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Preparatory measures and initial release as a prerequsite for the remediation of the European sturgeon, *Acipenser sturio*, in Germany*

Vorbereitende Maßnahmen und erster Versuchsbesatz als Grundlage der Wiedereinbürgerung des Europäischen Störes, *Acipenser sturio*, in Deutschland

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Summary: Sturgeon were among the first fish species that revealed a population decline in response to the increased anthropogenic pressures upon the river systems in the 19th century. Safeguarding and remediation attempts were taken only after the species was almost extinct, relying on potential populations in the historic range. Through support of the German Federal Agency for Nature Conservation, a first pilot project was initiated by the in the mid 1990s attempting to identify potential donor populations for ex - situ measures. At the same time forty juvenile *Acipenser sturio* originating of a controlled reproduction of wild spawners from the Gironde River were transferred from the French Cemagref to the Leibniz - Institute for Freshwater Ecology and Inland Fisheries in Berlin for experimental purposes and broodstock development, providing the nucleus of the German ex-situ stock. Habitat assessments were carried out to identify suitable river systems for remediation of the species. Genetically the French *A. sturio* have been proven suitable for the reintroduction in the German North Sea tributaries. Since 2007 offspring of the first ex-situ reproductions in France were used to expand the future broodstocks both in France and Germany as well as to restock the Gironde system. These transfers also were utilized to carry out the first experimental release in the Elbe River system since 2008. First insights into the migration behaviour and habitat utilization were obtained through a telemetry study between the release site at Lenzen (river - km 485) to Hamburg Harbour (river - km 614). Furthermore, an outlook on the future requirements with regard to adaptation of rearing techniques to allow the adaptation of fish designated for release as well as options for stakeholder involvement are discussed.

Key words: European Sturgeon, broodstock, rearing, experimental release, telemetry

Zusammenfassung: Der europäische Stör war eine der ersten Fischarten, die mit massiven Populationsrückgängen auf die anthropogenen Veränderungen der Flüsse in 19. Jahrhundert reagierte. Maßnahmen zur Arterhaltung und zum Bestandsaufbau, die über Fischereimanagement hinausgingen, wurden erst ergriffen, als die Art in ihrem gesamten Verbreitungsgebiet kurz vor dem Aussterben stand. Mit Unterstützung des Bundesamtes für Naturschutz wurde ab 1996 auch ein erster Versuch unternommen Restpopulationen als Grundlage für eine ex-situ Maßnahme zu identifizieren. Zeitgleich gelang es der Cemagref eine erste erfolgreiche Vermehrung von Wildfischen durchzuführen. Ein erster Transfer dieser Nachzuchten an

*Dedicated to Prof. Dr. F. KIRSCHBAUM, who has given direction to the studies on *Acipenser sturio* on the occasion of his 65th birthday and retirement. It is a pleasure to honour him with the present article and with coauthorship.

das Leibniz-Institut für Gewässerökologie und Binnenfischerei im Rahmen einer bilateralen Kooperation bildet den Grundstein des deutschen Wiedereinbürgerungsprogramms. Begleitende Habitatuntersuchungen zur Bestimmung der Eignung von Flusssystemen für die Wiederansiedlung anhand der Verfügbarkeit von Laichhabitaten beigetragen. Genetische Untersuchungen der Artzugehörigkeit und der Bestandsstruktur zeigten, dass der französische *Acipenser sturio* für die geplanten Arbeiten im Nordseeeinzugsgebiet geeignet ist. Seit 2007 wird der deutsche ex-situ Bestand durch Nachzuchten aus kontrollierter Haltung in Frankreich weiter ausgebaut. Ein Teil der Tiere wird seit 2008 auch für die experimentelle Überprüfung der Eignung ausgewählter Gewässer genutzt. Anhand von telemetrischen Untersuchungen werden Habitatnutzung, Wanderverhalten und Risikofaktoren bestimmt. Perspektivisch soll durch die Entwicklung von angepassten Aufzuchttechniken und die zunehmende Einbeziehung der Gewässernutzer eine breite Basis für die Wiedereinbürgerung der Art geschaffen werden.

Schlüsselwörter: Europäischer Stör, Elterntierbestand, Aufzucht, experimenteller Besatz, Telemetrie

1. Introduction

Sturgeons are extremely long-lived, some reaching maximum ages over 150 years (TRAUTMAN 1954) and up to 10 m in total length and 2000 kg in weight (PIROGOVSKIJ et al. 1989). The European sturgeon is reported to attain maximum lengths of 5 - 6 m and 1000 kg in weight (HOLCIK et al. 1989). It is an anadromous species historically found in the major rivers and coastal waters of Europe. In the past it occurred in the Black Sea, in the Mediterranean Sea, including the Adriatic and Tyrrhenian Sea along the Atlantic coast, from Portugal to the Scandinavian Peninsula, in the North Sea and their major tributaries. Single specimens have been reported along the coasts of Iceland and of the White Sea, as well as along the Atlantic and Mediterranean coasts of Northern Africa (MAGNIN 1962, HOLCIK et al. 1989). Of all sturgeon species in Europe, *Acipenser sturio* historically had the largest area of distribution (HOLCIK et al. 1989).

