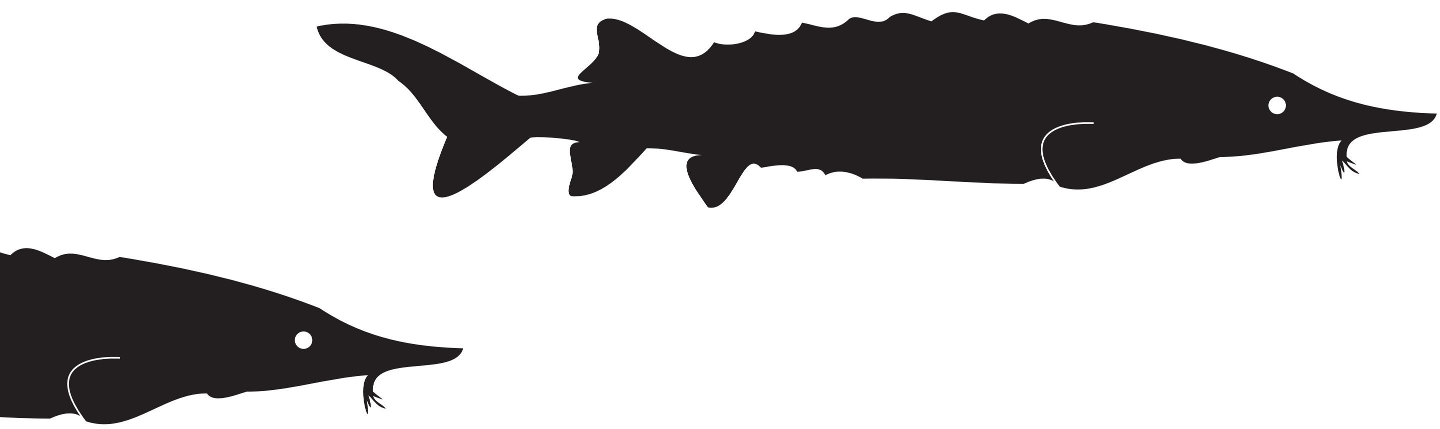
After juveniles reach a certain age (2–6 years) or perhaps, a certain body size (76– 92 cm TL), they leave their natal estuary and initiate a coastal foraging migration (Dovel & Berggren 1983, Gilbert & Moran 1989).

In the North American coastal waters subadult *A. oxyrinchus* tend to show movements towards warmer regions during November–January, and northward movements during February–April (Gilbert & Moran, 1989). Migrations and the physical habitat used by the species in the marine environment are just beginning to be better understood based on analysis of fishery-independent data. During the fall, spring, and summer, subadult Atlantic sturgeon may congregate near the mouths of large bays and estuaries in relatively shallow water (i.e. <20 m) over sandy or muddy substrates (Dunton *et al.* 2010).

3.9. Water quality (Temperature, Oxygen, Toxins)

Sturgeons are sensitive to low levels of dissolved oxygen due to hemoglobin with fairly low oxygen affinity and a lack of a compensatory strategy. As a result, sturgeons tend to reduce their turnover in an attempt to reduce O_2 demand. Critically low levels of O_2 concentrations are reached at 2mg/l already (Delage et al 2014). As such hypoxic conditions affect bioenergetic processes including metabolism, activity, growth, and reproduction (Cech & Doroshov 2010).

The growth of juvenile *A. oxyrinchus* is highly dependent on temperature, salinity, and dissolved oxygen, with optimal growth under oxygen concentrations >70% saturation, temperatures of approx. 20°C, and brackish salinities (8–15 ppt) (Niklitschek & Secor 2009a,b). Their tolerance for increasing salinities develops over time and with increasing body mass. In the St. Lawrence estuary, age-0 *A. oxyrinchus* inhabited fresh waters almost exclusively, whereas age-2 fish strongly associate with the salt wedge (Hatin *et al.* 2007). Food consumption rates and growth of YOY and juvenile specimen are highest at brackish salinities (8 – 20 ppt), with growth and condition showing a marked decrease at high salinities (Allen *et al.* 2014). Oxygen consumption rates suggest increasing ionic and osmotic regulation impacts in younger fish at higher salinities (Allen *et al.* 2014).



4. Past range in the Baltic range states

4.1. Past range

The first signs of Sturgeon presence in the Baltic Sea area date back to the Early Neolith period, more than 5000 years b.p. Sturgeons were abundant in the Oder River and its confluences, especially Warta River, Notec, Prosna and some Silesian rivers (Wittmack 1874). Main spawning sites were located in the middle Oder River from Bad Freienwalde on the Old Oder up to the city of Ratiborcz, in Warta River the vicinity of Poznan and upriver near Konin were aggregation areas during spawning season, but also tributaries such as Prosna and Drawa were documented spawning sites.

In the southern Baltic Sea and its tributaries, sturgeon remains were most frequently recorded between the 10th and 14th century (Makowiecki 2008). Sturgeon were observed in the Vistula River near Tynice, 880 km from the river mouth, at the end of the 19th century (Wałecki 1984). Past catches of sturgeon included the Dunajec River near Nidzica in 1921, the Raba and San rivers, where they reached as far upstream as Przemyśl, and Wisłok and Wisłoka rivers (Wałecki 1864, Wiśniewolski & Engel 2006, Cios 2017). One of the largest sturgeon spawning grounds in the Lower Vistula were located in the lower and midle course of the Drwęca River (Grabda 1968).

Sturgeon catches focused on Kurian Lagoon and Gulf of Gdańsk, with Pillau/ Baltijsk and Gdańsk as centers of processing and exporting mostly of cured meat to England. In the Vistula River sturgeon fisheries was a main commercial source of income for the city of Gdansk in the 16th and 17th century when fisheries leases were rented out to English companies and sturgeon pickling became the main trade of the Pillau fisheries. In Elblang, located on the connection between Kurian Lagoon and Vistula River, sturgeon comprised 70% of the protein consumed (Hofmann 1996). The number of outmigrating juveniles led to the utilization of sturgeon YOY as fertilizer and pig feed (Seligo 1907, Hofmann 1996). The fisheries underwent a dramatic decrease when the new Vistula River mouth was built in 1894 and subsequently the Kurian Lagoon was disconnected by the lock construction in the Nogat River – which previously was the main river arm leading into the forebay (Mamcarz 2000). The stock was subjected to commercial harvest until the 1930s.

In Lithuania the Baltic sturgeon was relatively common in the Nemunas basin until the 19th century. However just after few decades in mid-19th century sturgeons were considered rare in the inland waters of Lithuania due to overfishing especially in Nemunas River delta and Curonian Lagoon (Berg 1911, 1948). Best spawning grounds in Lithuania were located in the middle catchments of Nemunas, Šventoji, Merkys and Neris Rivers (Virbickas 2000). Spawning migration reached as far as 600 km upstream from the Curonian lagoon via Nemunas River into Belarus (Berg 1932, Zhukov 1965).

In Latvia just a few sturgeon bone findings were observed from Neolithic times because the predominant study sites s are located at inland marshes and lakes, which do not have or have very weak connection with Daugava, Gauja, Venta, Salaca and the Baltic Sea. In contrast, very rich archeological information, indicating that the territory of Latvia was heavily populated by sturgeons, comes from human settlements situated on the banks of River Daugava from Bronze Age until early Medieval ages between 1500 years BC until 1400 years AD (Sloka 1979). Sturgeon remnants from this period were also found in river basins of Gauja and Salaca (Sloka 2000).

The most abundant archeological sturgeon bone material originates from the period between oldest Iron Age to early Medieval ages (800 BC – 1400 AD), from surrounding area of the Daugava River. The sturgeon remains in several settlements account for 2-95 % from the total fish remnants. It should be noted that at some settlements sturgeon was much more commonly fished species than salmon, for instance in Martinsala village, located on Daugava River approximately 50 km from estuary and Gulf of Riga, site deposits of sturgeon bones account even for 95%, salmon just for 3 %, but others species for just 2 % (Sloka 1979, Caune 1992). Abundance of sturgeon remains in all settlements on the banks of the River Daugava provides evidence that sturgeon was an important target species for fishermen in Medieval period.

In Riga rural county, Chancellery holding payments and notes from the 16th – 17th century listed eight main fish species - salmon, herring, smelt, pike, bream, ide, eel and sturgeon, but detailed description has been made only for salmon fishing. For example, in 1659 in the Riga county Daugava River 12 fishermen congregations were fishing. They had to pay a duty of 132 salmon to the City council, in addition 85 salmon as fish consignments had to be forwarded to the city council lords and masters but it was noted that 3 salmons can be outweighed by 2 sturgeons (Caune 1992).

In Estonia, there are the historical data on sturgeon presence in Narva River from the 14th century. By the end of 17th century the abundance of sturgeon in Narva River decreased drastically. An archaeological data from 14th century indicate that sturgeon have inhabited Pärnu River too (Lõugas 2001) but there is no sturgeon catch data from later periods to confirm that.

The historic range of the Baltic sturgeon covers the coasts of the Russian section of the Gulf of Finland and of Ladoga Lake being connected by Neva River. Kessler (1864), described sturgeons to migrate from the Baltic Sea through the River Neva into the Ladoga Lake and from there into the tributaries to spawn. Anyhow, the seasonality of catch differed indicating that the lake was a habitat for the fish, not only a migration route.

Almost all sturgeon catches in Neva River occurred in its lower reaches (in the city of Saint-Petersburg) while in the middle section of the river long stretches with riffle structures and rapid current existed. A similar setup was documented in Volkhov River. Where sturgeons were observed downstream of the riffles (Kessler 1864), but rarely migrated through them to the upper reaches (Domracheev & Pravdin 1926). Considering the migration obstacles, the Ladoga sturgeons most likely formed an isolated population with little exchange with the Baltic Sea. A comparable situation was found in Svir' River connecting Ladoga and Onega Lakes. Only two sturgeons had been caught in the upper reaches of Svir' in 1850s (Kessler 1868). In Onega Lake only sturgeon had been found at the source of Svir' (Pravdin 1948).

In excavations from ancient settlements at the banks of Volkhov River dating back to the VII century, archaeologists found the remnants of about 60 sturgeons (Tikhy 1923). There is evidence that sturgeon fishing was under control of local authorities in the remote past.

Some of the mentioned rivers are blocked by dams nowadays, but the dams were either built after the disappearance of sturgeons, or upstream of their spawning grounds. The rivers Luga and Volkhov flow through territories where settlements and arable lands are numerous. This land use has the potential for pollution through nutrient input, but such pollution can hardly have been strong enough to exterminate sturgeons. Several sensitive species still exist in the system: lamprey, smelt, whitefish, and in Luga river salmon and brown trout (Popov 2017).

In Sweden current investigations are ongoing to verify the historic presence of *A. oxyrinchus* in the Götaälv River. Catches of juveniles with up to 20 cm indicate potential reproduction in the river in the 19th century. Depending upon the outcome, the initiation of a recovery project is considered.

4.2. Reasons for decline, and drawbacks for population recovery

4.2.1 Fisheries

Harvest records show that fisheries for sturgeon were conducted in all major coastal rivers along the southern Baltic Sea coast during the spawning migration but also targeted juvenile fish in rivers and coastal waters.

Ivanauskas (1956) indicated that during the pre-war period, the sturgeon was not that rare in Nemunas basin and Lithuanian water bodies, however only single specimens were caught and not each year: in 1927–1932, sturgeon catches ranged from 50 to 300 kg; no data on catches are available for the period 1933–1935; in 1936, 120 kg of sturgeons were caught. After World War II just four sturgeons were caught in Lithuania: in 1955, 1960, 1962, and 1975. Based on records, these fish were of the following sizes: 254 cm and 122 kg, 210 cm and 82 kg, 18 kg (length not known), 100 cm (weight not known). Increasing pollution, river damming and reclamation of arable land adversely affected their habitats. Generally on the turn on 20th century destruction of spawning grounds and habitats due navigation and channelization together with pollution and overfishing delivered final lethal blow for Atlantic sturgeon population in whole Baltic (Debus 1996 Mamcarz 2000). The last sturgeon was caught in the Baltic Sea in 1996 near Saaremaa Island, and in the Lithuanian waters – in 1975, near Palanga. In Latvia no official records are available for commercial sturgeon landings from the end of 18th century. According Fischer (1791) Sturgeon was a rare species already at that time. From 19th century only approximately 10 reports are available in public literature about sturgeon catches in Rivers Daugava, Gauja, Irbe, Rinda, Venta and the Gulf of Riga. For example, in 1887 in the newspaper "Dienas Lapa" (Daily Sheet) an article was published, about a farmer who caught 2.4 m long and 136 kg heavy sturgeon in small Engure River located between Usma and Puze Lakes, the caviar alone weighted 36 kg. The fish was delivered to Ventspils, and profitably sold to the local confectionery. Sapunow (1893, cit.by Auziņš 1925), mentioned that "formerly" (!) sturgeon was fished at the Vidzeme coastline in the Gulf of Riga from the end of April until May, during ice movement in springtime. Since the beginning of 20th century only 5 records of native sturgeon caught in Latvia waters were found.

Similarily, it is believed that sturgeon has never been numerous in Estonia. Well-documented information about sturgeon caches in Estonia only is available from recent history. About 30 findings of sturgeon from its native population have been recorded from Estonian waters from the end of the 19th century up to the present. At the beginning of the 20th century, sturgeon were caught mainly in the Narva River or the Gulf of Finland. According to archival sources about fisheries in Narva region sturgeon had been probably extirpated by the end of 17th century (or even earlier). For example, the abstracted sturgeon picture on the code of arms of the city of Narva in the 14th century was replaced with graylings in the 15th century.

The most probable cause of the extinction of local sturgeons in the Neva and Ladoga area is overfishing. It was described especially for the Luga River in the end of the 19th century (Grimm 1889). In the beginning of the 18th century its mainstream has been blocked by trap-nets in the middle reaches. Later on the number of trap-nets increased. By end of the 19th century about 20 trap-nets have been installed in the low reaches of the river. Numerous gillnets were used in addition to them. Several fisheries gears were used in the Luga River mouth as well. Local inhabitants even caught salmon parrs by means of special small drag-nets. Hence, a rapid decline of the local populations of salmon and white fish took place, while sturgeon had become a great rarity. Similar situations were documented in other rivers. By the beginning of the 20th century Neva River was used for fishery along the whole length. The number of registered fishermen working in big enterprises ranged from 300 to 450, while the length of the river is only 75 km (Luzanskaya 1940). Meanwhile, the coasts became densely populated, and the local inhabitants actively participated in fisheries. Even now it is possible to observe unregistered fishery by local inhabitants there, but it was evidently much more intensive in the past. The same is true for Volkhov River. Moreover, communications on special fishing aiming to get sturgeon are known. Domracheev and Pravdin (1926) described such a case: "the whole settlement tried to catch one sturgeon by surrounding the spawning grounds with numerous nets"(Popov 2017).

Both targeted fisheries for the mature fish approaching their reproduction sites for human consumption as well as the utilization of juveniles as fertilizer or pig-feed (Seligo 1907) illustrate that the wealth of past sturgeon populations was wasted in overexploitation. The first signs of overharvest of the Baltic sturgeon were observed already in the catch reports of the Pillau/Baltijsk harvest in the 17th century, when the number and size of the fish harvested began to decline drastically (Debus 1996). A trend that continued over the 18th century and found its termination in the early 20th century when the harvest finally collapsed even in the most productive Vistula River. Similarly, the fishery for sturgeon, while being productive in the 1880s revealed a rapid decline in Oder River with a short increase at the onset of the 20th century resulting from a massive increase in effort due to the low catches in the Elbe River and the establishment of the new Vistula mouth that let a large number of fish disoriented since the old river mouth was cut off from the mainstream and impassable. As such fisheries must be considered the most important single driver for the extirpation of sturgeons in their former range.

This trend was increased since fisheries management was lagging behind the development of the populations. Fisheries restrictions were limited to the provision of fishing rights for adult fish. Temporal, spatial or size related restrictions were ineffective if taken at all. Among the states in which harvesting was restricted by minimum size restrictions (Berg 1935), only Poland (1932) introduced a size limit which allowed females the opportunity to spawn once before being harvested (Kulmatycki 1932). Between 1919 and 1936, eight or nine sturgeons with a body length over 150 cm were caught on average. After introduction of full protection of sturgeon in 1936, the catches of 27 specimens were officially confirmed in the Vistula River and its tributaries in 1936 -1965. The last wild sturgeon was caught in 1996 near Saareema Island (Estonia).

