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AND NATURAL HABITATS

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Draft Action Plan for the conservation and restoration of the European Sturgeon

(Acipenser sturio)

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The European sturgeon (*Acipenser sturio* L.1758) is an anadromous (migratory) fish, spending most of its life in marine waters while returning to its native river for reproduction. The vernacular name "common sturgeon" reflects an earlier status as a well known species with high economic importance across its former range. Of all sturgeon species in Europe, A. *sturio* historically had the largest area of distribution among European sturgeon species. The status of the species has completely changed during the last century.

Besides man-made changes to rivers such as embankments, the construction of hydrodams (which block the upstream migration to spawning sites), and pollution overharvest has been identified to be among the key elements that caused the dramatic decline of the populations.

There are **five primary problem areas** impacting on survival and reproductive efficiency of the species (ranked in approximate order of importance):

- accidental catch (bycatch) and illegal fishing (poaching) are critical to the survival of very limited number of remaining individuals;
- drastic changes of hydrologic and hydrodynamic regimes in rivers and estuaries (i.e. sand and gravel extraction, dyking and channelization, hydrodams and navigation barriers) are greatly affecting spawning and nursery habitats and block migration to spawning sites;
- environmental pollution (i.e. agricultural, domestic and industrial wastes in rivers and estuaries) drastically affects the reproductive success;
- restriction of the chances for natural populations to effectively reproduce due to very small size of the highly dispersed remaining population (Allee effect); this would be enhanced even further with continued catches additonally reducing the mating probability;
- interspecific competition with allochthonous species, disease transfer, and potentially risk of hybridization pose additional threats to the dwindling natural population, particularly if introductions are not reduced to negligible levels;

Additionally, climate change may also have an impact on future performance characteristics of the species.

The current situation with only one known remaining population worldwide in France, in the Gironde, Garonne and Dordogne basin, is dramatic. Although the size of the North-East Atlantic population remains unknown it is commonly admitted that this population is probably limited to no more than just a few hundred individuals. **All indicators concur that this is now one of the most threatened fish species in Europe, being in critical danger of extinction.**

It has to be noted that a small population is more at risk of extinction than a large one. Continuous environmental change (environmental stochasticity), requires a minimal potential for adaptation. It is more likely that a larger population contains the entire genetic diversity, providing a better fitness for adaptation to environmental alterations. The longer the period with a critically small population lasts (genetic bottleneck), the higher the risk for loss of fitness for survival and subsequent risk of extinction.

Additionally, the Allee effect (Myers *et al.* 1995) predicts a negative growth rate at extremely low population sizes even if all environmental factors are favourable. Low numbers limit the chances for spawning encounters. This effect is compounded for sturgeons since adults only reproduce at long intervals. It is estimated that females mate only two or three times per decade, additionally limiting the encounters of mature fish at low population size.

Even the loss of one single adult specimen would be significant, compromising the future of the species at the currently critical state of the population.

Therefore, action is needed now to halt this downward trend.

To support a self-sustaining population of the European sturgeon is an obligation to which European member states have jointly and individually made a variety of serious commitments which

also would allow the re-establishment of the species in key areas of its former natural range. These measures would also provide an important contribution to maintain biodiversity. This species with its diverse habitat requirements and high longevity can also serve as an indicator species, integrating over space and time the effectiveness of conservation measures.

Presently, a multi-task approach seems to offer the most promising options for rescuing and recovering the species. It is concluded that:

(a) A consequent and massively supported *ex-situ* conservation programme to take advantage of the specimens already secured is inevitable,

(b) An *in-situ* conservation programme aggressively enforced is needed to prevent further loss of the remaining specimens and also to recover them for improving the genetic diversity of the *ex-situ* brood stock,

(c) A strategic (long-term) programme on habitat rehabilitation is required to assure that nursing and spawning sites meet the needs of the species and are accessible for the respective life cycle stages and

(c) A programme to re-establish self-sustaining populations in selected key areas within the historic range is aggressively promoted.