Details on the biology and especially the autecology of the European sturgeon are poorly known. Since the life cycle of this demersal species is both long and complex with a lifespan presumed to last over 60 years, maturity being reached after 10-16 years (depending upon geographical range and sex), lifestyle, spawning season, age at first maturity, nutrition and growth varied between river systems over the entire geographical range (HOLCIK et al. 1989, WILLIOT et al. 2007). Considering the late maturation, even the high numbers of eggs per female do not lead to an absolutely high fecundity (BOREMAN 1997). The European sturgeon is an anadromous migratory species utilizing a variety of different fresh water, estuarine and marine habitats throughout its life cycle (HOLCIK et al.1989, DETTLAFF et al.1993, HOLCIK 2000, fig. 1). Adults live on the continental shelf. When entering the stage of maturity, they return to their native river to reproduce. Spawning takes place in early summer in swift currents over gravel substrate.

The decline of the species became apparent in the late 19th century and was similar in most of the range states. An overview on the status and management of the European sturgeon has been provided at the onset of the century by GESSNER (2000). In the second half of the 20th century probably only two small reproductive populations persisted, one in the Gironde estuary (France) and the other in the Rioni River (Georgia) (DEBUS 1996). In the 1990s only one population was still confirmed, revealing a rapid overall decline (ROCHARD et al 1997). All populations have disappeared within a century (ALMAÇA & ELVIRA 2000, GESSNER 2000).

It has been widely recognized that sturgeon species, including the European sturgeon, share a variety of characteristics that render them very vulnerable to anthropogenic impact. The reproduction of the fish is restricted to specific freshwaters sites. Due to the late maturation and large size, sturgeons are especially sensitive to overfishing. Overharvest in fact has been identified as one of the key elements that caused the decline of the populations (EHRENBAUM

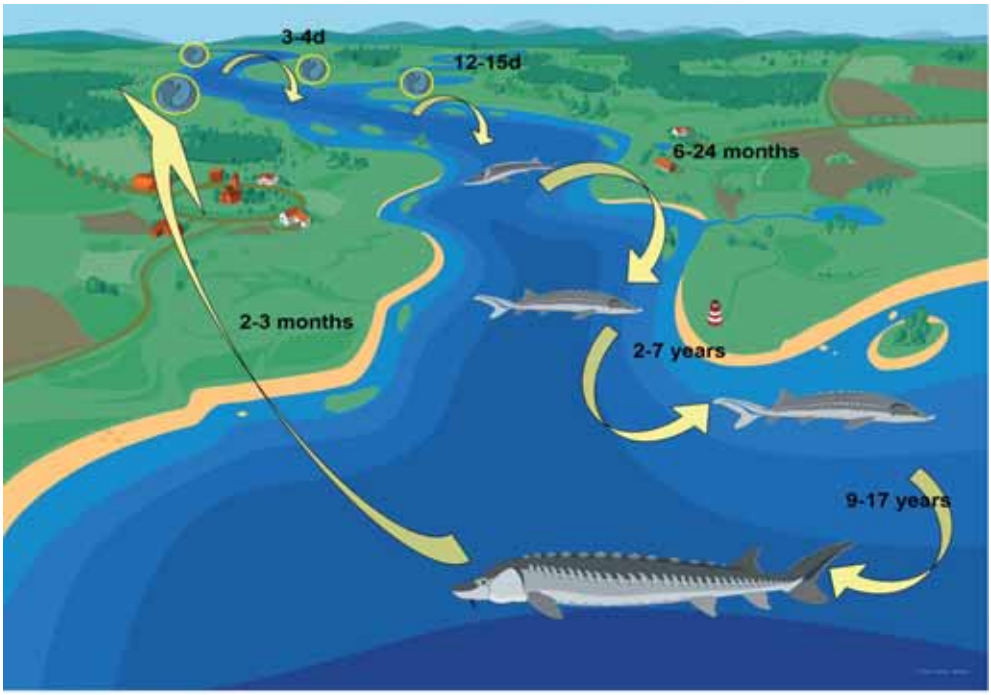

Fig. 1: Life cycle and associated habitat utilization of the European sturgeon (*Acipenser sturio*) under undisturbed conditions; the time patterns orient upon the northern range.
Abb. 1: Lebenszyklus und Habitatnutzung des Europäischen Störs (*Acipenser sturio*) unter natürlichen Bedingungen; die Zeitangaben beziehen sich auf das nördliche Verbreitungsgebiet.