4.2.2 Habitat alterations and pollution

Baltic sturgeon, like all anadromous fish, are vulnerable to diverse habitat impacts because they use rivers, estuaries, bays, and the ocean at various points of their life. Habitat alterations potentially affecting sturgeon include dam construction and operation, dredging and disposal, and water quality modifications such as changes in levels of dissolved oxygen, water temperature, and contaminants. Criteria for the habitats of Baltic sturgeon were summarized by Arndt *et al.* 2006.

Loss of habitat and poor water quality has contributed to the decline of Baltic sturgeon since European settlement. The increased pollution of the rivers by agricultural, communal and industrial wastes increasingly became an obstacle for a successful completion of the sturgeon life-cycle at the turn of the last century, adversely affecting substantial sections of the rivers (Bonne 1905, Schiemenz 1906). However, the importance of this threat has varied over time and from river to river. Some important aspects of habitat quality, especially water quality, have improved during the last thirty years. Examination of the impact of present or threatened destruction, modification, or curtailment of habitat or range on Baltic sturgeon is presented. If information was not available specifically for Baltic sturgeon, information relevant to other sturgeon species is presented. Similarities in sturgeon life history and physiology make these data and analyses applicable, with occasional qualification, to Baltic sturgeon.

The industrial revolution, followed by adverse impact on environment occurred in the second half of the 18th century and the beginning 19th century in Latvia. It seems that in Latvia, industrialization did not affect sturgeon population, because the sturgeon already disappeared in the beginning of 18th century. According to the available information, the main reasons determining decrease of sturgeons in Latvia was not pollution, ecosystem changes or damming of rivers, but more likely climate changes. From 1500 till 1850 in Europe was so called "Little Ice Age". Probably during the end of 17th and beginning of 18th century the Northern border of sturgeon distribution moved to the south and probably Latvia was the northern border of sturgeon population range at that time Purvina & Medne, 2018.

In contrast to the situation on the Baltic States major impacts upon sturgeon populations and other migratory fish species in Germany and Poland resulted from river development for hydropower, navigation, flood protection and the development of arable lands (Gessner *et al.* 2000, Mamcarcz 2000). The blocking of migration routes, disconnection of productive side-channels and backwaters, the destruction of floodplains and meandering river sections have led to a quantitative and qualitative deterioration of the riverine habitats. Resulting uncoupling of freshets, temperature alterations, as well as increased sediment mobility and nutrient impacts have led to the destruction of spawning and early life stage habitats. Because of global changes and human activity, environmental conditions of the spawning and feeding habitats have changed dramatically over the last century.

4.2.3 Hydromorphological alterations

As described in the earlier sections, requirements with regard to water quality and temperature are high. Improved knowledge on the sensitivity of sturgeons to temperature, dissolved oxygen and pollutant is necessary to evaluate their capacities to recolonize the catchments in their historic range. Hydromorphology of spawning sites determines its suitability. Key points are sufficient water exchange in the interstitial space and sufficient prevention of accumulation of fines (culmation). In addition, the quality of the gravel (3-7 cm diameter, presence of boulders or bedrock), with clean surfaces without periphyton growth being highly preferred outline the need for sufficient flow dynamics allowing the gravel to be mobilized (Jego *et al.* 2002, Arndt *et al.* 2006). Similarly, in post-hatch eleutheroembryos, tigmotactic behavior makes the availability of 1.5-3cm gravel a prerequisite for adequate rearing conditions during the embryonal development (Gessner *et al.* 2008, Bates *et al.* 2014). At the onset of feeding, productive regions with moderate currents and high abundances of Chironomids are habitat criteria that serve the requirements of the early life phase of the species (Gessner *et al.* in press). Functionality of habitats also depends upon the potential of the fish to hide from predation. Telemetry experiments with 10 month old juveniles have shown that the fish prefer habitats with deep pools and deadwood over open spaces or bank structures.

4.2.4 Climate change

Other impacts such as climate change are postulated to have played a significant role in the decline of *A. sturio* in the Baltic Sea area during the Little Ice Age (Ludwig *et al.* 2002). Today, the decreasing precipitation and increasing temperatures might contribute to the alteration of the environmental conditions for migration and reproduction of this species. Temperature appears to be an important constraint on the distribution of anadromous fish in Western Europe. However, a recently published study by Beguer *et al.* (2007) does not indicate a significant influence of temperature on the European sturgeon which is coherent with historical observations of this species in the wild with a temperature tolerance of 3 to 30 °C as described in Williot *et al.* (1997). Nevertheless, changes in annual temperature trends in combination with altered river discharge patterns and subsequently changed seasonal water flow rates may well have an effect on spawning migration and riverine residence time of juveniles. This becomes ever more important under the impression of climate change and the resulting alterations of discharge and summer temperatures.

A case study was carried out for *A. sturio* by Delage *et al.* (2015) which is cited in the following paragraphs since the same undelying mechanisms are expected to be effective in *A. oxyrinchus* but specific studies are lacking. Sensitivity towards present and future oxygen and temperature conditions were evaluated in *A. sturio* for the Gironde Garonne Dordogne (GGD) catchment. Because of global change, the water temperature and the frequency and severity of hypoxic events in the GGD system have increased. The sensitivity of *A. sturio* early life phases to temperature and oxygen saturation and possible implications for the reproduction of the species were evaluated. Embryos and early -larvae were exposed to a combination of temperatures, ranging from 12°C to 30°C, and dissolved oxygen, ranging from 30 to 90 % O2 saturation. Lethal and sublethal effects were evaluated using embryonic and larval mortality, as well as hatching success, malformation rate, yolk sac resorption, tissue development, routine metabolic rate and swimming speed.

Embryonic survival peaked at 20°C and no survival was recorded at 30°C. No hatch occurred at 50 % O2 saturation or below. Malformation appeared to be minimal at 20°C and 90 % O2. Maximum routine metabolic rates were recorded at 20°C under 90 % O2 and at 16°C under 70 % O2 saturation (Figure 6). At 20°C a lower metabolism was observed at 70% O2 than at 90% O2. Maximum swimming speed was recorded at 16°C.

A. sturio's temperature optimum was shown to be close to 20°C (Figure 7). Its upper tolerance limit is between 26 and 30°C and its lower tolerance limit is below 12°C. Oxygen deficiency induces sublethal effects at 70 % O2 and lethal effects at 50 % O2. A preliminary study in European sturgeon has shown that the embryo-larval stage is more sensitive to high temperatures than older stages (Delage *et al.* 2015).

In the same species, the sensitivity of the early stages to pollutants mixture found in the GGD catchment was also evaluated. Results obtained show a high sensitivity of the young stages of this species to oxygen concentration. Thermal optimum, optimal and critical tolerance windows were determined. Sensitivity to pollutants mixtures found in the GGD was relatively low (Delage *et al.* 2014).

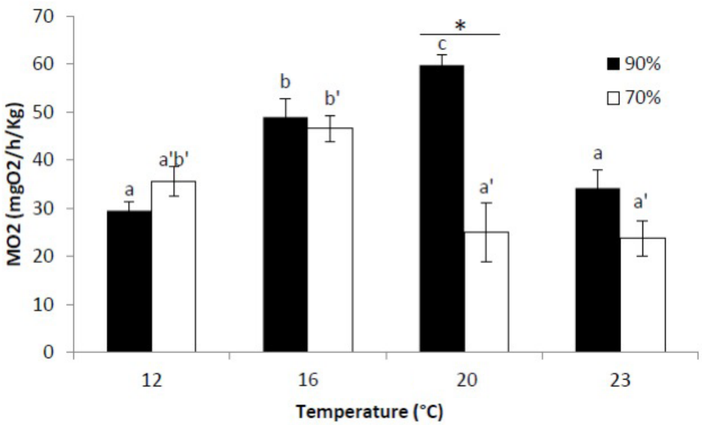


Figure 6: Routine metabolic rate in 2 dph *A. sturio* larvae in relation to temperature of rearing throughout their development (mean ± SE) at 90 and 70 %O2 saturation for the first 48h of incubation; statistical differences between temperature conditions (p<0.05) are indicated by different letters; stars show differences within a single temperature condition (N= 271) (after Delage 2015)

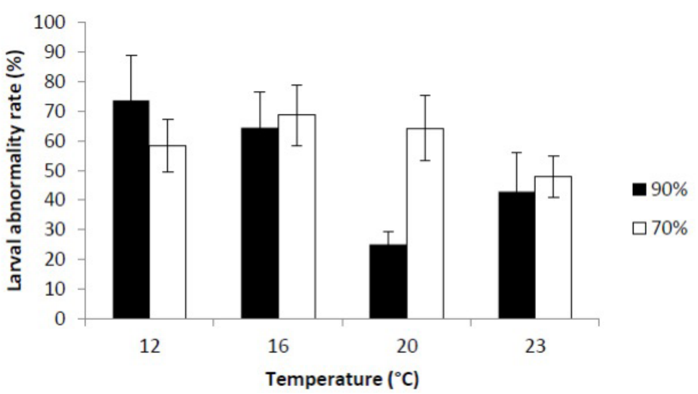


Figure 7: Malformation rate (Mean ± SE) in *A. sturio* larvae (2 dph) according to temperature exposure throughout their development at 70 or 90% O2 saturation for the first 48h of incubation (after Delage 2015).

4.2.5 Hydropower impacts

A drawback with regard to the migration facilitation for sturgeons is related to the fact that although sturgeons depend upon access to their spawning habitats, they are not regularly described to use fish passage devices, as only very few of the passage facilities have yet been designed to accommodate adult-size sturgeon. Alternative habitats below dams might be of limited applicability, since the site has to provide sufficiently long drifting distance for larvae and juveniles before entering coastal waters.

Dams for hydropower generation and flood control can have profound effects on anadromous species by impeding access to spawning and foraging habitat, modifying free-flowing rivers to reservoirs, physically damaging fish on up- and down-stream migrations, and altering downstream flows and water temperatures. In addition to dams impeding anadromous fish migration and associated mortalities, Hill (1996) identified the following potential impacts from hydropower plants: altered O2 concentrations and temperature, artificial de-stratification, water withdrawal, changed sediment load, and channel morphology, accelerated eutrophication and change in nutrient cycling as well as contamination of water and sediment.

Based upon the presence or absence of clean gravel, the suitability of riverine habitat for Baltic sturgeon spawning and rearing depends on annual discharge dynamics, which can be greatly altered or reduced by the presence of dams as has been shown for White sturgeon (Acipenser transmontanus) (Beamesderfer & Farr 1997). Activities associated with dam maintenance, such as reservoir flushing, dredging and minor excavations along the shore, can release silt and other fine river sediments which are deposited in nearby spawning habitat.

Overall, from the habitat assessments carried out so far, it can be concluded that in Oder River approx. 60% of Baltic sturgeon habitat seems to be accessible, in Vistula the availability reaches only 35%, in Pregola 65%, in Nemunas 40-45%, in Daugava 15%, while in Gauja, Irbe, Rinda, Venta the available habitat is reduced to 50%, in Narva River 100%, and in Newa and Volchov rivers 100% and 65% respectively. Although approx. 50% of the Baltic sturgeon habitat seems to be available, the suitability of the remaining portions of habitat as spawning and nursery grounds is unknown, since availability do not necessarily equate to 100% functionality. This is illustrated by large sections of Oder River that have been subjected to navigation development resulting in highly mobile sediments in the mainstem sections as well as the loss of the spawning sites in these habitats.

4.3. Mitigation options

Activities with the aim to decrease of adverse impacts must address a variety of topics that have altered the hydromorphology and hydrobiology of the rivers in question. Since the species is capable of sustaining only very modest rates of annual exploitation (Jaric & Gessner 2014). Recommendations for efficient protection include a complete moratorium on harvest until self-sustaining populations are established at a harvestable size (60-100 years). Enhanced monitoring programs, specifications on the role of cultured fish in stock enhancement as well as restoration programs, need to be accompanied by a commitment to reduce bycatch if necessary.

Mitigation measures for climate change are extremely long-term and associated with high uncertainties. It seems uncertain that the species in question can quickly adapt to earlier spawning seasons to avoid the critical temperature windows during early ontogeny. For most of the Baltic Sea states a prediction model by Lassalle *et al.* (2010) shows rather limited effects of climate change on the suitability of the watersheds for sturgeon reproduction.

Oxygen concentrations are largely influenced by various nutrient and pollution sources that affect the river productivity and the resulting oxygen consumption during night. Mitigation measures must act upon the sources directly and have shown good results for instance in the Oder River over the last decade of increased installation of wastewater purification and reduced application of fertilizers. Heavy metals and pesticide show a long-term persistence and are frequently associated with the substrates. As such, their transformation and eventually their dilution depend predominantly on the dynamics of the river sediment.

Numerous studies revealed that sturgeons are very vulnerable for fishing especially with gill nets. Unsustainably high catch rates of sturgeons in gillnets forced scientists to develop and test modified fishing gear with promising results (Gessner & Arndt 2006, Levesque *et al.* 2016). The next step is to implement sturgeon friendly fishing gear and/or techniques in the Baltic Sea area. Intense public awareness programs are needed across Baltic Sea area since very often every new fishing regulations usually induces negative feedback from fishers.

5. Catchment status

Along the German Baltic Sea coast, only the Oder River offers a suitable habitat for the sturgeon. Other rivers (Trave, Warnow, Peene, Uecker) are either too small or do not provide habitat qualities considered essential for early life phases of the Baltic sturgeon. The same holds true for the rivers in Denmark and southern Sweden entering the Baltic Sea and the Kattegat.

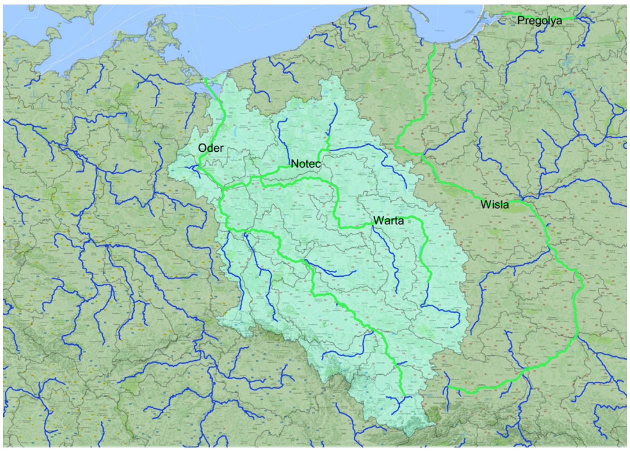


Figure 8: Oder and Wartha River catchment (© Google Earth Physical, Hallermann 2018)

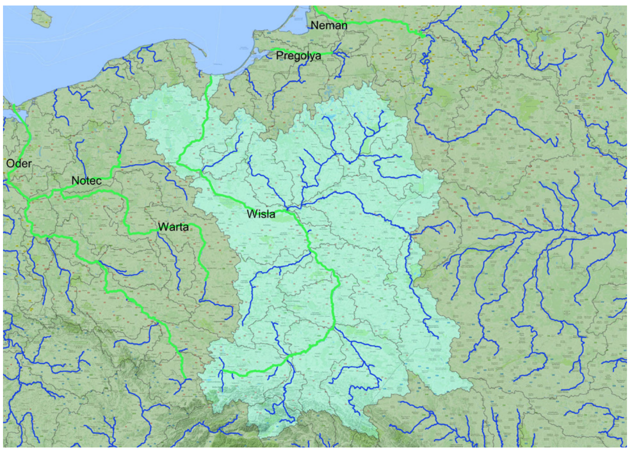


Figure 9: Vistula River catchment (© Google Earth Physical, Hallermann 2018)

5.1. Oder River

Oder River over 150km of it lower course is the Border River between Germany and Poland. In total it is 898 km long and has an average discharge of 574 m3s-1. The river originates in the Silesian mountains (Odergebirge) at 634 m above sea level and receives several tributaries (Oława, Kaczawa, Barycz, Bobr, Nysla/Neiße, until its confluence with the Warta River (with Prosna, Obra, Notec, Drawa as main tributaries), The catchment comprises an area of 800.000km2 of which 90% are Polish territory including the central plains of Poland (Figure 8). The rivers are characterized by a fairly low gradient and are populated by a variety of large settlements. The river mouth is a lagoon with 3 arms (Peenestrom, Swina, Dziwna) that connect it to the Pomeraninan Lagoon.

Despite the existing hydro-constructions in the basin, the rivers allow free migration for up to 450 km in both Warta and Oder Rivers. Habitat assessments were carried out on the main historic spawning grounds (Grabda 1968, Przybyl 1968) and have confirmed the presence and functionality of 40% of the historic spawning sites (Gessner & Bartel 2000, Arndt *et al.* 2006).