This Action Plan aims at preventing *A. sturio* from becoming extinct in Europe while subsequently reconstituting viable populations of the European sturgeon in its historic range through close national and international co-operation of range States, at all organisational levels. **The sequence of actions listed in this chapter resembles BY NO MEANS a priority listing. Many of the issues require simultaneous implementation of several actions while also some range states would need to place priorities in a different sequence than others**.

The plan has seven main conservation objectives which may be grouped under four general components. Details of the required measures for each of the actions are listed in Annex 1 under each of the objectives. Included are the responsible organisations, indicators of success and specific milestones to be reached. These components are:

- ✓ **Component 1** : *In-situ* conservation of *A. sturio*
- ✓ **Component 2** : Protection and restoration of essential sturgeon habitats
- ✓ **Component 3** : *Ex-situ* conservation and re-introduction of *A. sturio*
- ✓ **Component 4**: International cooperation

The specific objectives and related actions for each of these components have been identified as follows:

Component 1: *IN-SITU* CONSERVATION OF *A. STURIO*

Objective 1: Significant reduction of fishing mortality

The support of fishermen to a programme of reduction of accidental captures and of *in-situ* monitoring of the species is critical to success of the Action Plan. The experience in France clearly demonstrates that this is both practicable and possible.

Objective 2: Effective control of allochthonous species

The introduction and transfer of non-indigenous species poses a critical threat to changes of biodiversity, a fact of equal importance to the loss of native species. The present rate of increasing reports of exotic sturgeon species (including hybrids) within the native range of *A. sturio* is alarming, as these non-native species may negatively affect the integrity of ecosystems in which the common sturgeon thrives, mainly competing for habitat and food resources.

Component 2: PROTECTION AND RESTORATION OF ESSENTIAL STURGEON HABITATS

Objective 3: Protecting and improving the quality and continuity of essential riverine and estuarine sturgeon habitats

Habitats previously utilized by *A. sturio* as spawning and nursery grounds in riverine and coastal waters have deteriorated and information on their status and option for rehabilitation is scarce to non-existing. Current attempts under OSPAR try to overcome this problem. There is an urgent need to improve the knowledge base on the subject while also seriously addressing issues on habitat fragmentation and needs for interconnections ("ecological footholds").

Objective 4: Improvement of water quality

Water quality objectives certainly play an important role in habitat restoration and species recovery programmes. Our knowledge on requirements of various life cycle stages of sturgeons in terms of chemical and biological water quality criteria is fragmentary and needs urgent attention.

Component 3: *EX-SITU* CONSERVATION AND RE-INTRODUCTION OF *A. STURIO*

Objective 5: *Ex-situ* conservation of *A. sturio*

Presently there seems to be no alternative but to pursue *ex-situ* conservation to save the common European sturgeon from becoming extinct while building up a broodstock sufficiently large for mass reproduction and develop rearing programmes for release of produced juveniles into restored habitats.

The ongoing and successful small-scale ex-situ production of the species from captive brood stock in June 2007 certainly signals a highly positive option to achieve the above listed objectives.

Objective 6: Release of *A. sturio* for re-establishment or enhancement

The ultimate goal of the objective is to re-establish self-sustaining populations in as many areas of its natural range as possible. These releases have to be (a) substantial in number because of the high natural mortality, (b) long-lasting (for decades) because of the late maturity of the species and its extreme longevity, (c) at the right "time-size-release window" to minimize mortalities, and (d) at habitats of strategic importance for nursing and imprinting (homing).

Component 4: INTERNATIONAL COOPERATION

The six conservation objectives above have to be complemented by the establishment of an appropriate co-operation mechanism between all stakeholders, including governmental agencies, research institutions and NGOs in range states actively involved in sturgeon conservation projects and long-term programmes. Therefore, it is proposed to set up a European Group possibly comprising such active members from range States, to specifically discuss and co-ordinate the implementation of the Action Plan and relevant national actions. The composition of the group may vary, depending on the number of ongoing projects and programmes in participating range states.