1913, ROCHARD et al. 1990, BEAMESDERFER & FARR 1997, FERNANDEZ-PASQUIER 2000). However, constructions altering the flow regime of the rivers utilized for spawning or providing obstruction to migration as well as pollution have significantly contributed to the lack of reproductive success and subsequently to the decline of the species. In most cases attempts to protect the species have been taken too late or the measures were ineffective (EHRENBAUM 1916, TROUVERY et al.1984, GESSNER 2000). The dynamics and mechanisms of the decline can be exemplified by the data available for the Elbe River system historically most clearly (fig. 2).

The Elbe River population comprised the majority of the sturgeon catches in German waters at the end of the 19th century. After 20 years of high catches, comprising 4000 - 7000 adult sturgeons annually, the catch decreased after 1888 by an average 50 % per year. The underlying reasons were overharvest, pollution and hydro - constructions. The intensive catch of spawners as well as insufficient legal sizes (EHRENBAUM 1913) the population came under pressure. The management measures applied in the fisheries did not result in any change in the general negative trend. The development of the Hamburg harbour and the alteration of the river into a navigation route destroyed major spawning sites for instance on Köhlbrand. The increased influx of sea water expanded the brackish water zones in the lower river to Glückstadt (KAUSCH 1996), being detrimental to the reproductive success in this river stretch (QUANTZ 1903). But also the increase and centralized discharge of communal and industrial wastes caused oxygen depletion and high organic matter content in the summer months (BONNE 1905), the main reproduction period of the species. Due to the mentioned combination of impacts the population collapsed within 25 years from the first warning signs (fig. 2).

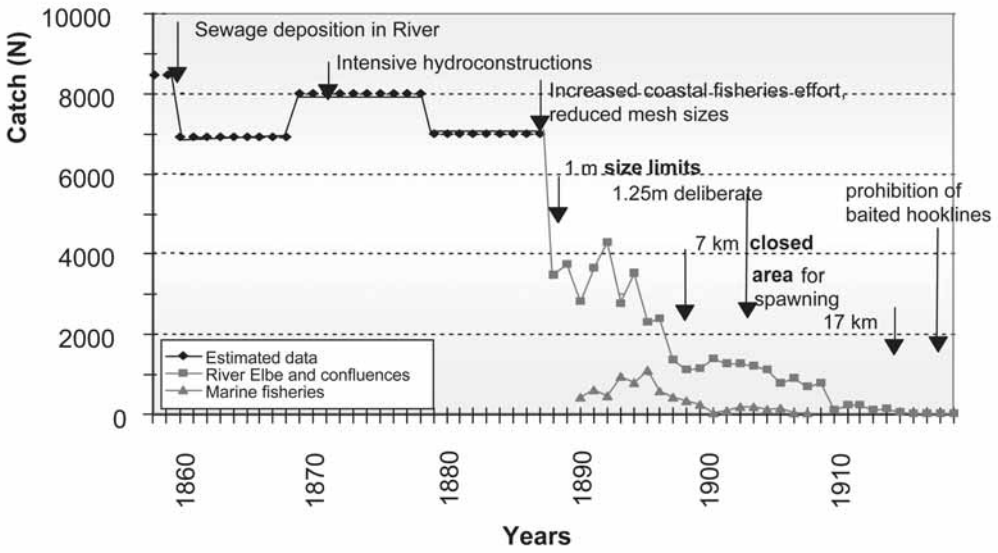

Fig. 2: Decrease in landings of the European sturgeon(*Acipenser sturio*) in the Elbe River between 1840 and 1915; the rhombus line gives estimated catch data, the square line are recorded fisheries landings and the triangle line represents marine catches; the time and the quality of adverse impacts are indicated by the arrows.
Abb. 2: Abnahme der Anlandungen von *Acipenser sturio* im Elbe-System zwischen 1840 und 1915; die Linie mit Rhomben gibt Schätzdaten, die Linie mit Quadraten Daten aus Fischereistatistiken für die Flussgebiete und die Linie mit Dreiecken gibt die Anlandungen aus mariner Fischerei wieder, Pfeile geben den Zeitpunkt und die Art von ausgewählten Einflussfaktoren an.

A good example for the specific effects of impacts in different rivers is the development of the catches from the Eider River. Here, the sturgeon fisheries landings continued despite the fisheries pressure imposed upon the population. The increase in landings in the 1920s is more of a statistical problem. Since Hamburg had lost its sturgeon fleet due to the decrease of catches, the remaining fishing grounds were located at the Eider River. Therefore, sturgeon catches on the Wadden Sea were considered to be Eider River fish if not caught in the river mouth of the Elbe. This increased the proportion of the Eider catches (Kirschbaum & Gessner 2000).