Due to the improvement of water quality which followed the HELCOMBSAP and the accession of Poland to the EU, the main obstacles for successful reproduction are today associated to the altered sediment mobility resulting from inland navigation adaptations and the loss of floodplanins.

Future construction for flood protection, inland navigation and hydropower development in Poland currently foresees to build 14 additional dams on the mainstem Oder River, an extension of the canal connection between Vistula and Warta River, as well as the channelization of the largely rewildered Warta River below Konin. This development would adversely affect the restoration attempts for all migratory fish species and be clearly in opposition to the current environmental protection laws of the EU.

5.2. Vistula River

The Vistula River (Figure 9) is the longest and the largest river in Poland. Its total length is 1,047 km and has an average discharge of 1046 m3/s. the Vistula River basin has a catchment area of 194,424 km2. In comparison with the rivers in Western Europe, those on Polish territory have been subjected to regulation to a relatively small degree. In the upper Vistula River segment between Soła and San rivers, are equipped with seven barriers with dam heights ranging from 3.7 to 6.7 m. Pools and fish passes have been built at the five dams, but their efficiency is questionable and their sizes are too small to facilitate sturgeon migration.

The ecological state of upper Vistula River is generally poor due to the pollution from the Silesian and Cracow agglomerations. Its tributary Dunajec River below Czchowski Reservoir is a large river with a slope of 0.08%. There are very few technical alternations and just one barrage 1.2 m high that dams water near Tarnów (rkm 33). This barrage was built of large rocks but does not impose a barrier for fish migration. The Dunajec River has only been regulated to a small degree. In the Wisłoka River the most significant obstacles are in Mielec (rkm 21+500) and Dębica (rkm 56+160). The San River between Przemyśl and the confluence with Vistula (169 km) is available for migratory fish. The effectiveness of the new fish ladder built in 2014 has not been monitored so far. The Wisłok River is a tributary of the San River. The first dam in the Wisłok River is located at rkm 58+550 in the city Rzeszów.

In the middle Vistula basin populations of migratory fish have never been abundant. Historically sturgeon occurred in Narew, Bug, Pilica and Bzura rivers. Spawning grounds were located in the middle Vistula River near Annopol at rkm 299, about 642 km from river mouth. Today, the dam in Włocławek at rkm 675 (266 km from the river mouth) blocks access to 90% of the Vistula River and therefore is of key importance. The poorly functioning fishway in the dam was modified into a vertical slot pass at the end of 2014. This new migration facility has not been adapted for sturgeons. The construction of a second dam on the lower Vistula is planned in Nieszawa at rkm 703 (240 km from river mouth).

The Drwęca River is the most significant right tributary in the lower Vistula River system. Historically, sturgeon ascended it for spawning. The Drwęca River has been a nature reserve since 1961. Two obstacles significant for sturgeon migration are found in Lubicz at rkm 11. The fish migration aids are not adapted for sturgeon. Both passes require reconstruction. The improvement of water quality in Polish rivers has been noted since the mid-1990s. The ecological status of Polish rivers has been classified as moderate for more than 10 years and the chemical status is good.

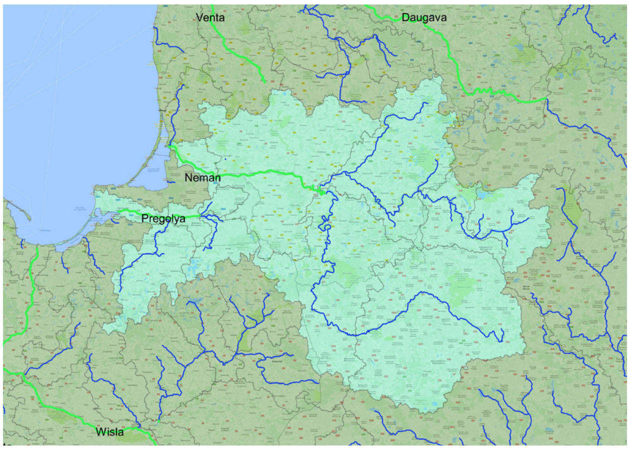


Figure 10: Pregolya and Nemunas catchments (© Google Earth Physical, Hallermann 2018)

5.3. Pregolya, Angrapa

Progolya River (Figure 10) originates at the confluence of the Angrapa River with the Instrutsch River. It is 123 km long and flows through a flatland area, reaching the Kurian Laggon near Kaliningrad. Its catchment is 15,500km2 and its mean runoff is 90m3s-1.The improvement of water quality in the rivers of Kaliningrad region is observed starting from 2000 that is related to the undertaken measures on waste water purifying and transfer of the industrial enterprises for new technologies. Elaborate hydro-biological investigation conducted with the laboratory of marine ecology of Atlantic Branch of the Institute of Oceanology of Russian Academy of Science (AB IO RAS) showed that current state of the river is the best for the last 100 years (Ejova *et al.* 2013). The possibility exists for the restoration of sturgeon spawning ground near the city of Tchernyakhovsk.

5.4. Nemunas River with Neris and Šventoji rivers

In Lithuania Nemunas River (Figure 10) and two of its tributaries were chosen for sturgeon introduction based on historical data and present ecological and habitat status – Neris and Šventoji River. The Nemunas River system has a catchment area of 97,928 km2 of which 47.7 % belong to Lithuania, 46.4 % to Belarus, 3.2 % to Russia, 2.6 % to Poland and 0.1 % to Latvia. The main tributary is the Neris River, which contributes approximately 33 % of the total flow. Lower part of Nemunas still provides floodplains, backwaters and side channels. Large stretches of the river-system are freely accessible (in Nemunas River 230 km with additional 400 km in Neris River and 100 km in Šventoji River). Today, upper reaches of Nemunas river are excluded because of Kaunas Hydropower plant (230 km from lagoon, 280 km from sea) however good condition historical spawning sites are accessible in middle and lower reaches of Neris River and in lower reaches of Šventoji River (Virbickas 2000). Suitable substrates are still dominant in many stretches of mentioned river parts. Both rivers are under Natura 2000 protection status and this together with absence of commercial navigation and improving ecological status provides strong background for sturgeon restoration success in Lithuania (Environmental Protection Agency 2017).

The release sites in the Šventoji River are located 275 km and the Neris River 326 km from the Curonian Lagoon. No dams or other significant migration barriers block the migration of the fish downstream. In Nemunas basin 116,500 sturgeons were released until 2017 starting from 2010 with 4,646 specimens tagged with Floy® T-Bar Anchor Tags or radio tags. First years of sturgeon reintroduction highlighted that commercial fishing in Curonian Lagoon, and Baltic Sea as well as angling in rivers could be main threats. A tagging study revealed that sturgeons are very vulnerable towards gill nets and that especially in hot summer period sturgeons die rather quickly in the gill nets,. Therefore, unsustainably high mortalities of sturgeons in gillnets requires some mitigation measures and tested modified sturgeon- friendly fishing gear are one of the most promising solutions (Gessner & Arndt 2006, Levesque *et al.* 2016).

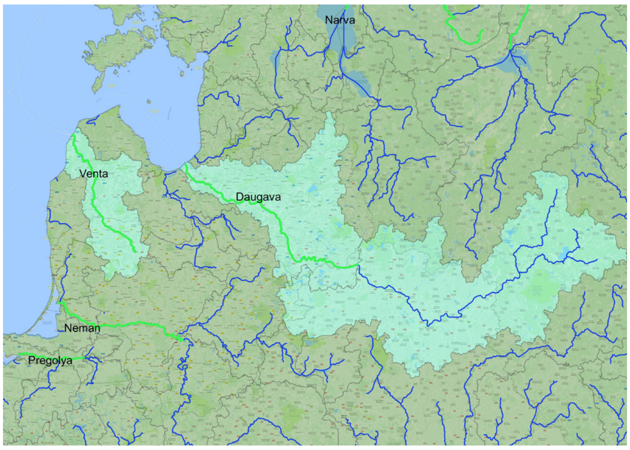


Figure 11: Catchments of rivers Venta and Daugava, Latvia (© Google Earth Physical, Hallermann 2018)

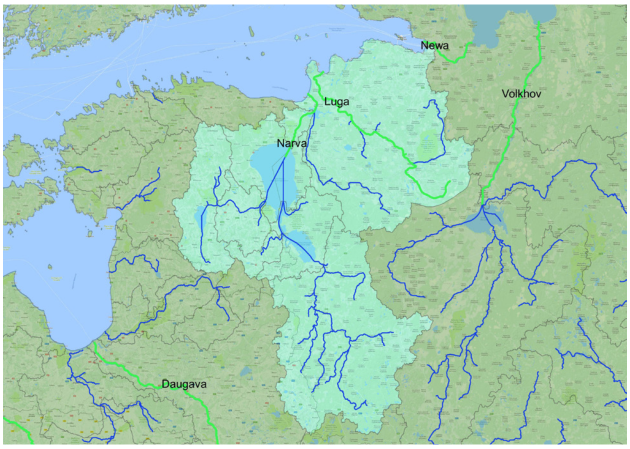


Figure 12: Catchments of Narva and Luga rivers (© Google Earth Physical, Hallermann 2018)

5.5. Rivers Venta and Daugava

In Latvia, there are 3 rivers where sturgeon could find adequate spawning sites (Figure 11) since salmon still spawn there naturally. These rivers are: River Venta with tributaries till the waterfall Ventas Rumba (85 km), River Gauja with tributaries up to the dams (314 km), and the river basin of Salaca (96 km). The latter are rivers and river districts that are not dammed and their hydro ecological features as well as water quality confirm requirements that are necessary for salmon spawn and likely will meet the requirements necessary for sturgeon. Additionally, in Daugava River basin up to the first mainstem dam (30 km) spawning habitat could exist while the remaining 990km of the river are inaccessible.

5.6. Narva River

It is assessed that the quality of potential habitats of the lower course of River Narva (Figure 12) from the city of Narva to the river mouth area (20km) is suitable for sturgeon as breeding and nursery habitat. Improving of sturgeon habitats in the Narva River can be done by restoring a destroyed spawning ground at the foot on Narva waterfall. Preliminary design for these works has been carried out already.

The future stocking of Pärnu River is planned. On the Pärnu River, the removal of the Sindi dam blocking upstream movements of fish 16 km from the river mouth has been started, the removal will be accomplished by 2020.

5.7. Luga River

Luga River is a potential sturgeon river in the West of the Russian Federation with a length of 353 km and a catchment of 13,200 m2. Sturgeon were fished in the River mouth area until the onset of the 20th century. In 1915 the dam had been built 70 km from the mouth, but it was destroyed some decades ago. Nowadays the dams are absent in the mainstem river. There are five sections with rifles a part of them is suitable for sturgeons, as well as the section at the river mouth, where the river is 200 m wide and up to 5 m deep (Popov 2017).

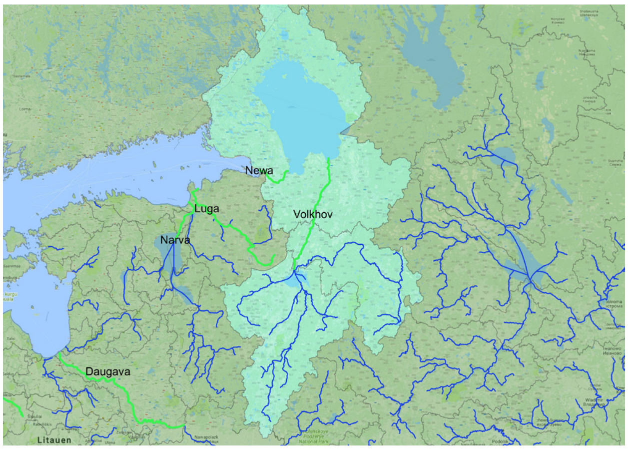


Figure 13: Catchments of Newa and Volchov river with Lake Ladoga (© Google Earth Physical, Hallermann 2018)

5.8. Neva River

Neva River (Figure 13) is connecting the Gulf of Finland to Lake Ladoga. Dams are absent in the river, but it suffered some transformations since the time, when sturgeons were caught there. In 1970s the section with long riffles had been deepened, big rocks were eliminated, the stony shoal at one bank had been removed. The navigation channel was widened twice. Previously one-way traffic of boats was implemented, after the reconstruction it became suitable for two-way traffic (Nezhikhovsky 1981). This exterminated the spawning grounds of the Atlantic salmon, but increased the area of potential spawning grounds for sturgeons. At the river mouth the river also suffered some transformations, but the main part of the river remains unchanged. The spawning grounds for sturgeons could exist in the whole river, which on average is 8-11 m deep (Popov 2017).

5.9. Volchov River

Volchov River (Figure 13) is entering Lake Ladoga in the south. The river is 224 km long and its total slope is 14 m. The catchment is 80,200km2 and the average discharge is 580m3s-1. Fish migration is inhibited at Woclchowski hydropower plant in the lower section of the river.

Historic sources indicate a river section, where spawning of sturgeons took place. This section is about 10 km long. It is located in the lower reaches of the river below the dam. Probably, it is still suitable for the spawning of sturgeons, as well as the section at the river mouth, where the river is more than 200 m wide (Popov 2017).

6. Legal status of *A. oxyrinchus*

6.1. IUCN Status

The Baltic sturgeon was not listed as a separate entity of the North American Atlantic sturgeon on the IUCN Red List until 2017. *A. oxyrinchus* was listed as Neat Threatened (St Pierre, IUCN 2015) with the subspecies *A. oxyrinchus oxyrinchus* being classified as vulnerable (ibid.). The Baltic Sea area population is currently re-assessed with the North American species. It is listed as a subunit with a CR/EX in the wild status.

6.2. Washington Convention/CITES (1973)

The Baltic sturgeon (*A. oxyrinchus*) has been listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (also known as CITES or the Washington Convention) in 1996 as part of the American Atlantic sturgeon complex. The category comprises species which require management measures for their survival. Listing means that international trade of the species needs to be authorized through a trade permit. Resolution Conf. 12.7 (Rev. CoP14) on "Conservation of and trade in sturgeons and paddlefish" (adopted in 2002 and amended in 2003 and 2007), urges range states to: "encourage scientific research and adequate monitoring of the status of populations", curtail the illegal fishing of and trade in sturgeon and paddlefish specimens, "explore ways of enhancing the participation of representatives of all agencies responsible for sturgeon and paddlefish fisheries in conservation and sustainable - use programs for these species", "promote regional agreements between range states of sturgeon and paddlefish species aiming at proper management and sustainable utilization of these species", in the case of range states of sturgeons in the Eurasian region, take into account the recommendations in document CoP12 Doc. 42.1 when developing regional conservation strategies and action plans. CITES regulates imports and exports of live sturgeon (fingerlings, juveniles and adults) as well as of fertilized eggs and sturgeon products, which may be relevant in the context of measures aimed at the conservation and restoration of the sturgeons. The European Union enforces CITES on a uniform and binding basis via European species protection law. It aims to protect wild animals and plants currently or likely to become threatened by international trade, by regulating the trade in these species. While *A. sturio* is listed in Annex A of Council Regulation (EC) 338/97 with Article 8 of this Regulation prohibiting trade, *A. oxyrinchus* is listed on Annex B.

6.3. Bern Convention

Since the European sturgeon (*A. sturio*) is listed as a strictly protected species (Annex II) in the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) *A. oxyrinchus* would have to be treated analogous to *A. sturio* due to the late discrimination of the species.

Each Contracting Party is required to take appropriate and necessary legislative and administrative measures to ensure its special protection and, in particular, prohibit (Article 6): "all forms of deliberate capture and keeping and deliberate killing", "the deliberate damage to or destruction of breeding or nesting sites", "the deliberate disturbance of wild fauna, particularly during the period of breeding, rearing and hibernation, insofar as disturbance would be significant in relation to the objectives of this Convention", "the deliberate destruction or taking of eggs from the wild or keeping these eggs", "the possession of and internal trade in these animals, alive or dead, including stuffed animals and any readily recognizable part or derivative thereof, where this would contribute to the effectiveness of the provisions of this article." Parties are required to coordinate their efforts to ensure the species conservation throughout its range (Article 10). They commit themselves to: "cooperate whenever appropriate and in particular where this would enhance the effectiveness of measures taken under other articles of this Convention, and to encourage and coordinate research related to the purposes of this Convention", and "encourage the reintroduction of native species of wild flora and fauna when this would contribute to the conservation of an endangered species, provided that a study is first made in the light of the experiences of other Contracting Parties to establish that such reintroduction would be effective and acceptable (Article 11)". There are two approved by the Standing Committee of the Bern Convention: The Action plan for the protection and recovery of the European sturgeon (*Acipenser sturio*) and by adopting Recommendation 116 (2005) on the conservation of sturgeon (Acipenseridae) in the Danube River Basin, asking Parties to consider drafting and implementing national action plans for the sturgeon species listed in the Appendix to the Recommendation, and to take note, in that context, of the Action Plan for the Conservation of Sturgeons (Acipenseridae) in the Danube River Basin.