Actions, Indicators and Milestones

All of the respective Actions, the measures needed to fulfil them, the groups or organisations to whom these actions are addressed and finally the milestones and indicators that can serve to follow the progress and success of the Action Plan are presented in great detail in the Table in Annex 1.

Gaps in science and technology to be urgently addressed

Certain gaps in Science and Technology need to be urgently filled to properly implement the Action Plan for sturgeon conservation. Some of the required knowledge base has an over-arching significance for several of the Actions and their required measures. While they are mostly included or implied in the proposed measures presented in Annex 1, these knowledge gaps are also presented and justified in Chapter 7. They have to be addressed flexibly and directly within the proposed measures and/or independently carried out by national, international and EU-supported research projects. Such actions will greatly assist the achievement of the milestones and indicators in a timely fashion, thereby contributing to the survival and restoration of the European Atlantic or Common sturgeon as a European heritage.

1. INTRODUCTION

The European sturgeon (*Acipenser sturio* L.1758) is an anadromous (migratory) fish, once one of the most widespread of sturgeon species. The vernacular name "common sturgeon" reflects an earlier

status as a well known species with high economic importance across its former range. Status of the species has completely changed over the last century. 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 now 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.

The European sturgeon is now restricted to only one known relict population in the Gironde, France. This population reproduces infrequently and reveals signs of a continuous, substantial decline over the last few decades. The main reasons for the dramatic decline of the species are anthropogenic activities such as overexploitation, modification of habitats and pollution.

The Action Plan attempts to arrest this decline and secure the future for this species, first in the Gironde and ultimately throughout the species historic range in general.

The sturgeon has a complex life cycle, requiring a variety of different habitats throughout its very long life span (Holčik *et al.* 1989; Dettlaff *et al.* 1993, Holčik , 2000). These characteristics make the species an ideally suited indicator for environmental quality and connectivity and an excellent model species for good ecological status in rivers, estuaries and marine waters as has been outlined in the Ramsar Declaration on Global Sturgeon Conservation (Beamesderfer & Farr 1997; Rosenthal *et al*. 2006).

A self-sustaining population of the European sturgeon would provide an important contribution to maintaining biodiversity, which is a strict obligation under a number of national and international regulations.

Finally, the species supported in the past large-scale fisheries in a variety of rivers in its former range. As an important socio-economic factor in the coastal communities it enjoyed an iconic status and is still very present in the minds of many people. Decreasing populations rendered the fishery uneconomic. Protection has banned any legal harvest for the last few decades. However, when viewed from a long-term perspective, (which according to experience with *A. oxyrinchus* recovery in the Hudson River might take 80 years), the idea that a restored sturgeon population could support a sustainable exploitation (St-Pierre 1999; Collins *et al*. 2000) still needs to be proven although the potential is known from other anadromous teleost species through continued stocking programmes. Sofar, no experiences are available on complete restoration of extirpated populations in habitats previously inhabited but some examples exist on recovery of critically reduced populations through well-managed programmes (e.g. Winnebago Lake Sturgeon Management programme in Wisconsin, USA, over the past 40 years).

The main problems for the conservation and restoration for the European Common Sturgeon are the small population left in the wild, the complex life cycle and cultivation challenges, as well as those anthropogenic factors negatively influencing the natural population described above.

These are all good reasons in support of a proactive approach towards effective conservation, sound recovery and sustained resource use measures. The development of the Action Plan for the conservation of the European sturgeon will effectively draw the attention of the contracting parties to the Bern Convention towards the requirements of this approach.

II. DESCRIPTION OF THE SPECIES

2.1 Phylogeny

Sturgeons and the closely related paddlefishes belong to the class of bony fishes, the Osteichthyes, within which the subclass Actinopterygii (ray-finned fishes) includes the Chondrostei and the order Acipenseriformes. The order Acipenseriformes is composed of three families, of which the family Acipenseridae (sturgeons: 26 species in the genera *Acipenser*, *Huso*, *Scaphirhynchus* and *Pseudoscaphirhynchus*) as well as the family Polyodontidae (paddlefishes; containing the two monospecific genera *Polyodon* and *Psephurus*) are still represented by living species. The third family, the Chondrosteidae, is extinct and comprises species known from archaeological records only.