The major difference between the Eider and other rivers is that only small settlements and little industry were located along the river in the 19th century. Apart from damming the tributaries Sorge and Treene in the 17th and 18th century and the upper reaches of the Eider in the 1860s no major hydro - construction took place until 1890. Then the construction of the Kiel Canal had a detrimental impact on the river habitat, eliminating approx. 35 % of the catchment area from the main river (Fock & Rickleffs 1996)., The reduction of the flow laid to an increased tidal influence in the lower parts of the river accompanied by increased flooding frequency and sediment transport from the coastal areas into the river. This resulted in the second measure that adversely affected the species: the erection of the dam at Nordfeld in 1934, which blocked the migration route to the spawning sites located upstream (Kroezus 1953). As a consequence of the recruitment failure, the sturgeon catches declined in the 1950s to occasional catches of single individuals. The attempt to artificially reproduce the remaining fish starting in 1953 came too late and was poorly communicated. As a consequence, no delivery of a ripe male or female was recorded for the subsequent years (Spratte & Hartmann 1992). In 1967 the last sturgeon was caught from the Eider River, immediately before the last migration obstacle,

the dam at the river mouth at Vollerwiek was constructed in 1972, to complete the coastal flood prevention.

The last reproduction in German waters confirmed through catches of juveniles occurred in 1957 in the Oste River, a tributary to the River Elbe (GAUMERT & KÄMMEREIT 1993). During the 1980s until today only single catches of *A. sturio* were observed in Northern Germany with the last catch being recorded in 1993 near Heligoland (ARNDT et al.2000).

In the current situation, the past decline was complete in most of the historic range revealing similar dynamics as described above. Today, the only known remaining population exists in France, in the Gironde, Garonne and Dordogne basin (LEPAGE & ROCHARD 1995). Although the size of the North-East Atlantic population remains unknown it is commonly admitted that this population is probably limited to a few hundreds individuals (ROCHARD et al.2001) scattered over a very large area from the Bay of Biscay to the North Sea (ROCHARD et al.1997). Natural reproductions were last observed in 1988 and 1994 (WILLIOT et al.1997).

The species is classified as critically endangered (CR - A2d) according to the IUCN criteria, and considered extinct in the following countries of its former range: Albania, Algeria, Croatia, Denmark, Georgia, Greece, Ireland, Italy, Morocco, Norway, Portugal, Romania, Russian Federation, Slovenia, Spain, Sweden, Switzerland, Turkey and Ukraine. It is now one of the most threatened fish species in Europe, being in a critical danger of extinction (ROCHARD et al.1990). The species is strictly protected (IUCN Red List) also under a number of International and European legislations (e.g. CITES, Bern Convention, European Habitat Directive) as well as under national legislation in most countries of its historic range. An Action Plan for the conservation and restoration of the European sturgeon under the Bern Convention (ROSENTHAL et al. 2007) attempts to stop this decline and secure the future for this species, first in the Gironde River and ultimately throughout the species historic range in general.

2. Onset of remediation measures

Until the 1990s the idea of conservation of a fisheries resource has not finally been accepted in scientific community and general public, more likely loosing the species due to lack of prevention was considered inevitable at this time as outlined by NELLEN et al. (1994). The slow change in attitude concerning the conservation measures for the sturgeon in Germany in the 1990s was mainly influenced by the altered perception of biodiversity and the measures necessary to protect them (EU FLORA FAUNA HABITAT DIRECTIVE 1992). Furthermore, it was supported though the decreasing in pollution in the course of the German unification. This helped to make large systems like the Elbe River available for re - introduction measures. In an attempt to facilitate the remediation of the species, the Society to Save the Sturgeon was founded in 1994, as a means to coordinate the planned measures on a national basis, unifying practitioners, administrators and researchers jointly working towards this aim. This development was promoted by the success with the re - introduction of the salmon in tributaries of the rivers Rhine and Elbe.

Since 1996 the Federal Agency for Nature Conservation supported an initial investigation to determine the status and the prerequisites for a successful conservation of the species and to start with the necessary preparations. At the same time the first successful reproduction performed by the French researchers allowed to support the bilateral cooperation with the first exchange of fish from the Cemagref (Centre national du Machinisme Agricole, du Génie Rural, des Eaux et Forêts, Bordeaux, Frankreich) to the IGB (Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany) for behavioural research and as a starting point for the broodstock development (WILLIOT et al. 2000).

3. Genetic characterisation of populations

In order to verify the hypothesis that *A. sturio* comprised different geographic subunits based

upon morphological data (HOLCIK 2000, ARTYUKHIN & VECSEI 1999) and to assess the genetic differences described for the last sturgeon caught in the Baltic Sea in 1996 and the French population (BIRSTEIN et al. 1998) a genetic assessment of the status of the Baltic sturgeon was carried out, aiming at the determination of the suitability of the French *A. sturio* for the Baltic Sea remediation programme. The analysis was performed using excavation material a well as museum specimens originating from catches from the Baltic, North Sea and the north - eastern Atlantic. LUDWIG et al. (2002) confirmed the species assignment for the Baltic sturgeon as *Acipenser oxyrinchus* but also (LUDWIG et al. 2000, 2004) confirmed the large similarities between the Gironde and the North Sea populations, comprising a single haplotype according to the mitochondrial DNA (mtDNA) analysis. Therefore, it was concluded that the fish originating from the Gironde are suitable for the remediation of the North Sea populations. Nevertheless, the heterogeneity within the French population showed a marked decrease between 1823 and 1993, indicating the need to develop breeding plans for the ex-situ stock to avoid a further decrease of the genetic heterogeneity.