6.4. Convention on Migratory Species (CMS)

The decision to include the European sturgeon (*Acipenser sturio*) in Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (also referred to as CMS or Bonn Convention) was taken in 1999, by the 6th meeting of the Conference of the Parties (COP6) to the CMS, in response to an initiative by Germany. Appendix II covers migratory species that have an unfavourable conservation status or would benefit significantly from international cooperation. As such the listing would include *A. oxyrinchus* due to the fact that the species was identified only after the listing went into force.

The Convention encourages range states to conclude global or regional agreements for species listed in Appendix II, giving priority to those species in an unfavorable conservation status. In 2005, COP8 decided to add *Acipenser sturio* to Appendix I of the CMS as well, which lists migratory species in danger of extinction (the Convention allows the listing of a migratory species in both Appendix I and Appendix II, as the obligations of Parties with respect to species listed in the two appendices are different and complementary). According to the Convention, parties are to: “promote, cooperate in and support research relating to migratory species; endeavor to provide immediate protection for migratory species included in Appendix I, including the prohibition of taking of animals belonging to such species (exceptions for research purposes are possible)”. In addition, range states of Appendix I species must endeavor to: “conserve and, where feasible and appropriate, restore those habitats of the species which are of importance in removing the species from danger of extinction”; prevent, remove, compensate for or minimize, as appropriate, the adverse effects of activities or obstacles that seriously impede or prevent the migration of the species”; “prevent, reduce or control factors that are endangering or are likely to further endanger the species, including strictly controlling the introduction of, or controlling or eliminating, already introduced exotic species”. Furthermore, Resolution 7.7 on the Implementation of Existing Agreements and Development of Future Agreements, adopted in 2002, called upon CMS Party Range States of sturgeons listed in CMS Appendices to take the lead to develop an appropriate CMS instrument on sturgeons. In 2005, Resolution 8.5 was adopted, on the same issue of existing and future agreements under the CMS. Concerning sturgeons, this Resolution urged the resumption of cooperative activities with CITES (see section below) and invited consideration of possible CMS action regarding an appropriate instrument for sturgeons. European countries such as France and Germany have given greater priority to utilizing the Bern Convention (see 7.3), as an existing instrument which permits direct agreements to be made for the protection of the sturgeon in the European range, than to adopt new instruments under the CMS.

6.5. The Convention on the Protection of the Marine Environment of the Baltic Sea (Helsinki Commission – HELCOM)

HELCOM (Baltic Marine Environment Protection Commission) is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, known as the Helsinki Convention. The Contracting Parties are Denmark, Estonia, the European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. HELCOM was established in 1974 and extended in 1992 in order to protect the marine environment and biodiversity of the Baltic Sea from all sources of pollution through intergovernmental cooperation. HELCOM’s vision for the future is a healthy Baltic Sea environment with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable economic and social activities.

The HELCOM Baltic Sea Action Plan (BSAP) was adopted on 15 November 2007 in Cracow, Poland by the HELCOM Extraordinary Ministerial Meeting. It was developed to co-ordinate and harmonise the work within the HELCOM Baltic Sea and to take into account various on-going initiatives at the international and national level, including the EU Marine Strategy Directive, the EU Maritime Policy and the Maritime Doctrine of the Russian Federation. It represents the framework to achieve good environmental status in the Baltic Sea by 2021. Specifically with the focus on migratory species, the BSAP requests the member states to classify and prepare an inventory of rivers with historic and existing migratory fish species (e.g. salmon, eel, sea trout and sturgeon) and the development of restoration plans (including restoration of spawning sites and migration routes) in suitable rivers to reinstate migratory fish species. Furthermore, the Contracting States should develop long-term plans for the protection and monitoring of the most threatened and/or declining coastal fish species, in particular anadromous ones (according to the HELCOM Red List of HELCOM Baltic Sea species in danger of becoming extinct, BSEP No. 140). In addition such plans should be used to develop a suite of indicators with region-specific reference values and targets for coastal fish as well as tools for assessment and sustainable management of coastal fish. The Baltic sturgeon, *A. oxyrinchus*, is listed on the HELCOM Red List from 2013 as regionally extinct (RE).

Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.

The so called Habitats Directive aims inter alia at the protection of species and their interaction by minimizing adverse effects on both the individuals and their life-cycle through the protection of critical habitats. This EU-Directive is among the key instruments for reaching the goals of the EU Biodiversity Strategy to halt the loss of biodiversity and habitat degradation in the EU and help stop global biodiversity loss by 2020. It is also a key instrument for reaching the global Aichi Targets of 2010 under the Convention on Biodiversity (CBD).

As the main focus of the directive lies on maintaining and/or restoring a favourable conservation status for habitat types and species of community interest, member states are legally obliged to report every six years about the progress made with the implementation of the Habitats Directive.

As the European and the Adriatic sturgeons are listed in the Habitats Directive among the priority animal species of Community Interest (Annex II), their conservation requires inter alia the designation of Special Areas of Conservation (SAC). For *A. oxyrinchus* such designations are still lacking in many Baltic Sea States, although, upon request, an in-kind acknowledgement of the species status was provided by DG Environment in 2014. The letter outlines the position that *A. oxyrinchus* is to be treated as *A. sturio* in the Baltic. The respective document is enclosed in the Annex 2 to this document. Whereas, according to the Habitats Directive, respective protection measures impose an excessive financial burden, under certain circumstances, a contribution by means of Community co-financing should be provided for within the limits of the resources made available under the Community's decisions.

For priority sturgeon species listed under Annex II of the Habitats Directive, the EU and those member states, where they occur have a special responsibility for their protection. Among others Article 6 is a key provision of the Habitats Directive, and aims to protect plant and animal species from negative effects of plans or projects. "Where the site concerned hosts a priority natural habitat type and / or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or , further to an opinion from the Commission, to other imperative reasons of overriding public interest (Article 6 (4), Habitats Directive)." The transposition of the Directive and hence this Article into the national legislation of the member states constitutes a strict obligation. Nevertheless, the European Court of Justice has ruled that lack of transposition does not free affected states from their obligations derived from this legal instrument. This includes that member states must take appropriate steps to avoid the deterioration of the habitat of priority species, such as sturgeons, as well as disturbance of those species.

Over the past decade, the Habitats Directive has been implemented primarily in relation to terrestrial and aquatic habitats. However, the peculiarities of natural marine habitats and marine species or, as in the case of sturgeon, diadromous species, have to be considered. Discussions were conducted within the European Commission to improve the implementation of the NATURA 2000 network of protected areas in the European marine environment, which led to the publication of Commission guidelines in May 2007, including: "a better interpretation of the definition of some marine habitats, establishment of selection guidelines for marine SACs, guidance on issues related to the management of such areas".

6.6. Action Plan for nature, people and the economy

Based on the findings of a fitness check of the Habitats Directives, the EU Commission has developed the Action Plan for nature, people and the economy of April 2017[1] which aims to rapidly improve practical implementation of the Nature Directives and accelerate progress towards the EU 2020 goal of halting and reversing the loss of biodiversity and ecosystem services.

Integrated action towards safeguarding sturgeon habitats is in line with Action 7 "Further develop Species and Habitats Action Plans for the most threatened species and natural habitats". This needs to take into account existing documents under the Bern Convention (see below): the Action Plan for the conservation and restoration of the European Sturgeon (*Acipenser sturio*[2]) and the Action Plan for the conservation of Danube sturgeons (Acipenseridae) in the Danube River Basin[3]. Synergies with existing national conservation strategies or plans shall be fostered, duplications avoided.

6.7. EU Water Framework Directive (WFD) (Directive No. 2000/60/EC of 23 October 2000)

The Water Framework Directive (WFD) sets ambitious environmental targets, aiming for "good status" of all freshwater, transitional and coastal water bodies, as well as for groundwater, the latest by 2027 and introduces the principle of prevent-

1 Brussels, 27.4.2017 COM(2017) 198 final

2 https://rm.coe.int/168074646f

3 https://rm.coe.int/1680746946

ing any further deterioration of status. Ecological status assessment[4] in the WFD focuses on selected references for aquatic plants and animals and these are used as indicators to determine the overall structure and functioning of the aquatic ecosystem. The directive requires Member States to identify river basins in their territories, assign responsible authorities, assess and monitor the status of the river basins and produce and implement river basin management plans (RBMPs) as well as programs of measures to fulfil the objective of the directive.

Annex V of the WFD lists "composition, abundance and partially age structure" of a water body's fish fauna among the key elements for classifying the ecological status of surface and transitional waters. In this context, monitoring of the status of the sturgeon populations may become a valid component when assessing the overall status of migratory fish in the various river basins of its historical distribution area in the EU once the restoration has been started.

The normative definitions included in Annex V define good ecological status (GES) as meaning "only slight changes in species composition, abundance and age structure from type-specific reference condition communities". WFD and GES can only be employed as drivers for restoration measures where it can be proven where the sturgeon did form part of the pristine, historical reference condition. This is undoubtedly the case for the Gironde, the German Rivers Elbe and Rhine and their tributaries and possibly for several others such as the Portuguese, Spanish and some Italian rivers. It is therefore vitally important that range States within the EU do develop robust historic distribution databases. With time, this may well add other situations to those listed above. The WFD also states that its implementation must achieve compliance with the environmental objectives laid down in other EU legislation for protected areas, notably under the Habitats Directive. As the European sturgeon is a priority species listed in the Annexes of the Habitats Directive, the achievement of a favourable conservation status for this species would be an important indicator for successful implementation of the WFD.

Due to their complex life-cycle and long life span, sturgeons form an excellent indicator for the ecological status of rivers and coastal waters. River Basin Management Plans in remaining or prospective sturgeon spawning rivers should therefore include measures for sturgeons as long-distance migrators, which is currently neglected in some basins. Wherever possible, exchange of monitoring results under the Habitats and Water Framework Directives should be arranged in order to save resources and provide for a comprehensive assessment of the status of sturgeon populations and their habitats. This is also advisable in a transboundary context.

4 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Annex 5; COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE (2000/60/EC), Guidance Document # 13, Overall Approach to the Classification of Ecological Status and Ecological Potential

6.8. The Marine Strategy Framework Directive (MSFD)

The Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishes a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

As most sturgeon species are diadromous and repeatedly spawn in freshwater while migrating over long distances to and in marine areas for feeding in certain phases of their live cycles, conservation efforts have to include marine and coastal habitats. The Marine Directive aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. It is the first EU legislative instrument related to the protection of marine biodiversity, containing the explicit regulatory objective that "biodiversity is maintained by 2020", as the cornerstone for achieving GES. Member States shall, in respect of each marine region or sub-region concerned, identify the measures which need to be taken in order to achieve or maintain good environmental status, as determined pursuant to Article 9(1), in their marine waters.

6.9. Community regulation concerning Common Fisheries Policy (CFP)

Regulation (EU) No 1380/2013 on the Common Fisheries Policy sets the framework for the exploitation of living aquatic resources including anadromous and catadromous species during their marine life. The CFP aims to ensure that fishing and aquaculture are environmentally, economically and socially sustainable and that they provide a source of healthy food for EU citizens. It is taking into account the impact of fishing activities on the environment. The precautionary approach to fisheries management is applied as a strict prerequisite, taking sound management measures to conserve target species, associated or dependent species, as well as non-target species.

The Common Fisheries Policy and the control regulation require EU Member States to ensure sustainable exploitation, management and conservation of marine biological resources and the marine environment including reduction of capture of endangered, threatened and protected species and enforcement of measures against IUU in European waters.

As stated in the Pan European Action Plan on Sturgeon (PAN-EUROPEAN ACTION PLAN FOR STURGEONS 2018)t To achieve sustainability objectives, the EU Council must establish Community-specific measures to reduce the impact of fishing activities on marine ecosystems and non-target species (chapter II, article 4, item (g), indent (iv) of the 2002 Regulation). Therefore, sturgeons should not be ignored in these considerations, despite the fact that commercial harvest of the different species is not permissible due to the poor conservation status. Applying the precautionary approach, all measures possible have to be employed to ensure that bycatch is prevented to facilitate a recovery of these population.

6.10. Council Resolution concerning alien and locally absent species

The Council of the European Union adopted Regulation (EC) No 708 in June 2007, concerning the use of alien and locally absent species in aquaculture. This regulation aims to better control the introduction of non-native species in aquaculture in order to prevent negative impacts on native species and ecosystems. This regulation builds on the voluntary Codes of Practice developed over the past decades by intergovernmental organisations such as ICES (International Council for the Exploration of the Sea), EIFAC (European Inland Fisheries Advisory Commission of FAO) and IOE (International Ofice of Epizooties). For further information consult the website.[5]

6.11. Communication from the Commission: Our life insurance, our natural capital: an EU Biodiversity Strategy to 2020 (COM(2011) 244)

The EU Biodiversity Strategy aims to halt the loss of biodiversity and ecosystem services in the EU and help stop global biodiversity loss by 2020. It reflects the commitments taken by the EU in 2010, within the international Convention on Biological Diversity.

In practice: In 2011, the EU adopted an ambitious strategy setting out 6 targets and 20 actions to halt the loss of biodiversity and ecosystem services in the EU by 2020. The mid-term review of the strategy assesses whether the EU is on track to achieve this objective. It shows progress in many areas, but highlights the need for much greater effort.

On 16 December 2015, the Environmental Council adopted Conclusions on the mid-term review of the EU Biodiversity Strategy to 2020 and on 2 February 2016, the European Parliament adopted a Resolution on the mid-term review of the EU Biodiversity Strategy to 2020.

6.12. Marcoregional Strategies

Three of the EU's currently four ‘macroregional strategies’ support implicitly or explicitly sturgeon conservation. They serve as cooperation platforms connecting several policies and helping to identify possible funding sources.

The EU Strategy for the Danube Region (EUSDR) specifically mentions sturgeon conservation as a target in Priority Area 6 (Biodiversity) and Priority Area 4 (Water).

The way the objective of sturgeon conservation has catalyzed policy integration under the EUSDR and made tangible the benefit of cooperation can serve as inspiration to the Baltic Sea and Adriatic strategies and mobilize action for sturgeon conservation across Europe.

6.13. National protection status

- Denmark: Not listed yet, *A. sturio* is listed as native.
- Estonia: listing *A. oxyrinchus* as native species in progress by 2018, RED List status: *A. sturio* is listed as regionally extinct, *A. sturio* is protected under nature protection law and all sturgeons under fisheries law.
- Finland: Not listed yet, *A. sturio* is listed as native.
- Germany: *A. oxyrinchus* is listed as native, red listed as missing, protected by nature conservation law and federal states fisheries laws.
- Latvia: *A. oxyrinchus* not listed yet. Only *A. sturio* is protected. Discussions are ongoing with the Ministry of Agriculture about protection measures for *A. oxyrinchus* and which regulation must be changed for *A. oxyrinchus* protection.
- Lithuania: Legislation changed in 2011 and 2012. *A. oxyrinchus* is considered native, it is red listed as extinct, and is strictly protected.
- Poland: *A. oxyrinchus* is listed as native species since 2017, listed in Red Book as EX (extinct).
- Russia: Not listed yet, *A. sturio* is listed as native and is considered CR.
- Sweden: Not listed yet, *A. sturio* is still listed as native.

5 http://eur-ex.europa.eu/LexUriServ/site/en/oj/2007/l_168/l_16820070628en00010017.pdf

7. Population remediation strategy

Sturgeons are affected by a variety of impacts, as described above. The main impacts that are to be addressed by the restoration strategy have to focus on the following list.

There are five primary impacts upon the survival and reproductive efficiency (ranked in approximate order of importance):

1. Accidental catch (bycatch) and illegal fishing (poaching) which is particularly detrimental because of inappropriate fisheries management and lack of enforcement of regulations;
2. Drastic changes of hydrological and hydrodynamic regimes in rivers and estuaries (sand and gravel extraction, dyking and channelization, hydrodams and barriers for navigation);
3. Environmental pollution (agricultural, domestic and industrial wastes in rivers and estuaries);
4. Low mating probability due to very small size of the remaining population (Allee effect);
5. Interspecific competition with allochthonous species.