Acipenseriformes are confined to the northern hemisphere (Holčik, 1989; Birstein *et al.* 1997a, b). Biogeographic analysis suggests that the order originated approximately 200 million years ago. Early diversification took place in Asia. The majority of species today occurs in East Asia (9 species), North America (8 species), the Ponto-Caspian region (6 species), and the remainder in North Western Europe (3 species).

State of the art scientific knowledge of most species has been presented in the Proceedings of a series of specific International Symposia on Sturgeons (ISS) which were held at 4 years interval: first in Bordeaux, France in 1989 (Williot 1991), 1993 in Moscow, Russia, (Gershanovich and Smith 1995), 1997 in Piacenza, Italy, (Rosenthal *et al.* 1999), 2001 in Oshkosh, Wisconsin, USA (Rosenthal *et al.* 2002), and more recently in Ramsar, Iran in 2005 (Rosenthal *et al.* 2006).

2.2 Species identification

Sound taxonomy is a prerequisite for biodiversity conservation. Many sturgeon caught in Western Europe today are actually non-indigenous species originating from aquaculture escape or illegal and accidental releases (i.e. aquarium hobbyists and petfish industry; Arndt *et al*. 2001). The European Sturgeon can be identified by a number of morphological, morphometric and genetic characteristics. However, under field conditions discrimination between species can be difficult and in most cases requires expert assistance. The following chapters give a short description of the characteristics of *A. sturio.* For a more detailed overview of the sympatric species in European waters we refer to the Action Plan for the conservation of sturgeons (Acipenseridae) in the Danube River Basin (Bloesch *et al*. 2006: Council of Europe Publishing; Nature and Environment No 144).

2.2.1 Morphological Characteristics

The body of the European sturgeon (*A. sturio*) is elongated with a maximum depth of 10 – 13.5% of the total length. It is covered with 5 longitudinal rows of bony plates (scuta). The number of dorsal scutes varies from 12 - 15, the lateral scutes from 31-39 and the ventral scutes from 11-14. Between the rows of scutae the skin is covered with rhombic platelets, resembling the remains of an external amouring. The tail is heterocercal with an extended upper lobe. The dorsal fin is located in a posterior position, comprising 30-50 soft fin rays. The snout is pointed with the protrudable mouth being located in an inferior position on the ventral side of the head; the lower lip is divided. The four barbels are positioned approximately half way between the tip of the snout and the mouth. *A. sturio* has 16-26 branchiospines on the first gill arch (Marti 1939; Magnin 1963; Ninua 1976; Almaca 1988).

Figure 1 - Acipenser sturio (source Bauchot 1987)

The back is grayish-brown with green reflections. The belly is yellowish-white with silver reflections. The maximum length is reported to exceed 3.5 meters with a weight of more than 300 kg. Anecdotal information indicates that in rare cases specimens may have reached up to 5 meters in total length. Holčik *et al*. (1989) gives size ranges for a number of areas during the past century, indicating that the average total length of fish entering the rivers ranged between about 94 to 220 cm for males and 105 to 250 cm for females.

For detailed morphological characteristics compare Marti 1939, Magnin 1963, Holčik *et al*. 1989, Arthukhin & Vecsei 1999, Ludwig *et al*. 2002.

2.2.2 Morphometric characteristics

The proportion of the head relative to overall body size varies with size due to allometric growth. A number of typical morphometric characteristics have been established for *A. sturio* allowing

discrimination of the species from the sympatric species. For details see Elvira *et al*. 2000, Gröger & Debus 2000, Magnin & Beaulieu 1963, Ninua 1976. Also, a fairly comprehensive analysis of the pertinent literature on morphometrics, sexual dimorphism and geographic variation in meristic characters is given by Holčik *et al.* (1989).