4. Development of the French *ex-situ* stock

The lack of fish from the wild in Germany and other regions of the historic range limited the options for the development of an ex-situ stock and the subsequent reproduction from this stock. The only option for the establishment of such a brood stock was the cooperation with the French Cemagref.

The French work on the protection of *Acipenser sturio* dated back to the 1970s when the decline of the Gironde population became manifest (ROCHARD et al. 1990, LEPAGE & ROCHARD 1995, WILLIOT et al. 1997). In order to develop the biotechnologies for the successful reproduction of the species initial trials were carried out with Siberian sturgeon *A. baerii* since the onset of the 1980s. In parallel, mature *A. sturio* spawners were collected from the Gironde River for controlled reproduction. Within 15 years of experimental reproduction trials only three reproduction attempts succeeded in fertilizing eggs while only the last reproduction in 1995 lead to the successful rearing of larvae. Several hundred of the fish were integrated into the French ex - situ stock that was developed primarily of wild caught fish since the onset of the 1990s (WILLIOT et al. 1997, 2000). This reflects a change in the strategy that took place in the early 1990s when after a decade of trials to catch and reproduce mature sturgeon, the development of an ex - situ stock became widely accepted. This stock mostly comprised fish of 1994 and 1995 reproductions as well as some fish of 1988 and earlier year - classes., while older year classes mostly had to be released following the reproduction attempts according to the policy of the French government at that time.

Fish from the ex-situ stock were successfully reproduced in 2007 for the first time (WILLIOT et al. 2009). This initial success was repeated in 2008 and 2009. In total 130.000 fish were produced and the vast majority was released into the Dordogne and Garonne Rivers.

5. Development of the German *ex-situ* stock

Following the reproduction of 1995 the first 40 fish were transferred to Germany in April 1996 for experimental purposes. It was agreed to apply different rearing methods in France and Germany to increase the availability of information about the biology of the species. Salinity of the rearing water, illumination, and handling were among the parameters that differed between the strategies (WILLIOT et al. 2002). Feeding also was carried out following different approaches. At IGB different feed items were tested (KIRSCHBAUM et al. 2006) while the French stock mainly was supplied with two shrimp species (WILLIOT et al. 1997). Until 2007 these differences in rearing practice did not result in significant differences in performance between the two groups (compare fig. 3 for the growth of the German stock over 15 years).

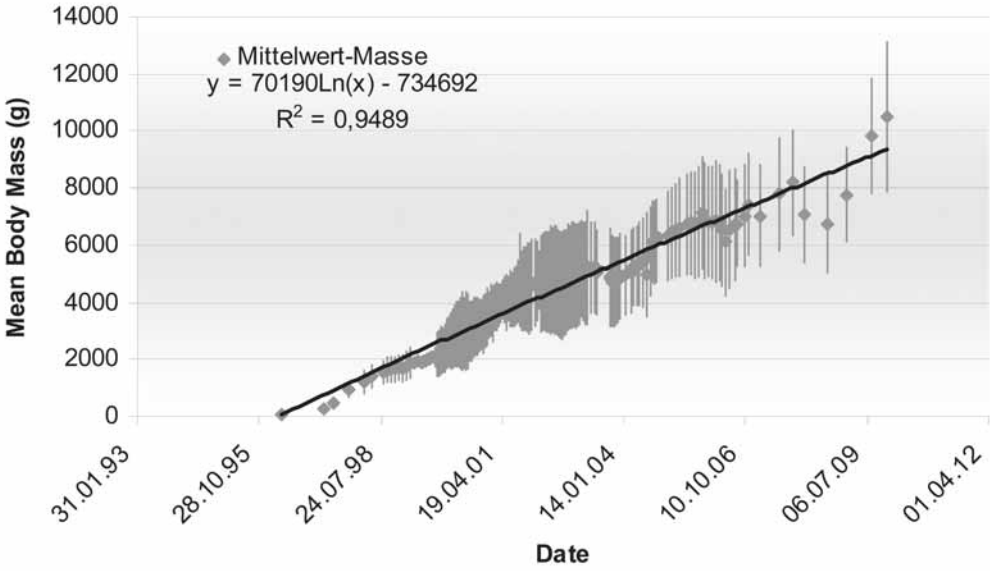

Fig. 3: Mean weight of *Acipenser sturio* of the German ex situ stock between 1996 and 2009.
Abb. 3: Mittlere Masse der *Acipenser sturio* des ex-situ-Bestandes am IGB zwischen 1996 und 2009.