For the implementation of sturgeon conservation actions four main adverse impacts are challenging:

1. Limited knowledge of species-specific habitat requirements,
2. Adverse impacts of habitat alterations and potential counter-measures against habitat loss, in particular in the marine environment,
3. Dispersal of the a very small population over a very large area from the Gulf of Finland to the English Channel;
4. Dependence on the *ex situ* brood stock; potential risk of altered environmental conditions due to climate change.

The remediation approach is based on the insight that for long distance migrants, the measures for recovery must be harmonized between the range countries. This AP is intended to be realized in a joint fashion between the range countries of the Baltic Sea under the inclusion of the OSPAR countries for outreach. The objectives and actions of the AP target different stakeholder groups and implementing agencies. While a variety of actions are directly addressed to the managers and scientists involved in the program, others are focusing on the administrative or the political level.

The success of the restoration attempts depends upon the timely and harmonized application of a variety of measures to control and eliminate the factors that caused the population decline, while at the same time establishing sufficiently strong year classes for future spawners that are to sustain the future generations of wild sturgeon. Depending upon the local drivers and conditions, the various aspects of the AP implementation vary largely between river catchments and countries. As such, not all objectives are equally relevant or important for the range states.

The development of a broodstock for instance is a common objective that requires massive effort. As such the optimal solution is a joint utilization of the broodstock maintained in 3 units to ensure long-term safety and sufficient backup potential to minimize risk of fatal losses. In contrast rearing for release has to be carried out locally to allow the adaptation of the fish to the conditions of the recipient waters and ensure homing. *In situ* measures largely depend upon the local conditions. As such the applicability of the measures outlined is case-sensitive and are influenced by the prerequisites in the different member states. In contrast, the stakeholder involvement (e.g. of fishermen with the aim to reduce bycatch and accidental mortalities, volunteers to support the activities, the navigation and hydropower sector to apply adaptive management) is a common approach to be implemented in all range countries although having to consider local peculiarities. The effectiveness of this measure is vital for the long-term success of the restoration since the information and understanding of stakeholders determine their norms and responses. As such effective dissemination of project information and active involvement of stakeholders and the general public are essential to gain their support.

In the following text, the general outlines of different measures are described. Detailed information on the measures, actions and indicators of progress as well as the prioritization of the implementation and its duration are summarized in Appendix 1. In cases where the implementation will be reached only after the formal termination of this AP, the actions are considered a carry over into the next plan.

7.1. *Ex situ* measures

obj.1

7.1.1 Objective 1: Actively support the recovery of the target populations to initiate a positive population trend.

#1

7.1.1.1 *Action 1: Ex situ broodstock development of Acipenser oxyrinchus*

Ex situ conservation is the maintenance of a genetic resource under controlled conditions in order to prevent further loss of biodiversity. In this case the *ex situ* stock is based upon the closest genetic similarity, utilizing the historic founder population of the Baltic sturgeon populations (Ludwig *et al.* 2002, 2008, IUCN 2014, Popović *et al.* 2014).

Target

For the recovery of the Baltic sturgeon the release of juveniles to establish a population is a key measure. In order to produce these fish for release the *ex situ* measure is unavoidable prerequisite for the restoration of the species since the wild population is considered extinct preventing its recovery through *in situ* measures only.

Implementation

Safeguarding of the broodstock is an essential element since most of the project concrete conservation actions depend upon it. In order to achieve this aim, imports of wild fish originating from Saint John River as well as F1 from the source population and fish deriving from reproductions since 2011, which are subsequently maturing, are reared in the different sites in the range countries as a failsafe measure. The maintenance of the fish under controlled conditions is required to increase the effective stock size in the short- and mid-term.

The rearing conditions and its relation to the source or founder population has been set in place under due consideration of the ICES Code of Practice (ICES 2005) and the respective IUCN reintroduction and *ex situ* guidelines (IUCN 2002, IUCN 2014). As such the broodstock currently under development is the only means to reduce the dependence from the source population in Canada and to minimize the impact upon this population.

The restoration efforts in the range states have already led to the establishment of a large and diverse future broodstock in captivity. This will be sufficient to provide the material for release for the near future. This valuable resource has to be maintained to ensure the continuation of the program. To achieve the objective of establishing a viable population of *Acipenser oxyrinchus* in the Baltic Sea area, the existing broodstock must be further expanded to reflect the founder population diversity. The rearing conditions for the broodstock are subject to adaptive management and should be optimized with regard to the safety and welfare of the fish.

Figure 14: *A. oxyrinchus* juveniles in rearing environment © S. Hennings 2016

Impact

The broodstock establishment is the essential prerequisite for the long-term effectiveness of the release programs. A sequence of measures is required to achieve the objective.

Measures

- Establish and expand existing broodstock as a founder population for subsequent release.
- Characterize all individuals of the broodstock genetically, applying harmonized methodology, as a prerequisite for the comparison with the wild donor stock and for the implementation of a genetic breeding plan with the aim to maximize genetic diversity.
- Improve cultivation methodology to optimize survival rates.
- Improve growth and prevent diseases specific to fish kept in captivity.
- Optimize diet composition and feeding regimes according to the requirements of life-cycle stages.
- Implement appropriate risk management systems to safeguard cultivation.
- Establish a sustainable health management system.

#2

7.1.1.2 *Action 2: Controlled reproduction and rearing for fitness*

Maturation of broodstock under controlled conditions provides the opportunity to obtain gametes of both sexes for fertilization with as little mortality as possible while maintaining the genetic heterogeneity through the implementation breeding plans. The resulting offspring is to be provided with optimal conditions for its development and growth to sizes suitable for release. While the approach is designed to minimize mortalities it has to ensure that the fish reared are developing the skills to survive in nature after their release.

Therefore, hatchery operations must be adapted to "fitness for survival"-strategies rather than commercial rearing practices. The performance of the offspring is subject to a continuous monitoring to implement rational improvements in rearing practice.

Target
Mate choice, near natural fertilization and incubation, maintenance of genetic diversity, preventing in and outbreeding, rearing of fish under conditions that allow the effective adaptation to natural conditions after release is the guiding principle of this objective. The methodology of such rearing methods still is in its infancy and will be developed throughout the process in an approach that utilizes the adaptive mismanagement approach. Harmonization of the methods, based upon the results obtained is an important tool in this endeavor.

Implementation
Controlled reproduction and rearing with the aim to maximize fitness for survival in the offspring must be based upon the results of current research and practice. The reproduction and rearing techniques are to be adapted to provide near natural conditions with the most relevant cues to produce nature-like offspring with high behavioral plasticity and fitness. At the same time they are to minimize mortalities in order to provide sufficient numbers of fish for subsequent release. These attempts need to be harmonized and accompanied by in depth monitoring on the drivers of the adaptive processes.

The reproduction, fertilization, incubation, and rearing should develop a best practice approach, implementing the FAO Guideline (2011) through adaptive management and subsequent improvement of existing facilities. As such the rearing must ensure the adaptation of the fish for the subsequent releases.

Impact
The production of high quality offspring is essential for the release and thus population establishment depends upon the successful implementation of this task.

Measures
— Develop rearing practices of spawners that promote mate choice.
— Adopt fertilization and incubation techniques in order to meet the biological requirements of the species and renders these close to natural.
— Develop methods for gamete quality assessment to allow optimal control of the maturation process.
— Rearing of eleutheroembryos during the yolk sac phase must implement state of the art approaches to develop best practice methods, considering the behavioral peculiarities of the species.
— Rearing conditions for early juveniles must be designed to ensure proper development and maximize behavioral plasticity and fitness in the fish, rendering them fit for survival in the wild by providing sufficient swimming capacity, predator recognition and adaptive potential and imprinting for homing.
— Quality criteria have to be established for fish to be released and their application for release preparation must be ensured.
— A health management system is to be developed to ensure fish welfare in a competitive environment utilizing suitable fish density, oxygen level, flow rate and diverse current velocities, light regimes and temperatures to promote responsiveness to environmental change. At the same time productivity and growth of the fish as well as controlling pathogen prevalence have to be verified.
— An appropriate risk management system to safeguard egg incubation and juveniles rearing must be implemented to prevent losses through technical or human error.

#3

7.1.1.3 Action 3: Release of *A. oxyrinchus* for population re-establishment and enhancement

The goal to re-establish self-sustaining populations in as many areas of the natural range of the Baltic sturgeon as possible under the current situation requires the release of reared juveniles to develop populations of fish that are large enough to sustain themselves in the long-term.

These releases comprise all activities between leaving the hatchery and being introduced in the natural environment. These releases have to be (a) substantial in number because of the high natural mortality, (b) long-lasting (for decades) because of the late sexual maturation of the species and its extreme longevity, (c) establish and apply river specific, appropriate "time-size-release windows" and (d) utilize habitats of strategic importance for reproduction, nursing and ongrowing in order to meet the requirements of the fish released.

Target
The release is one of the key operations that impact the future population size. As such the releases must be highly effective to prevent excessive mortalities due to maladaptation, stress or predation. The measures must be carried out in a way to ensure high survival and quick adaptation for natural conditions.

Implementation
The selection of rivers and release sites is based upon historic range and the quality assessments carried out in the preparation phases. In order for the release to be effective, fit stocking material, appropriate transport techniques, proper adapta-

tion to the environmental conditions in the receiving water body, as well as the selection of appropriate distribution and introduction methodology are essential for the success of the measure. As such the releases as all other activities are subjected to consistent monitoring to verify the performance and improve its outcome. This includes the size of the fish at stocking, the application of transport and release techniques as well.

Impact
Since the future population size is determined through the survival of the year classes subsequently released, the success of the measures directly impact the chance for success and the duration of the releases until self-sustaining populations are established.

Measures
— Select suitable river basins and the critical habitat that is suitable for restocking.
— Prepare management plans (including designation of responsibilities, e.g. responsible authority, monitoring, surveillance of success), for the re-establishment of populations in those rivers.
— Develop and apply marking techniques and establish monitoring programs to determine the success of the release programs.
— Establish best practice guidelines for the transport, handling, time of release, release practices with regard to target densities and habitats to be stocked
— Establish the optimum time-size-release window for juveniles allowing best survival and rates of return.

Figure 15: Juvenile *A. oxyrinchus* following release © J. Gustafson 2017

7.2. *In situ* measures

The *in situ* measures comprise all measures to be applied in order to improve the status of the species in its natural environment. These include protection of the species from human activities and interventions such as fishing, introduction of new allochthonous species, while at the same time addressing the prevention of the degradation of sturgeon habitats through agriculture, wastewater discharge, cooling water impacts, inland navigation, and flood protection as well as hydropower and coastal development. Thus the *in situ* protection includes the proper management and protection of critical habitats and migration corridors.

obj.2

7.2.1 Objective 2: Protect the populations under recovery from accidental and directed removal of individuals

#4

7.2.1.1 *Action 4: Significantly reduce by-catch mortality*

In order to protect the Baltic sturgeon in its natural habitat, legal measures are implemented in national conservation or fisheries legislation in most range countries. These measures in general comprise the assignment of protected areas under Natura 2000. In several countries sturgeon, due to its status as being extinct, was not considered in the Natura 2000 process. Despite this drawback, in a variety of Baltic Sea states protection of the species from commercial or recreational fisheries activities has been ensured. The extent of compliance with the regulations is known only to a low degree range countries. Based upon direct interviews that partners collected and anecdotal evidence, fishermen comply to regulation only to a limited degree. Active collaboration with regard to sturgeon by-catch reporting is even less frequent.

Modeling results (Jaric & Gessner 2014) demonstrate that without legal protection and adequate compliance by fishermen reintroduction efforts cannot be successful in the long-term. Thus this Action is critical to the overall success, and will quantify the current status of fisheries interactions with reintroduced sturgeon while improving two-way communication, reporting, and bycatch mitigation.

Avoiding losses due to fisheries-related mortality is one of the most important prerequisites to protect the populations under restoration *in situ*. The resulting mortality can be differentiated according to the three main drivers:

1. Accidental bycatch in fishery operations targeting other target species, resulting in mortalities due to extended soak times of the nets, or fatal mesh sizes that strangulate the fish;

2. Ignorance of the legal framework resulting in harvest of protected species for curiosity;
3. Poaching and illegal marketing of protected species as a result of insufficient enforcement.

Target

Since fishery associated mortality and overharvest have been the main driver in the decline of the species, the mitigation of fisheries related impacts is paramount for the long-term success of the restoration attempts. As such a high level of awareness and support from the fishery sector are crucial to the success of the Action Plan.

Measures must include, for example, a program to reduce accidental catches and *in situ* monitoring. Except from increased efficiency of the fishery inspections in preventing illegal killing of sturgeons in the fishery, the most important measures to be carried out is communication with the stakeholders to a) increase the awareness, b) facilitate increased compliance and c) accurate reporting of by-catch. Along with the awareness-raising, it is essential that trust building through the long-term active contact establishment takes place to ensure open communication also of drawbacks and problems encountered in the fishery. The recent experience in France and in Germany clearly demonstrates that this is possible, provided that the effort is consistent and long-lasting.

Along with the communication activities, monitoring of the effects of the measures is essential to adapt measures accordingly. Also, the data acquisition from fisheries with regard to gear selectivity, encounter probability etc. is essential to plan and implement countermeasures where necessary. These can include altered release strategies, gear modifications, the implementation of closed seasons or areas for essential habitats but mainly are focused on the deliberate release of by-catch since sturgeon have an exceptional tolerance and survival in commercial fishing gear. Therefore, what is most important is the active support of the fishery sector.

Implementation

The implementation of the measures is to be carried out jointly with fisheries inspections and project staff to reach maximum consistency and effectiveness.

Impact

Due to the massive potential impact of fisheries this objective has high relevance for the overall success of the activities in total, especially on the establishment of self-sustaining populations.

Measures

- Intensively involve and provide further training for professional and recreational fisheries to significantly reduce mortality due to accidental catches.
- Raise public and stakeholder awareness about the threat to and protected status of *A. oxyrinchus*.
- Enhance cooperation of fishermen and fisheries inspections to increase awareness of the protection status of the species.
- Carry out information workshops to increase awareness and compliance of the key stakeholders and to change their norms and beliefs.
- Develop incentives to promote release and accurate reporting.
- Monitor *A. oxyrinchus* by-catch and by-catch mortality to identify threats timely and to use the data for population and range assessments
- Develop and introduce selective fisheries techniques, and exclude non-selective clearly adverse fishing techniques in critical habitats of *A. oxyrinchus* (spawning sites, juvenile aggregations, nursing grounds) in inland waters and if necessary in marine waters (feeding aggregations, wintering sites).

#5

7.2.1.2 *Action 5: Monitor population sizes and structure to facilitate timely and continuous detection of adverse impacts*

In order to enable the program coordinators and managers to apply adaptive management strategies the effect of the measures carried out to improve the status of the species in question need to be properly assessed. The monitoring can be structured into three phases. During the first phase following the release and the initiation of a self-sustaining population, the habitat use and the migration of the fish is of major importance along with the determination of the post release mortality. The second phase primarily focusing upon the population size and structure to assess the result of the release strategy. The third phase also seeks to identify the number and condition of returning adults as well as their effectiveness in reproduction and the subsequent recruitment.

Target

Adverse impacts are to be identified in all three phases to be able to adapt management to increase the chances for success.

Implementation

For the initial phase, telemetry approaches are recommended for the determination of migration routes and mobility. For the population assessment and the determination of performance following the release, fisheries approaches are suited best to obtain qualitative and quantitative data. The same holds true for the third phase of the monitoring although a combination of catch and telemetry approaches might be beneficial for the spawners.

Provided that the fuding for the manpower and the equipment required are available the monitoring should be carried out bey a fisheries management entity or a research institute. It is important to develop a design for the monitoring that would provide consistent time series of data to follow up the population development but which at the same time allows for improvements. A standard procedure will be developed by the WSCS within the next two years, specifically for sturgeons.

Impact

The activity produces a wide outreach for the rearing and release activities, the habitat assessment and the habitat protection oriented objectives as well as for the fisheries management. The results serve to fine-tune future operations and approaches towards limiting the adverse effects upon the fish population under development.

Measures

— Develop a comprehensive monitoring plan for the follow up of release.
— Integrate the monitoring with the rearing trials to be able to verify effects of changes in rearing practice.
— Allocate sufficient funding to enable the team to collect a sufficient amount of good quality data to be able to apply adaptive management.
— Implement a joint telemetry study approach with the neighbouring countries to allow to detect out of reach migrations.
— Set up a joint marking guideline to ensure proper identification and assignment of incidental captures.
— Harmonize monitoring approaches in range states to be able to compare the outcome of the releases and ease the identification of drawbacks through comparative approaches.
— Identification of locations and extend of losses through water abstraction.
— Implementation of avoidance measures for water abstraction facilities.