2.2.3 Genetic identification

Acipenser sturio has 116±4 chromosomes (Fontana & Colombo 1974, Fontana 1976). The species has been described to have species-specific mitochondrial (mt) DNA patterns on Cytochrome (Cyt) b, 16s, 12s and D-loop (Birstein *et al*. 1998, Ludwig & Kirschbaum 1998 and 2000; Ludwig *et al*. 2000; 2002), as well as microsatellites (Ludwig *et al*. 2002). Coding genes of the MHC class have recently been used for species characterization (Tiedemann *et al*. 2007).

2.2.4 Behavioural characteristics

Experimentally, (Magnin, 1962) demonstrated that *A. sturio* become progressively tolerant to salt water and cannot move to sea before they reach 50 cm . These results are coherent with historical and present field observations. An extensive monitoring of a cohort of juveniles in the Gironde estuary and in the nearby coastal areas provided a sound understanding of their progressive movements through the estuary (Rochard *et al*. 2001; Taverny *et al*. 2002; Lepage *et al*. 2005). In the Black Sea, young-of-year *Acipenser sturio* are reported to leave the estuary and migrate along the coast (Ninua 1976).

According to both field investigations (Brosse *et al*. 2000), as well as laboratory studies (Hensel *et al*. 2002; Kirschbaum *et al.* 2006), food selectivity is reported to be very specific.

2.3 Life Cycle

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 (Holčik *et al*. 1989). More detailed and highly demanding research is urgently required to improve the status of the remaining population. Specific knowledge on habitat requirements, feed preferences and environmental clues (including behaviour) is very important to understand the underlying reasons for the decline of the populations and the restoration requirements.

It should be noted that most of the available knowledge on the ecology of the species described in the following has been acquired for the European sturgeon of the Gironde. Some data may be specific to this region and to the state of the population in the 1990's while older literature from various other regions describing habitat utilization by various age classes and migration patterns as well as hardiness, feeding habits, longevity, growth rates, spawning periods and sites may no longer reflect the actual ecological status (Holčik *et al.* 1989).

The life cycle of the European sturgeon comprises several stages (Figure 2). The European sturgeon is an anadromous migratory species, utilizing fresh water, estuaries and marine habitats at different life cycle stages. Adults live on the continental shelf. When entering the stage of maturity, they return to the river they originate from in order to reproduce. While in the estuary and lower reaches of the rivers, the driving external triggers to reach final maturity for spawning are substrate structure, water discharge volume, temperature profile and the presence of conspecifics (Detlaff *et al*. 1993). Spawning takes place in early summer (May to June in the Gironde, France). Historically, the spawning period in other European rivers has been reported to occur from April to May (in the Guadalquivir, Spain); and between June and August (in the Elbe River and its tributaries such as the rivers Eider, Oste and Stör, Germany), from March to June in the Po River (Pavesi 1907) slightly earlier in the Tyrrenian rivers (D'Ancona 1924a). Spawning takes place in swift currents over suitable substrate.

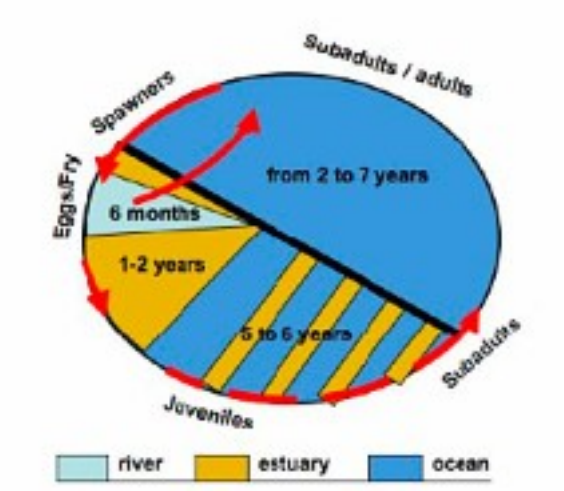

Figure 2 – Habitat occupation and migration of various life cycle stages of A. sturio in the Dordogne basin, France (source: modified after Castelnaud et al. 1991)