The main drawbacks with regard to the rearing of the species are associated to the feeding preferences. The 1995 cohort of *A. sturio* was not weaned to formulated diets (KIRSCHBAUM et al. 2006). With the frozen diets, initially being utilized as a means to prevent adverse effects of formulated diets, the potential for the introduction of pollutants with Chironomids and of pathogens with Chironomids and Shrimp increased. This was verified after 12 years of rearing when elevated heavy metal and polycyclic hydrocarbon contents (KIRSCHBAUM et al. 2009) were determined during a phase of elevated mortalities.

Since 2005 the gonad development (BRUCH et al. 2001) of the German stock revealed occasional maturation of both males and females without simultaneous occurrence, preventing successful reproduction up to 2009.

6. Initial experimental release

The first release of *Acipenser sturio* took place in the middle part of the Elbe River near Lenzen (rkm 485) on September 4th, 2008 (fig. 4) being accompanied by supporters and cooperation partners both regionally and internationally. The 50 fish released (mean body mass of 62 g and 26 cm total length) originated from the first controlled reproduction of the ex - situ stock in France in 2007. They were tagged with grey Floy T-bar anchor tags at the base of the dorsal fin (fig. 5). Fishermen and anglers were informed to release and report occasional catches through flyers and direct contacts as well as press articles prior to the release. Three recaptures were reported 1-2 days following release from fyke net fisheries 30 km below the release site. No further catches were reported.

6.1. Telemetry of juvenile *Acipenser sturio* in the middle Elbe River

One individual (35 cm length, 158 g body mass) was equipped with an ultrasonic transmitter (Vemco V9-1H) in the body cavity (for the implantation method see Fredrich et al. 2008) and released at rkm 485. Tracking was carried out by boat with a hydrophone receiver

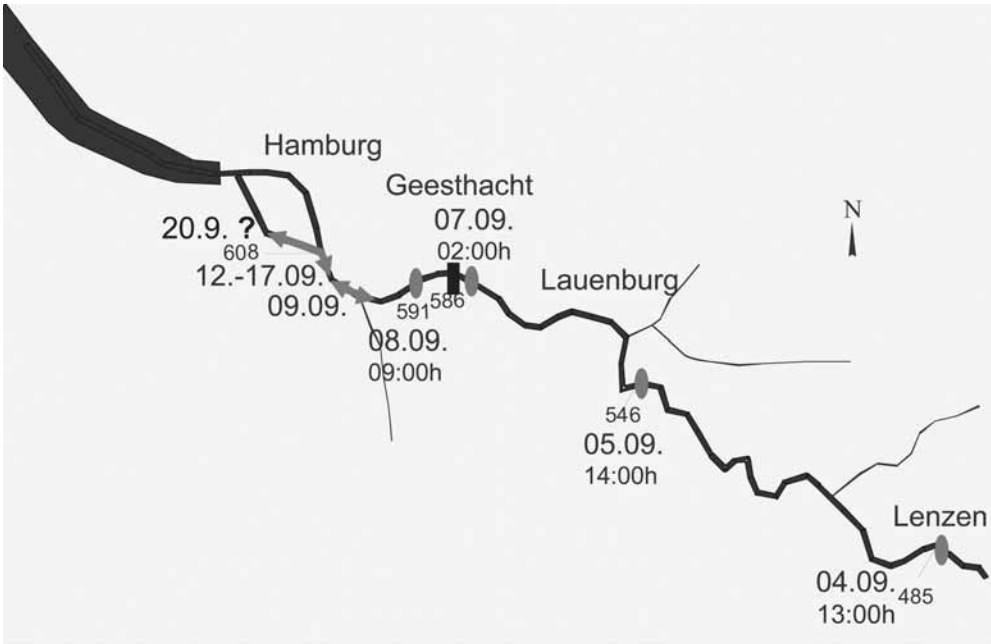

Fig. 4: Map of the migration pattern of *Acipenser sturio,* released at Lenzen (rkm 485) on September 4th, 2008, in the middle Elbe River to rkm 620.
Abb. 4: Karte der Wanderbewegung des *Acipenser sturio* aus experimentellem Besatz am 4.9.08 in Lenzen (Elbe km 485) bis zum Hamburger Hafen (Stromkilometer 620).

Fig. 5: European sturgeon (*Acipenser sturio*) with external T-Bar anchor tag for identification.
Abb. 5: *Acipenser sturio* mit externer Markierung zur Identifikation.

combination. The migration distances given were determined by GPS as longitudinal net downstream tracks.

Upon release the fish covered a distance of 17 km in 5 hours (fig. 4), while commencing downstream migration with an average speed of 3.5 km h^{-1} until the next morning. During the next days, the migration speed slowed down from 1.5 km h^{-1} to below 0.5 km h^{-1}, while approaching the weir at Geesthacht. For 2 hours the fish was tracked in the headwater until it crossed the weir during night.