Figure 16: Illegal utilization of Baltic sturgeon (dried skin on display) © M. Skora

#6

7.2.1.3
Action 6: Eliminate illegal trade of all sturgeon products

Illegal catch and commercialization of native (e.g. fish under a restoration program) sturgeons does occur as a result from illegal, uncontrolled and unreported (IUU) fishing as well as from the utilization of bycatch (for instance after mortality of the respective fish).

Since caviar and sturgeon products are expensive and rare, commercialization of illegal catch feeds into the market chain of illegal trade. As such, combating illegal trade reduces the outlets for illegal produce and thereby reduces the pressure on the natural stocks of sturgeons in the different populations under pressure and under recovery.

Target

Control of illegal trade plays a major role for the future protection of the native Baltic sturgeon in preventing the criminal structures to establish or in most cases to persist. As shown in a recent report (Jahrl & Rosenthal 2017) illegal trade of sturgeon products still is a major threat to the remaining populations. In the near future the same fate is foreseeable for returning Baltic sturgeon if not prevented efficiently. But in the case of the Baltic sturgeon not only the illegal caviar trade but also the illegal marketing of sturgeon meat threatens the recovery of the populations. In the early phases of the recovery programs illegal catches and sales of released sturgeons have been documented for live fish, fish for human consumption as well as for decorative purposes (Figure 16). Enforcement in all cases has been proven insufficient. Too little resources and too little political will are directed towards the issue that is indicative for IUU fishing in coastal waters. To counteract these attempts both improved communication and increased enforcement are urgently required to prevent further establishment of such detrimental habits. Therefore, direct removal of individuals must be eliminated basin-wide. Structures involved in illegal caviar trade have to be targeted as future channels of illegal harvest and sales.

— All targeted fishing of sturgeon species is to be prohibited until viable populations are established. Fisheries inspections and respective authorities must increase the communication and the enforcement drastically to also reduce bycatch mortality through identification of local and temporal occurrence of bycatch and its impacts.

- Strengthen or implement enforcement of existing legislation to prevent IUU fishing.
- Identification of management options (technical solutions, fishery restriction, closed areas, closed season) and gear modifications to reduce bycatch.
- Implementation of bycatch avoidance measures.
- Monitoring of compliance and adaptive management.
- Implementation of CITES trade control measures including the improvement of controls, labels etc (see WWF strategy).

Implementation
Increased awareness of fishermen is to be facilitated by concerted communication of project personnel, fisheries inspection and respective administration. As a preventive measure to avoid future illegal fishing for caviar, the illegal trade in caviar is closely surveyed and appropriate enforcement is put in place, including the establishment of identification techniques for species and source of caviar samples. Harmonized approaches between the agencies involved in illegal trade (customs, environmental agencies, fisheries inspections, and food safety administration) a concerted approach is developed throughout the range countries, including a real time reporting on the TWIX database.

Impact
Increased enforcement effectiveness and public information increases the awareness on the importance and value of the sturgeon populations while at the same time alters the perception of poaching. As such the measure directly benetfits the EU AP on combating illegal wildlife trade as well as the protection of the stocks under development, reducing the effort (amounts and time required) for supplemental stocking.

Measures
- A stakeholder survey is carried out to determine the target groups of the communication campaign.
- Diagnostic tools are established to differentiate species and origin of caviar and sturgeon products.
- Coordinated approaches for controls and seizures are agreed upon among the relevant authorities and enforcement agencies.
- Attitudes and mindsets of actors are analyzed in a scientific study.
- Target oriented communication campaigns are developed, tested, refined and implemented.
- Enforcement is massively increased and fines are adapted to a level reflecting the value of the fish based on the conservation program not on the price of the respective commodities.

obj.3

7.2.2 Objective 3: Protect and restore where necessary critical sturgeon habitats

#7

7.2.2.1 *Action 7: Habitat identification and assessment measures*

Sturgeon habitat utilization varies with life phase. Sturgeons spawn over gravel substrate in fast currents utilizing typical erosion-deposition or pool-riffle reaches with sufficient water depth as preferred habitat to deposit the fertilized eggs and for early embryonic development. First feeding requires areas of sufficient production mainly of worms and insect larvae further downstream. This initial downstream migration continues, utilizing the deep productive reaches of the rivers during the juvenile development and results in the outmigration of the 1-4 year old juveniles into the coastal waters and beyond with increasing sizes. In coastal waters, sturgeon stage in low to moderately deep water of up to 20 m but can go as deep as 200 m.

Habitat utilization might be different depending upon the characteristics of the rivers and therefore should be determined through appropriate methods. Habitat surveys are an important prerequisite for the reestablishment of the species since they help to determine the carrying capacity. As such habitat quality plays a major role for the effectiveness of the restoration measures.

Targets
Habitats historically utilized by *A. oxyrinchus* as spawning and nursery grounds in riverine and coastal waters have been modified and information on their status and options for rehabilitation is scanty. There is an urgent need to improve the knowledge base on the subject while also addressing issues concerning habitat fragmentation and needs for interconnections (“ecological footsteps”). Overviews on the availability of the habitats of different life phases as well as the options for their improvement are key data to manage them most effectively. The large overlap of sturgeons with typical riverine and migratory fishes promises additional benefits from appropriate implementation of habitat management.

Habitat assessments can use a variety of hydrobiological methods depending upon the habitat type and function to be investigated. The data required for the assessment reach from flow measurements to granulometry and from water quality to benthic community assessments. Also information on the composition and population characteristics of the fish fauna can be a good predictor of the problems that are encountered.

Implementation
Since most of the data required are obtained in standard monitoring processes for instance in Natura 2000 areas, the river management institutions are commonly in charge of such assessments. Close collaboration and communication helps to address the prerequisites of the species related assessment.

Impact
Since habitat quality and abundance is a key feature influencing the capacity of the river system to produce and maintain fish, this objective has outreach upon the maximum amounts to be stocked, as well as on the population establishment. The results obtained under this objective have a direct outreach into Objective 2.

Measures

- Determine and assess critical sturgeon habitat, its quality and accessibility as well as adverse impacts.
- Assess habitat utilization and resulting deficits of habitats for different life phases.
- Identify drivers for habitat use and essential habitat properties.
- Determine carrying capacity and potential for improvement.

#8

7.2.2.2
Action 8: Protect and restore essential riverine and estuarine sturgeon habitats

Due to past and ongoing habitat alterations as a result of ongoing infrastructure developments being implemented with too little concern for the indispensable requirements of aquatic species and communities, the pressure on rivers and their estuaries is steadily increasing. In order to reverse this trend, the integration of hydrodynamics into the development targets of river management plans is essential for the safeguarding of critical habitats and habitat functions. Rivers are disturbance driven systems that require temporal successions of hydrological conditions to maintain their key characteristics. There should be a particular focus on maintaining ecological functions such as the lateral and longitudinal connectivity of river systems, free up- and downstream passage (including that of sediment) as these constitute the main freshwater ranges.

Sturgeons utilize a large number of different habitats during their life cycle. Spawning habitat has specific characteristics that differ from the habitat of yolk-sac larvae and these again differ from first feeding sites (which are poorly known). During downstream migration, the macroinvertebrate community composition is the main key for the acceptance of in-river, main channel habitats for juveniles. Similarly late juveniles, subadults and adults utilize typical habitats on their search for prey. As such, aggregation areas and key habitats require the protection from adverse impacts. Where these habitats have been lost, restoration of habitat is required to help complete the life-cycle of the species. This holds true also in cases where the remaining habitat is insufficient to allow the species to self-sustain its population.

Targets
Results of the migration and habitat utilization assessments are essential for activities associated with the reintroduction of sturgeon in the Baltic Sea area. They serve as background information on which to base management measures related to fisheries. Furthermore, the information can be vital to differentiate between sturgeon-used and avoided river sections through in-depth research on hydro-morphology and faunal composition. As such, these data are also of high relevance for habitat remediation measures under the framework of the WFD. The information on migration patterns and criteria for habitat selection are of utmost importance to design effective measures that account for linear and lateral connectivity. The action will be carried out to determine the patterns of migration and habitat use by juvenile sturgeon in nature reserves and Natura 2000 areas. Implementation of the task is important due to determination of the presence of sturgeon in nature reserves and Natura 2000 areas and that current management plans for these areas also provide protection for sturgeon. Data from the monitoring will also be used to improve the release of juvenile sturgeon.

Identify the critical life phase habitats, assess their sizes, and implement a protection protocol to prevent hydromorphological deterioration of the habitat function rather than the specific location since habitat features in a dynamic system might be dislocated over time.

Implementation
Habitat utilization and habitat assessments are carried out by research institutions and regional agencies. Protection in the catchments of shared responsibility has to be enforced by the legal entity in charge of the respective site. A close communication with inland navigation and water management authorities is essential to prevent any adverse impacts through construction or upstream retention of flow.

Impact
The availability of critical habitats in sufficient sizes is determining the carrying capacity of the catchment. As such, the full protection and where necessary the restoration of habitats is a prerequisite for the success of the release actions and the subsequent establishment of self-sustaining populations.

Measures

- Based upon the result of Action 7 key areas of critical importance for the population development are identified and the potential conflicts with other uses are determined.
- Mediation of user-conflicts is implemented effectively to develop adaptive use of habitat features.
- Essential habitats are characterized and their developmental potential assessed.
- EU MS should describe self-sustaining habitats and habitats providing key functions with the need for improvement or undergoing restoration processes in the WFD targets (this could include discharge dynamics for habitat revitalization such as increased inundation and floodplain reconnection, reconnection of backwaters and side channels to increase habitat diversity, restoration of gravel banks, reduction of sediment transport to avoid culmation, reduction of mobile sediments to increase macrozoobenthos abundance and stable soil structures, lateral erosion and dynamic channel development), while measures to be taken to reach these targets for recovery are to be defined in the River Basin Management Plans in detail.
- Restored and protected habitats are monitored to ensure proper quality and to allow adaptive management.

#9

7.2.2.3
Action 9: Effectively control the introduction of allochthonous species

Allochthonous species are animals with a range outside of the Baltic Sea catchment which are transferred into the range countries either by vectors or are deliberately released to enhance fisheries yields or diversity. The release of allochthonous species must also be considered a potential threat, since their introduction may have negative effects on the native species, populations and the ecosystem as has been shown by Leppäkoski *et al.* (2002). In this treatise the authors clearly demonstrate the overall long-term impact exotic species can have on trophic interactions, particularly expanding during warmer summers (i.e. climate change).

Further, diseases may find new hosts and may also proliferate because of lack of pre-exposure with subsequent resistance as has evolved with native disease agents. Besides these overriding implications, exotic sturgeons may also exhibit the potential for hybridization and potentially this can occur between all sturgeon species. As a result, different risks at species level are potentially encountered such as hybridization in species with similar ploidy level, or sterile offspring due to different levels of ploidy in mating specimens (Kozhin 1964). These escapes provided a serious difficulty for inland fishermen or anglers, who now have to be able to distinguish between different sturgeon species, one protected and the others requiring removal.

Invasive non-indigenous species pose a critical threat to the faunal composition of an area, a fact of equal importance to the loss of native species for biodiversity. The present rate of increasing reports of exotic sturgeon species (including hybrids) within the native range of *A. oxyrinchus* is alarming, as these non-native species may negatively affect the integrity of ecosystems in which the native sturgeon thrives, either competing for habitat and food resources but also increasing the chances for pathogen transfer and hybridization.

Target

There are four potential sources of introduction of exotic sturgeon in Europe:

- Fish are released by aquarium and garden pond hobbyists who want to get rid of overly large specimens,
- Sport fishing clubs deliberately wish to add sturgeons to their trophies and release fish deliberately,
- Escapes from fishponds and farms happen accidentally, and
- Illegal stocking by others has also been observed (Britton & Davis 2006).

To prevent the spreading of exotic species in natural, open water bodies is taking place through various vectors. Countermeasures in international traffic progress slowly. Anyhow the spreading of exotic sturgeon species from aquaculture and aquarium trade can be restricted more easily, which would reduce the threat to the newly established Baltic sturgeon populations arising from pathogen transfer and hybridization, disintegrating the species properties and adaptations. Some sites are not fully secured and escapes often occur, especially during floods. Also, many releases originate from hobby aquaria when fish are becoming too big. The number of records of non-indigenous sturgeon species in coastal and estuarine waters has been reported to increase (Spratte and Rosenthal 1996, Arndt *et al.* 2000, Arndt *et al.* 2002, Skóra *et al.* 2018).

Implementation

Increased safeguarding and its enforcement in rearing facilities is an easy way to minimize the escapement for instance through the use of suitable sized screens are adapted outflow designs. Flood protection also plays a vital role as it is limiting economic losses for the farms as well as the adverse impact upon the ecosystems. In aquarium trade, increasing awareness and at the same time providing legal solutions for the elimination of undesired or too big individuals for instance through internet portals would be an easy means to reduce the dimension of these activities.

In addition, the effective prevention of deliberate releases of exotic species involves fisheries managers as well as anglers and aquarists. As such, increased efforts to increase the level of information on the adverse effects of such releases are urgently required as well as increased enforcement.

Establishment of stricter rules for the prevention of escapement from fish farms such as additional screens, wastewater disinfection, flood prevention and mitigation have to be established in close alliance with the IUCES Code of Practice (CoP) (ICES WGITMO 1997). The implementation of the measures depends upon a strict enforcement by the fisheries inspection in close cooperation with the veterinarian agencies.

Impact

The accidental and deliberate releases are a major source for larger numbers of exotic fish species in open waters. As such the countermeasures need to be increased to minimize the extent and subsequently the potential effect of this misconduct. The reduced release of sturgeons will help to prevent hybridization in natural reproductions as well as the infestation of pathogens in all life cycle phases with pathogens that the native species is not adapted too. On the other hand, releases of non-native predators affect primarily juvenile fish after release until outmigration and have the potential to reduce recruitment substantially. Alien species release is prohibited by the EU and requires permits from the national/regional agencies. Here, the information must be increased to elevate the knowledge on the adverse impacts, resulting in the limitation of permits. In cases of illegal stocking, more proper enforcement is required.

Measures

- Increase the legal prerequisites for safeguarding fish in rearing facilities, preventing escapement.
- Enforce prevent escapes from fish farms and ponds (especially sturgeon).
- Prevent illegal and accidental introductions of alien species (including sturgeons) into the wild by increasing awareness and compliance through communication campaigns and through the provision of alternative means to dispose unwanted individuals.
- Inform the general public about the risk of introductions focusing on sturgeon.
- Create the prerequisites for the removal of, and the skills to identify exotic species in accordance with national laws and if necessary adapt national laws in line with existing intergovernmental and international codes and guidelines.

obj.4

7.2.3 Objective 4: Secure or facilitate sturgeon migration in all target rivers

Migration is of outmost importance for anadromous species since their sub-populations have adapted to the migration distance with respect to the timing of migration and the physiological response towards maturation. As such, sturgeons cannot simply spawn below an obstacle as long as their imprinting and adaptation requires a longer migration distance. Also the drift of larvae and the habitat availability for early life phases render the availability of sufficient river length essential to allow the fish to prevent the contact with saline waters before they are physiologically able to regulate their homoeostasis.

Water diversion and hydropower generation are common objectives of dam construction. Regulated river flow contributed to the physical alterations of habitat by limiting or altering spring peaks of discharge, reducing translocation and cleaning of the gravel beds (Coutant 2004), thereby reducing the availability of spawning sites. Additionally, the decrease in discharge also reduces migration fidelity, limiting the distance of upstream migration as well as the number of fish to enter a given river (Holčik 1988, Kynard 1997).

Damming prevents passage to the spawning sites in various rivers where mitigation measures are not implemented yet. Despite the fact that the role of dams -blocking migration routes - has been acknowledged as early as the Middle Ages (Hoffmann 1996) the development of dams continued with the increasing importance of the waterways for industrial development in the middle of the 18th century (Kausch 1996).

Detailed studies on the effects of damming have been performed on a variety of sturgeon species in several river basins worldwide, for example for A. transmontanus on the Fraser River and the Columbia River (Hildebrand *et al.* 1999, Coutant 2004) and for A. sinensis in the Yangze River in China (Kynard *et al.* 1994, Yang *et al.* 2006). In addition, when upstream migration is facilitated, the downstream passage for outmigrating fish must be ensured to prevent impingement on bar racks.