Reaching the tidal freshwater part of the river the fish altered its migration pattern. In this river stretch the fish mainly moved with the tide, especially during the night. Over 5 days these movements took place in the same area, not resulting in significant net distances covered. The water - depths utilized during migration resembled those during stationary phases with the fish preferring the deepest channels and associated structures. As a result of small scale movements with the tide the fish reached the harbour area through the southern branch of the Elbe River but returned upstream in the mornings for 4 days.

After the 20th of September the fish has not been recorded again upstream or downstream of the harbour during the following weeks. This might indicate that the fish was staging in the harbour basins until the transmitters ran out of battery.

7. Perspective

The subject areas for the future work and the main fields for improvement of the restoration strategy are outlined in the National Action Plan for the protection and remediation of *Acipenser sturio*, currently under publication (Gessner et al. 2010). Four core elements are flagged out in this plan to reduce or stop the continued decline in free ranging populations, ensure the long term availability of brood stocks with sufficient genetic heterogeneity, and to improve the habitats especially for the critical early life stages in an internationally coordinated approach.

7.1. Expansion and effective utilization of the German *ex-situ* stock

7.1.1. Improvements of condition and effective reproduction of the 1995 year class

To allow repeated reproduction from the 1995 year class, the energy allocation and the physiological condition of the fish has to be optimized through optimal feeding regimes and improved rearing conditions, allowing a timely identification of mature fish as well as the controlled hibernation to induce a synchronized maturation of the fish. Effective control of the temperature and photoperiod are considered essential to allow the synchronous development of the gonads in the fish of the ex-situ stock. In 2009 it became apparent in *Acipenser sturio* too, that decreasing salinity in an attempt to simulate migration is not essential to induce the maturation effectively. This is in agreement with the first results indicating maturation in fish reared exclusively in freshwater in 2005 in the IGB facilities. More detailed research will be required to fully understand the maturation process and the important key factors contributing to it. Improved fish growth of the IGB stock during 2009 indicates a change in the physiological state that should be reflected in progressing gonad development soon.

7.1.2. Integration of F1 fish from controlled reproduction into the broodstock

Since the chances to effectively integrate live caught *Acipenser sturio* from the commercial fishery into the captive brood stock are close to zero, the focus for the future strategy is the increased integration of F1 fish from controlled reproduction into the ex-situ stock. The first steps were performed with the inclusion of 150 individuals of *A. sturio* from the reproductions of 2007-2009 by the Cemagref which were transferred year by year. These fish are currently weaned to dry diets to increase energy availability and to avoid long-term adverse effects through contaminants.

7.1.3. Breeding plan

In order to maintain the genetic heterogeneity in the F1 and subsequent generations, genetic breeding plans are developed, allowing to identify the crosses with high and low genetic value for the population. The major prerequisite for such a breeding plan is the genotyping of the fish in the ex-situ stock, currently carried out in cooperation with the University of Potsdam.

7.1.4. Cryoconservation

To enable the effective maintenance of genetic heterogeneity in the crosses, the availability of gametes is essential to fulfill the genetic breeding plan. Since the maturation intervals in sturgeon are long and differ between the sexes, it cannot be guaranteed that males and females of a given genotype are mature in the same year. Therefore, initial attempts to effectively provide sperm regardless of the maturation status of the male are required. Cryoconservation of sperm provides this asset, if adapted to the physiological peculiarities of the species. Preliminary data show that methods are available already to store sturgeon sperm over years with only minor degradation symptoms with regard to motility (HORVATH et al. 2008, MORISAWA 2008). Currently, long-term effects on fertilization and hatch rate are determined, also more directed research is required to identify genetic selection effects imposed through cryoconservation. Today the techniques available are suitable already to help minimizing the bottleneck of unsynchronized maturation. Further adaptations are on their way in close collaboration with Hungarian and French researchers.

7.2. Determination and characterization of habitat

The initial results deriving from the telemetric research in 2008 raised a couple of questions that have to be addressed in the upcoming years. The driving force for the fast coverage of the middle Elbe reaches, the criteria determining the suitability of habitat, the role of the tidal currents in migration patterns, as well as the feed preferences and feed availability remain to be explored in detail. For the future, the time and the pattern of acclimation to increased salinity are important points to verify the potential utilization of the estuary by different cohorts of fish. The identification of potential threats such as low oxygen contents in the harbour area, fisheries impact and water abstraction remain to be identified.

For this purpose the research was continued in spring 2009 in the main tributaries to the lower Elbe River, the Oste and Stör rivers. Here, the identification of migration patterns in tidal waters can be performed without the drawbacks of the size of the tidal Elbe River with its heavy traffic.

The long-term aim of the research is to develop an age specific habitat utilization model, to characterize the minimal requirements of the species. Such a model also is designated to serve as a tool to evaluate the functional state of habitat in river sections for the species as well as the restoration requirements.

7.3. Imprinting of juveniles to a native river

A further important prerequisite for successful remediation attempts of the species is to ensure the imprinting of the fish prior to or at release. In sturgeons, the timing and the mechanism of imprinting are only understood to a very limited extent. Unlike salmonids, imprinting does not take place at a well - defined physiological state. From Russian literature, it was concluded that imprinting sets off at the onset of exogenous feeding (Boyko 1999). Return of fish released a later life cycle stages has been observed (Mark Bain, pers. comm.) but the extent is undiscovered. Genetic data from American Gulf sturgeon (*A. oxyrinchus desotoi*) indicate that more than 94 % return rates occur per generation and straying takes place mostly between neighbouring basins. Therefore, to focus the attempts to initiate a self-sustaining population in a given river

Fig. 6: European wide information and reporting campaign to raise awareness and to increase releases of *Acipenser sturio* bycatch in the commercial fishery (courtesy CNPMREM 2008).
Abb. 6: Europaweite Information und Berichterstattung, um die Kenntnis über *Acipenser sturio* und die Freisetzungsrate von Beifängen der kommerziellen Fischerei zu erhöhen (mit Genehmigung der CNPMREM 2008).

system, the effectiveness of homing should be as high as possible. For this reason as well as to adapt the early life stages to the pathogens of the river system in dues time, rearing of stocking material is to be carried out in the river, preferably in the vicinity of potential spawning sites. Since no rearing facilities are available in those sites, the development of a mobile hatchery system takes place under the current project by the Federal Agency for Nature Conservation: These containers are intended to be run by local practitioners (e.g. fishermen) to increase the active participation of the fishery in the remediation programme.

7.4. Increasing awareness and cooperation in the fishery

To avoid the loss of subadult sturgeons from the Gironde population in coastal waters of Germany and other North - Sea countries, a major information campaign was carried out, initiated by the French Association of Commercial Marine Fisheries (CPNRM). This campaign was expanded from France to the range states with flyers and information material being translated and distributed through fisheries associations, fisheries administration and research institutions. The campaign (fig. 6) aims at commercial and recreational fishermen to increase their awareness, resulting in higher proportions of released fish and increasing the reporting fidelity of the fishermen involved in a catch. The effects would comprise increased survival and thereby a stabilization of the last reproductively active population as well as increased knowledge on the distribution of the fish during their time in marine habitats.

7.5. Stakeholder support

With the onset of the experimental releases, the focus of research will change to facilitate the transfer of the results of the monitoring work into strategies to improve habitat and to reduce anthropogenic stressors upon the population For this purpose the involvement of stakeholders in the river catchments is of vital importance for the long - term success or failure of the measures taken. A local network of practitioners as well as administration and management bodies will be of major importance to effectively tackle the open questions evolving. The framework will be set by the National Action Plan under the Bern Convention, outlining the major fields for activities. This document will subsequently set the baseline for the management plans to be developed for the river catchments involved. These measures are planned to lead to a long - term establishment of self - sustaining populations of *Acipenser sturio* in the river systems where they once were abundant resources. This target will not be achieved without lasting support of the Federal and regional agencies.

From a practical viewpoint, the most crucial part is the continued exchange and collaboration with the French partners not only for the transfer of fish for broodstock development and stocking but also for the joint identification of problem - areas effectuating the Action Plan and the research strategies required. This is also essential for the development of common methodologies and approaches towards the final aim of the remediation. In this scenario, the German attempts to establish a natural population are also part of a strategy to minimize the risk of the loss of the Gironde population. This approach was the target of Prof. Kirschbaum's initial steps in establishing contacts with the Cemagref in the mid 1990s. These initial contacts led to the transfer of the first fish in 1996 despite the adverse position of parts of the French administration.

Acknowledgements

Over 12 years Prof. KIRSCHBAUM continued the intensification of the bilateral contacts in an attempt to ensure the continuous supply of material and to establish an open cooperation. Also, his long term commitment and his persistent efforts to improve the infrastructure and rearing conditions at the IGB have laid the foundations for bringing the program to the

status today. At the occasion of the first release of 50 *A. sturio* in the Elbe River in September 2009, Prof. KIRSCHBAUM was rewarded for his achievements and contributions to the German restoration project with a golden sturgeon needle by the Society to Save the Sturgeon.

The work described above and the underlying research as well as the program on the remediation of the Baltic sturgeon would not have been possible without the support and contribution of the Federal Agency for Nature Conservation, the Federal Ministry for the Environment and the Federal Ministry for Science and Technology. Long term commitments and effective support was also provided by the regional administrations and research institutions of Mecklenburg - Vorpommern and Schleswig - Holstein as well as Brandenburg.

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