#10

7.2.3.1 Action 10: Prohibit the planning and construction of migration obstacles with less than 30% of discharge for mitigation facilitation in sturgeon rivers

Migration obstacles can be manifold. The comprise barriers such as natural obstacles such as rapids, dams, weirs, but also include oxygen deficient zones which do occur as a result of dredging and the formation of sedimentation zones which have an increased oxygen demand for decomposition of organic materials. The latter are to be dealt with in the chapter on habitat restoration.

Target

In order to prevent additional obstacles to adversely affect sturgeon migration and habitat use in sturgeon rivers no new dams are to be established. In cases where development cannot be prevented, the facilities must provide large scale bypasses with 30% of the discharge regardless of flow conditions.

Construction of bypasses that prevent the fish from delaying upstream or downstream migration, prevent turbine passage and facilitate sediment transport

Implementation

Planning and approval of dam constructions in sturgeon rivers must apply the ranking of "no dam, in flow energy production and damming with sufficiently scaled bypass": a safe limit would be a bypass solution that permits not less than 30% of the discharge for free passage.

Water management bodies, legal prerequisites must be in place to ensure the respective minimum standards.

Impact

Impacts act upon habitat availability, migration, effectiveness of reproduction, and as such on the duration of the *ex situ* measures and the release.

Measures

- Identify sturgeon rivers
- Establish legal prerequisites
- Implement strategy during all planning processes

#11

7.2.3.2 Action 11: Restore migration in key rivers with existing dams

In most Baltic Sea sturgeon rivers, dams are limiting the migration of the populations under recovery. Only in a few rivers (see Chapter 4) these dams don't adversely affect the migration due to their position in upstream sections, historically populated by sturgeons only to a very limited extent. In contrast many potential sturgeon rivers provide free migration only over less than 30km from the river mouth. Upstream migration facilitation alone is not a solution for such obstacles. The protection and effective guidance of downstream migrants regardless of size is of equal importance.

Target

In existing migration obstacles, facilitation of passage without creating delay in migration and without inhibiting migration of a fraction of the individuals is essential to allow the population to be restored. Furthermore, no mechanical damage should occur both during up- and downstream migration.

In order to facilitate the migration of all fish species and sizes both up and downstream at an obstacle - a prominent goal of the WFD as well as of this AP - several options are available. In the order of functionality for overarching management targets, the options rank as follows: dam removal, bypass installation, installation of technical solutions for up and downstream passage. Key criteria for upstream migration are defined in the German DWA 509 guideline (DWA 2014).

Implementation

Planning and approval of dam constructions rests with the water management bodies. In this case for renewal of water rights, passage facilitation must be considered. To allow the inclusion of migration facilitation for existing facilities, the decision of the European Court of Justice Case C529/15 in the judgment of June 1, 2017 applies which states that facilities built before 1998 are to be held liable for environmental damage, applying EU Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage, as amended by Directive 2009/31/EC and Article 4(7) of Directive 2000/60/EC establishing a framework for Community action in the field of water policy (OJ 2000 L 327, p. 1). As such, remediation measures are required for existing facilities too which must be reflected in the national legal prerequisites. As a result, hydropower companies are in charge to mitigate the environmental damage they create by the damming of a river.

Impact

While new hydropower facilities are difficult to construct in the EU range states due to the required mitigation measures, a large number of existing dams without functional migration facilitation blocks the migration of all migratory fish species, adversely affecting the ecological status of the waterbodies.

Impacts act upon habitat availability, migration, effectiveness of reproduction, and as such on the duration of the *ex situ* measures and the release.

Measures

- Identify sturgeon rivers.
- Identification of historic sturgeon migration limits.
- Establish legal prerequisites.
- Determine position of obstacle.
- Verify the options for mitigation (concession duration, profitability, etc.).
- SWAT analysis of removal, bypass or technical solutions to be performed.
- Implementation of measures.

7.3. Administrative prerequisites

Category 3: Outreach and administrative prerequisites

obj.5

7.3.1
Objective 5: Increase public, administrative and political awareness on sturgeon conservation

#12

7.3.1.1
Action 12: Target oriented communication strategies are to be implemented to provide a knowledge base for sturgeon restoration in the Baltic Sea states, increase awareness and acceptance of the measures

Since the Baltic sturgeon is considered missing or extinct in the range countries, little awareness exists on its current status, its life-cycle, habitat requirements and the implications for protection. In addition, several ministries and numerous agencies are involved in the management of the species and its habitats. While sturgeons are excellent communication faciilitators, they are largely unknown to the general public due to the long period of extirpation with low encounter probabilities. In order to successfully implement the recovery measures for the Baltic sturgeon, a joint effort is required to involve the general public actively in the restoration attempts to ensure that they buy in to the recovery measures and protection strategies. This applies to an even larger degree for the political and administrative level which must actively support the measures at various levels and through various initiatives.

Sturgeons become exotic species in public and political perception. The problem complex and its solution is assigned to countries and areas with persisting occurrence of sturgeons. Solidarity between regions and countries in problem solving is not established or lost respectively

A media communication and PR strategy has to be developed and implemented. The strategic approach towards the media needs to focus on best applicable methods to reach the project conservation objectives. The PR strategy needs to reach the different target audiences (e.g. decision makers at political levels, governmental sector, – ministries, agencies, fishermen, fishermen societies, coastal municipalities, general public, academia, business sector, etc.) using relevant media vehicles.

Publicity and dissemination of project results are to be ensured through provision of harmonized activity-specific press releases, invitations to project events such as releases, monitoring activities, broodstock control, fisheries meetings, etc. Implementation results must emphasize the cross-sectorial benefits of the project. Media presence is of special importance to reach the decision makers, since the relevance of issues to be placed on the political and managerial agenda for this group mainly is associated to the public attention that the issues generate. As such the consistency of the media presence as well as the positive attitude and the beneficial aspects are paramount for the attention that the project receives.

Target
Increased understanding of the necessities and support for the required measures at various levels are the targets of the strategy. The target groups are highly diverse, ranging from local inhabitants via stakeholders and administration and enforcement to the policy level.

Implementation
The general information dissemination is to be carried out by the environmental agencies in conjunction with the main stakeholders as a part of the general biodiversity communication and through project related communications.

Impact
The PR strategy will ensure the development of an effective key message, the definition of issues and statements and the setting of objectives. Based upon previous research, they will identify target audiences and participating communities/stakeholders, identify type of stakeholders to be reached, and the audience profiling etc.

Measures
- Development of a dissemination strategy.
- Production of the materials for implementation.
- Outreach activities.
- Stakeholder participation in conservation actions.
- Round tables to transmit and discuss actions with different stakeholders.
- Verification of effectiveness through scientific studies.
- Establish adaptive management and adaptation of communication strategy.

obj.6

7.3.2
Objective 6: Set proper financial and legal prerequisites for sturgeon restoration

Based upon the experiences with the already existing Action Plans for sturgeons (Action Plan for Danube sturgeons, 2005, Action Plan for the conservation and restoration of the European sturgeon, Bern Convention 2007, and the two Action Plans for Acipenser naccarii 2006 and 2010) increased efforts are urgently required to improve the implementation process. National and international coordination, funding and the shared responsibilities require much more commitment that previously experienced. As such, the following actions are considered a first attempt to provide adequate prerequisites and measures for follow up.

#13

7.3.2.1 Action 13: Promote the provision of adequate funding instruments for long term actions

There are no specific national or international resources provided, dedicated and allocated to the implementation of APs under the Bern Convention. No funding instruments are available to meet the requirements arising from the Action Plans in long lived species since project programs and funding instruments do not support any recurring long-term (conservation) activities such as *ex situ* rearing, reproduction and rearing as well as releases and monitoring.

The implementation of APs depends solely on the initiative and motivation of individuals and groups, who have to apply for funding in programs that are not properly set up for the purpose to be achieved. Important sturgeon conservation aspects like *in situ* and *ex situ* conservation (e.g. monitoring and release of juveniles) depend on recurring activities and are not eligible for funding under most grants.

Specific national and international resources for the implementation of conservation measures for threatened species under international conventions have to be provided. Long-term funding and support has to be established. International and inter-institutional cooperation and coordination has to be fostered. Coordinating entities with the ability to delegate and direct have to be established where and when necessary.

Target

To provide case specific and target oriented funding options as well as administrative support for the implementation of the required legal and administrative actions to be implemented.

Implementation

The provision of specific, target oriented, long-term funding perspectives for the necessary protection measures are to be implemented by the national ministries in collaboration with the EU.

Impact

The provision of funds and the institutional implementation of the AP is a basic prerequisite to be able to reach the targets formulated.

Measures

- Establish a coordinating body for the implementation of the AP.
- Identify costs for the different phases of the implementation.
- Designate a national agency responsible and allocate respective funding.
- National agencies jointly with a coordinating body for the HELCOM region address the EU to implement substantial changes to the funding policy and priorities.
- Quality criteria/ standards on the basis of the respective APs have to be established to evaluate funding proposals.
- Implement long term, prioritized programs for restoration.

7.3.2.2 Action 14: Increase the legal relevance of sturgeon conservation to ensure proper implementation

In the EU and in national legislation of the Baltic Sea countries, the Baltic sturgeon (*A. oxyrinchus*) is not (yet) considered due to its late description as a distinct species in the Baltic rather than the European sturgeon (*A. sturio*). As such, legal protection measures cannot be fully applied or only to a limited degree.

The role of the Action Plan and options to enhance its effectiveness should be analyzed. Action Plans should function as strategic backbones and "level pole" for sturgeon conservation. Even in cases where a revision of the current protection status is practically not feasible (Bern Convention, Appendices of the Habitats Directive) the prioritization of its protection is indispensable to achieve the conservation targets and resolve stakeholder conflicts.

Furthermore, the national Red Lists must reflect the recent scientific data on the presence of *A. oxyrinchus* as a native Baltic Sea species to grant effective protection. Similarly, fisheries jurisdiction must incorporate these changes too.

Quality criteria/ standards for conservation actions have to be implemented on the basis of the respective APs and must be enforced respectively.

Targets

Improve the protection status of the Baltic sturgeon to facilitate the establishment of viable, self-sustaining populations. For this purpose the legal protection and the prioritization of the related measures are essential to render the program successful and to effectively combat the loss of biodiversity.

Implementation

The prioritization and protection of the necessary protection measures are to be implemented by the national ministries in collaboration with the EU.

Impact

The protection of the species and prioritization of conservation actions is an urgent prerequisite to enable managers to solve pertinent stakeholder conflicts and to implement essential prerequisites for a functional recovery program. As such, the action has a direct effect upon all concrete conservation actions and their outcome.

Measures

- Include *A. oxyrinchus* on the respective national Red Lists.
- Prioritize restoration measures as outlined in the plan.
- Call for national round tables to resolve stakeholder conflicts.

obj.7

7.3.3 Objective 7: Monitor and evaluate Action Plan implementation to allow adaptive management

#15

7.3.3.1 Action 15: States; River Basin Management Units and Marine Conventions and EU authorities nominate coordinators responsible for the implementation of the AP for which a HELCOM Focal Point is established

Action Plans as strategic guidelines for planning and implementing sturgeon conservation measures are ignored. Reasons for this are unclear but might be associated to their complexity (holistic approach), their missing liability concerning national and international legislation or simply the ignorance or unwillingness of actors to comply with APs as a standard.

The implementation takes place in a difficult international environment as different national/regional administrative entities have to be involved for populations extending over borders. There are no international coordinating entities for sturgeon conservation with the necessary technical expertise and the ability to delegate and direct established in the member states.

Target
International and inter-institutional cooperation and coordination has to be fostered. Coordinating entities with the ability to delegate and direct have to be established where and when necessary. In addition, a HELCOM-wide coordinator is elected to help implementing the measures under the AP.

Implementation
The nomination of coordinators with sufficient command for the interagency harmonization of targets and measures is to be implemented by the national states where applicable with the river basin management units. The HELCOM focal point is to be designated. The coordinators appoint for an annual meeting to set priorities and to harmonize the AP implementation. Between meetings the facilitation of the implementation of measures in the national ranges is coordinated.

Impact
The role of the coordinator with sufficient authority would ease the implementation of the Objectives 1-5 under the AP and result in a timely achievement of targets.

Measures
- Definition of responsibilities and duties for the respective contact points.
- HELCOM designates a focal point for the coordination of the program.
- National authorities nominate national coordinators.
- River basin management entities nominate a contact point.
- Time plan and reporting schedules are set up
- Dissemination of results is agreed upon between all entities.

#16

7.3.3.2 Action 16: Evaluate the implementation of this Action Plan on HELCOM wide level.

To increase the implementation efficiency of the plans, the evaluation of its implementation is mandatory. For this purpose the measures and the respective targets are verified by a subset of measures and milestones to be reached. Reporting is carried out against milestones and includes detailed analysis of drawbacks in implementation.

Annual reports of responsible entities are presented at annual Standing Committee meetings HELCOM. Evaluation of AP implementation is suggested after 3, 6 and 10 years, before a revised AP is implemented.

Target
The evaluation is to increase the transparency of the measures taken, the strengths and weaknesses of the different approaches in range countries. The main idea is to facilitate an increased chance to implement critical aspects of the plan that have the potential to interfere with stakeholder interest.

Implementation
National authorities and HELCOM coordinator are to jointly evaluate the progress based upon the national reports.

Impact
The feedback from the evaluation is to support the implementation effectiveness of the whole plan and to provide transparency of the implementation process. As such all AP Objectives and all partners involved potentially benefit from a sound evaluation process.

Measures
- National or catchment wide AP implementation plans are agreed upon.
- National reports on the progress are submitted based on a harmonized questionnaire.
- Scientific evaluation of AP implementation progress is performed 3 years upon entering into force of the AP.
- Scientific and administrative evaluation of AP implementation progress is performed 6 years upon entering into force of the AP.
- Before the end of the AP term (10 years) a status report is submitted and the implementation of the AP is verified 9 years after AP adoption.
- Based upon the targets achieved and the drawbacks, a revision of the action plan is negotiated and presented for adoption.

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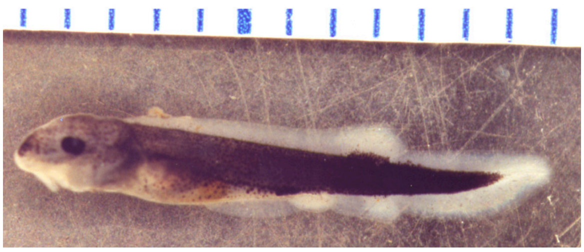
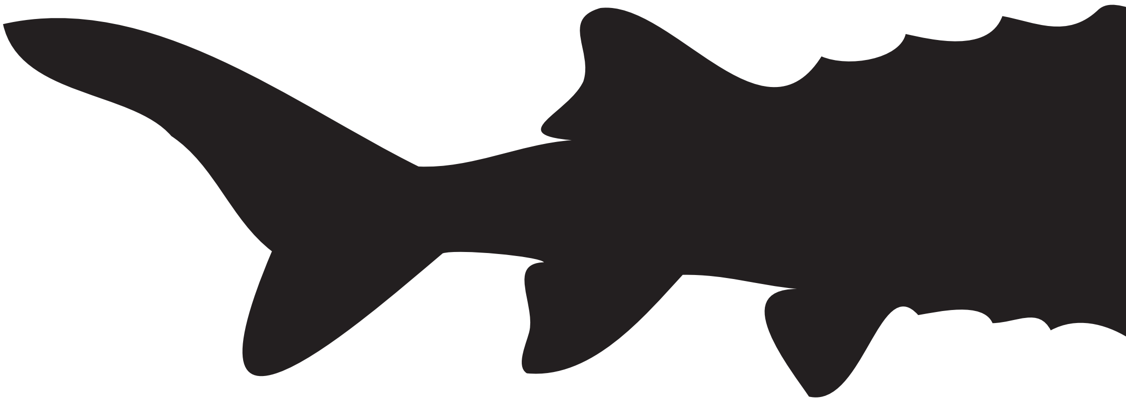
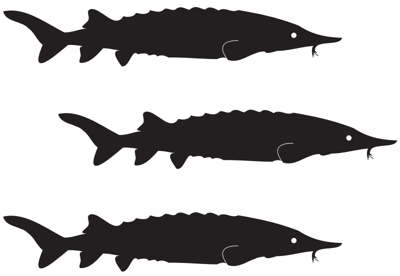


Figure 17: *A. oxyrinchus* 10 days post hatch © C.–M. Kamerichs

9. Appendices





1. Appendices:

○ Appendix 1: Table containing an overview on the Objectives, Actions, priority and timeline of conservation actions

Category 1: *Ex situ* protection

Objective 1: Actively support the historic population structure to initiate a positive population trend				
Action	***Measure***	***Priority***	***Time scale (to be completed)***	***Organisations responsible***
Action 1: Ex situ* broodstock development of *Acipenser oxyrinchus	1.1. Establish and expand regional ex situ programmes following best practice guidelines for husbandry (IUCN 2013, FAO 570)	High	Short Term	Research institutes and governmental agencies
	1.2. Characterize all individuals of the broodstock genetically, compare with wild donor stock, implement a genetic breeding plan to maintain genetic diversity, and expand it by new imports to represent min. 60 % of the diversity of the donor stocks	High	Ongoing	Research institutes, nationally (IGB, Warsaw University), national environmental protection agencies, fisheries administration
	1.3. Improve cultivation methodology for broostock to optimize survival rates	High	Ongoing	Research institutes (LFA, IGB, IRS, FSMA, BIOR)
	1.4. Improve growth and prevent diseases specific to fish kept in captivity	High	Long Term	Research institutes (LFA, IGB, IRS, FSMA, BIOR)

	1.5. Implement appropriate risk management systems to safeguard cultivation	Medium	Rolling	Research institutes (LFA, IGB, IRS, FSMA, BIOR) and state agencies
	1.6. Establish a sustainable health management	Medium	Medium	Research institutes (LFA, IGB, IRS, FSMA, BIOR) with state agencies

Action 2: Controlled reproduction and rearing for fitness	2.1. Develop rearing practices for spawners that promote mate choice	Medium	Medium	Research institutes (LFA, IGB, IRS, FSMA, BIOR) and state agencies
	2.2 Adopt fertilization and incubation techniques in order to meet the biological requirements of the species and render these close to natural	High	Ongoing	Research institutes (LFA, IGB, IRS)
	2.3 Develop methods for gamete quality assessment to allow optimal control of the maturation process	High	Onging	Research institutes (LFA, IGB, IRS, BIOR)
	2.4 Implement state of the art approaches for rearing of eleuthero embryos during the yolk sac phase to develop best practice methodologies, considering the behavioral peculiarities of the species	High	Rolling	Rearing facilities and research institutes
	2.5 Ensure rearing conditions for early juveniles to ensure proper development and maximize behavioral plasticity and fitness in the fish, rendering them fit for survival in the wild by providing sufficient swimming capacity, predator recognition and adaptive potential and imprinting for homing	High	Ongoing	Rearing facilities and research institutes
	2.6 Establish quality criteria for fish to be released and ensure their application	High	Medium	Research Institutes

	2.7 Establish a health management system to ensure fish welfare in a competitive environment	Medium	Medium	Research Institutes
	2.8 Implement an appropriate risk management system to safeguard egg incubation and juvenile rearing to prevent losses through technical failure or human error	High	Ongoing	Rearing facilities and research institutes

Action 3: Release of *A. oxyrinchus* for population re-establishment and enhancement	3.1. Select suitable river basins and the critical habitat, suitable for restocking	High	Ongoing	Research Institutes and River basin management
	3.2. Prepare management plans (including designation of responsibilities, e.g. responsible authority, monitoring, surveillance of success), for the re-establishment of populations in these rivers	Medium	Medium	Research Institutes and River basin management
	3.3. Develop and apply marking techniques and establish monitoring programs to determine the success of the release programs.	Medium	Short	Research Institutes and fisheries management agencies
	3.4. Establish best practice guidelines for the transport, handling, time of release, release practices with regard to target densities and habitats to be stocked	High	Short	Research Institutes
	3.5. Establish the optimum time size - release window for juveniles allowing best survival and rates of return, based upon monitoring results	Medium	Long - term	Research Institutes

Category 2: *in situ* protection

Objective 2: Protect the populations under recovery from accidental and directed removal of individuals				
Action	***Measure***	***Priority***	***Time scale***	***Organisations responsible***
Action 4: Significantly reduce bycatch mortality	4.1. Assess effects of fisheries upon population re-establishment	High	Ongoing	Fisheries administration, Research Institutes
	4.2. Increase awareness and effective compliance in fisheries	High	Immediate	Fisheries administration, Research Institutes
	4.3. Intensively involve and provide training for professional and recreational fisheries to significantly reduce mortality due to accidental catches.	High	Immediate	Fisheries administration, Research Institutes
	4.4. Enhance cooperation with fishermen and fisheries inspections to increase awareness of the protection status of the species.	High	Immediate	Fisheries administration, Research Institutes
	4.5. Carry out information workshops to increase awareness and compliance of the key stakeholders and to change their norms and beliefs.	High	Short	Fisheries administration, Research Institutes, NGOs

	4.6. Develop incentives to promote release and accurate reporting.	High	Short	Fisheries administration, Research Institutes, NGOs
	4.7. Monitor *A. oxyrinchus* by-catch and by -catch mortality to identify threats timely and to use the data for population and range assessments	High	Short	Fisheries administration, Research Institutes, NGOs
	4.8. Develop and introduce selective fisheries techniques, and exclude non - selective clearly adverse fishing techniques in critical habitats of *A. oxyrinchus* (spawning sites, juvenile aggregations, nursing grounds).	High	Medium	Fisheries administration, Research Institutes
	4.9. Determine and mitigate socio - economic effects of protection	High	Medium	Fisheries administration, Research Institutes

Action 5: Monitor population sizes and structure to facilitate timely and continuous detection of adverse impacts	5.1. Develop a comprehensive monitoring plan for the follow up of release 5.2.	High	Short	Fisheries administration, Research Institutes, NGOs
	5.2. Integrate the monitoring with the rearing trials to be able to verify effects of changes in rearing practice	High	Medium	Fisheries administration, Research Institutes, NGOs
	5.3. Allocate sufficient funding to facilitate collection of sufficient quality data for adaptive management	High	Short	Fisheries administration, Environmental agencies, foundations, ICES, WGDAM
	5.4. Implement a joint telemetry study approach with the neighbouring countries to allow to detect out of reach migrations	Medium	Long - term	Fisheries administration, River basin management, Research Institutes, NGOs
	5.5. Set up a joint marking guideline to ensure proper identification and assignment of incidental captures	High	Short	Research Institutes
	5.6. Harmonize monitoring approaches in range states to be able to compare the outcome of the releases and ease the identification of drawbacks through comparative methodology	High	Short	Fisheries administration, Research Institutes, NGOs

	5.7. Identify locations and extent of losses through water abstraction	Medium	Medium	River basin management, Power companies, Research Institutes, NGOs
	5.8. Implement of avoidance measures for water abstraction facilities	Medium	Long	Administration, Power companies

Action 6: Eliminate Illegal trade of all sturgeon products	6.1. Carry out stakeholder surveys to determine target groups of the communication campaign	High	Medium	Fisheries administration, Research Institutes
	6.2. Establish diagnostic tools to differentiate species and origin of caviar and sturgeon products in processing and trade	High	Short	Research Institutes, Enforcement agencies
	6.3. Implement coordinated approaches for controls and seizures among the relevant authorities and enforcement agencies nationally	High	Medium	Customs, CITES Enforcement agencies, Veterinary agencies, Fisheries inspection
	6.4. Assess attitudes and mindsets of actors in a scientific study	High	Short	Research
	6.5. Develop target oriented communication campaigns are, tested, refined and implemented	high	Medium	Research, NGOs,
	6.6. Drastically increase enforcement and adapt fines are to a level reflecting the value of the fish based on the conservation program not on the meat price	High	Medium	Policy and enforcement agencies

Objective 3: Protect and restore where necessary critical sturgeon habitats				
Action	***Measure***	***Priority***	***Time scale***	***Organisations responsible***
Action 7: Habitat identification and assessment measures	7.1. Determine and assess critical sturgeon habitat, its quality and accessibility as well as adverse impacts applying data collected under Actions 5.3 - 5.6.	Medium	Ongoing	Research and river basin management
	7.2. Assess habitat utilization and resulting deficits of habitats for different life phases see 5.4.	Medium	Ongoing	Research and river basin management
	7.3. Identify drivers for habitat use and essential habitat properties	Medium	Medium	Research
	7.4. Determine carrying capacity and potential for improvement	Medium	Ongoing	Research and river basin management

Action 8: Protect and restore essential riverine and estuarine sturgeon habitats	8.1. Based upon the result of Action 7 key areas of critical importance for the population development are identified and the potential conflicts with other uses are determined	Medium	Medium	Research, River basin management, Fisheries administration, Navigation
	8.2. Mediation of user - conflicts are carried out to develop adaptive use of habitat features	Medium	Medium	Research, River basin management, Fisheries administration, Navigation
	8.3. Essential habitats are characterized and their developmental potential assessed	Medium	Medium	Research, River basin management, Fisheries administration, Navigation
	8.4. Self - sustaining habitats and habitats providing key functions with the need for restoration are undergoing a protection process	Medium	Long - term	Research, River basin management, Fisheries administration, Navigation
	8.5. Conceptualize and implement restoration measures to combat habitat deficits	Medium	Long - term	Research, River basin management, Fisheries administration, Navigation
	8.6. Monitor restored and protected habitats are to ensure proper quality and to allow adaptive management	Medium	Medium	Research, River basin management, Fisheries administration, Navigation

Action 9: Effectively control the introduction of allochthonous species	9.1. Increase the legal prerequisites for safeguarding fish in rearing facilities and prevent escapement	Medium	Medium	Research, Fisheries administration, Veterinarian administration
	9.2. Enforce prevention of escapements from fish farms and ponds (especially sturgeon)	Medium	Medium	Research, Fisheries administration, Veterinarian administration
	9.3. Prevent illegal and accidental introductions of alien species (including sturgeons) into the wild by increasing awareness and compliance through communication campaigns and through the provision of alternative means to dispose unwanted individuals.	High	Short	Research, Fisheries administration, Fisheries associations, aquarium trade, NGOs
	9.4. Inform the general public about the risk of introductions focusing on sturgeon.	High	Short	Fisheries administration, Fisheries associations, aquarium trade, NGOs
	9.5. Create the prerequisites for the removal of, and the skills to identify exotic species in accordance with national laws and if necessary adapt national laws in line with existing intergovernmental and international codes and guidelines	Medium	Medium	Research, Fisheries administration, Fisheries associations, aquarium trade, NGOs

Objective 4: *Secure or facilitate sturgeon migration in all target rivers*				
Action	***Measure***	***Priority***	***Time scale***	***Organisations responsible***
Action 10: Prohibit the planning and construction of migration obstacles with less than 30 % of discharge for mitigation facilitation in sturgeon rivers	10.1. Identify sturgeon rivers	High	Ongoing	Research
	10.2. Establish legal prerequisites for future dam development including the prerequisite of a minimum bypass of 30 % of the discharge at all times	High	Short	Policy, Water administration
	10.3. Implement the strategy to improve connectivity throughout all planning processes	High	medium	Policy, Water administration

Action 11: Restore migration in key rivers with existing dams	11.1. Establish legal prerequisites for migration facilitation	High	ongoing	Policy, Water administration
	11.2. Identify sturgeon rivers with existing dams	High	Ongoing	Research
	11.3. Identification of historic sturgeon migration limits	High	Ongoing	Research
	11.4. Determine position of obstacle and prioritize dams for migration facilitation	High	Medium	Research, Fisheries administration, policy, Water administration
	11.5. Verify the options for mitigation (concession duration, profitability, etc.)	High	Medium	Research, policy, Water administration, hydropower companies
	11.6. SWAT analysis of removal, bypass or technical solutions to be performed	High	Medium	Water administration, hydropower companies
	11.7. Implement measures to restore migration both up and downstream	High	Long - term	Water administration, hydropower companies

Category 3: Administrative prerequisites and outreach

Objective 5: Increase public, administrative and political awareness on sturgeon conservation				
Action	***Measure***	***Priority***	***Time scale***	***Organisations responsible***
Action 12: Target oriented communication strategies are to be implemented to provide a knowledge base for sturgeon restoration in the Baltic range states, as well as to increase awareness and acceptance of the measures	12.1. Develop a dissemination strategy beyond 4.3 - 4.8.	High	Ongoing	Research, policy, Wateradministration Fisheries administration
	12.2. Produce the materials for implementation	Medium	Short	NGOs, Water administration, Fisheries administration
	12.3. Carry out outreach activities	Medium	Short	NGOs
	12.4. Involve stakeholders to participate in conservation actions	High	Ongoing	Research, policy, Water administration, Fisheries administration
	12.5. Establish round tables to interact with different stakeholders	Medium	Short	NGOs, Water administration, Fisheries administration, research
	12.6. Verify effectiveness of the above measures through scientific studies	Medium	Short	Research institutes
	12.7. Establish adaptive management and adaptation of communication strategy	Medium	Short	NGOs, Water administration, Fisheries administration, Research institutes

Objective 6: Set proper financial and legal prerequisites for sturgeon restoration				
Action	Measure	***Priority***	***Time scale***	***Organisations responsible***
***Action 13:* Promote the provision of adequate funding instruments for long-term actions**	13.1. Establish a coordinating body for the implementation of the AP	Hhigh	Short	Policy, administration
	13.2. Identify costs for the different phases of the implementation	High	Short	Policy, administration, research
	13.3. Designate a national agency responsible and allocate respective funding	High	Short	Policy, administration
	13.4. Initiate substantial changes in the funding policy and priorities of the Commission	High	Short	Policy, administration
	13.5. Establish quality criteria/ standards on the basis of the respective APs have to be to evaluate funding proposals	High	Short	Policy, administration, research
	13.6. Implement long term, prioritized programs for restoration	High	Medium	Policy, administration

Action	*Measure*	*Priority*	*Time scale*	*Organisations responsible*
Action 14: Increase the legal relevance of sturgeon conservation to ensure proper implementation	14.1. Include *A. oxyrinchus* on the respective national Red Lists	High	Short	Policy, administration
	14.2. Prioritize restoration measures as outlined in the plan for implementation in river basin and coastal zone management	High	Short	Policy, administration, research
	14.3. Call for national round tables to resolve stakeholder conflicts	High	Short	Policy, administration, research
	14.4. Push for harmonization of relevant EU Directives and regulations to prevent conflicting targets	High	Continuing	Policy and administration

Objective 7: Monitor and evaluate Action Plan implementation to allow adaptive management				
Action	***Measure***	***Priority***	***Time scale***	***Organisations responsible***
Action 15: **States and River Basin Management national authorities nominate coordinators responsible for the implementation of the AP for which a Helcom Focal Point is established**	15.1. Define responsibilities and duties for the respective contact points developed and agreed between entities	High	Short	Helcom, member countries
	15.2. Helcom designates a focal point for the coordination of the program	High	Short	Helcom through member countries
	15.3. National authorities nominate national coordinators	High	Short	member countries
	15.4. River basin management entities nominate a contact point	High	Short	member countries
	15.5. Time plan and reporting schedule are set up	High	Short	Helcom, member countries

Action 16: Evaluate the implementation of this Action Plan on Helcom level	16.1. National or catchment wide AP implementation plans are agreed upon	High	Medium	Helcom, member countries
	16.2. National reports on the progress are submitted based on a harmonized questionnaire	High	Rolling	Helcom, member countries
	16.3. Scientific evaluation of AP implementation progress is performed 3 years upon entering into force of the AP	Medium	Medium	Helcom, member countries, research
	16.4. Scientific and administrative evaluation of AP implementation progress is performed 6 years upon entering into force of the AP	Medium	Medium	Helcom, member countries, research
	16.5. Before the end of the AP term (10 years) a status report is submitted and the implementation of the AP is verified 9 years after AP adoption	Medium	Long - term	Helcom, member countries, research
	16.6. Based upon the targets achieved and the drawbacks, a revision of the action plan is negotiated and presented for adoption	Medium	Long - term	Helcom, member countries, research

o Appendix 2: Status of A. oxyrinchus according to DG Environment (2014)

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
ENVIRONMENT
Directorate B – Natural Capital
ENV.B.3 - Nature
Directorate E – Global and Regional Challenges, Life
ENV.E.3 – Life-Nature

Brussels, 07 AVR. 2014
FV/fl Ares (2014) 1080816

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Dear Mr Gessner,

On the basis of your request of 24 January 2014, to clarify the status of the Atlantic sturgeon (*Acipenser oxyrinchus*) under the EU Habitats Directive (Directive 92/43/EEC), we have consulted the Members of the Habitats Committee on 5 March 2014.

Following the outcome of that consultation, I am pleased to inform you that we will consider Baltic populations of Acipenser oxyrinchus as populations belonging to a priority species under Annex II of the Habitats Directive. This is based on the understanding that these populations were considered belonging to the European sturgeon (*Acipenser sturio*) at the time this Directive entered into force.

Yours sincerely,

Stefan Leiner
Head of Unit

Angelo Salsi
Head of Unit

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