The first stage from spawning, embryonic development, onset of feeding to the fingerling stage takes place in the lower reaches of rivers (bream region). Spawning occurs over habitats with coarse gravel (pebble), at considerable water depth (either in the main channel or in lotic branches), and current velocities between 0.8 and 2.0 m/s. Clear descriptions for habitat characteristics, habitat shifts during early larval and postlarval stages are incomplete or lacking for most previously known nursery areas. At an age of 6 months, young-of-the-year sturgeons migrate downstream until they reach the estuary (Fig. 2). They stay in areas of low salinity (<8 ‰) during their first year (Elie 1997). The brackish reaches of the estuary with moderate salinities are utilized by juvenile fish for a period of about 1-2 years. Between the age of 2 and 7, the juvenile fishes reveal an alternating movement between the sea and the estuary (known as the St. Jean migration). In the marine stage they stay on the continental shelf, starting at an age of 7-8 years, when they are referred to as late juveniles. At this stage, migrations back to the estuary are rare.

2.3.1 Fertilized eggs and free embryos

The eggs have a sticky coating and are fertilized in the open water. They do not float but sink to the bottom where they adhere to clean, coarse gravel and stones. The incubation time is temperature dependent, lasting for 4-5 days at 17-20°C (Williot *et al.* 2000). Other studies report incubation times ranging from 3 days (22°C) to 14 days (7.7°C) (Roule 1922 & 1925; Chalikov 1949; Spillmann 1961). Hatching takes place at a very early ontogenetic stage while still being considered as embryos with a large yolk sac, incompletely developed eyes and the mouth not yet opened. During this stage, fish rely on their yolk sac for provision of energy and nutrients. In the river, the hatched embryos and early larvae drift downstream and settle in crevices in the gravel where they continue their development. This phase still takes place close to the spawning sites.

2.3.2 The fry stage

Following the complete absorption of the yolk reserves, the fry start feeding on tiny plankton organisms for some days. During the onset of active feeding they gradually drift further downstream to more productive feeding grounds. Gradually, they undergo metamorphosis and convert from a pelagic to a benthic lifestyle, feeding mainly on bottom invertebrates, especially on oligochaetes and chironomid larvae, which they detect by the use of electroreceptors and taste buds on the barbels. This freshwater phase lasts approximately six months (Magnin and Beaulieu 1963, Kinzelbach 1987, Holčik *et al*. 1989). The behaviour throughout this stage is not well documented and may differ substantially from what is known in other sturgeon species. This leaves critical questions still unanswered, mainly concerning habitat specifications, feed selection and migratory behaviour in general (knowledge critical to ex-situ conservation and recovery programmes). In the first winter, the fry disperse notably while migrating to the estuary.

2.3.3 The juvenile stage

During the first two years of the juvenile stage, the fish of the Gironde stay exclusively in brackish waters of the estuary. In contrast, the fish of the Rioni River are reported to leave the river mouth during October of the year of reproduction (Ninua 1976). With increasing size, they progressively become acclimated to higher salinity (from 5 to 25‰). In the Gironde it has been observed that these life stages are found in high densities in some preferred areas with a sandy bottom, a depth exceeding five meters and temperatures of about 20°C (Rochard 2002; Rochard *et al.* 2001, Castelnaud *et al.* 1991).

The second phase of the juvenile stage commences between the ages of 2 to 8 years, when the fish are beginning to migrate to marine waters but regularly return to the estuary during winter.

2.3.4 The late juvenile stage

From the age of eight years onward, the sturgeons undergoe sexual differentiation and maturation assuming adult external characteristics. Both, late juveniles and adults live exclusively in the marine environment. All available data indicate that during its stay at sea, *A. sturio* continues to be littoral mainly utilizing sandy or muddy substrates. The late juvenile life cycle stages have never been observed directly (neither through tagging data or modern telemetry) and the only available data on their possible distribution in these habitats originate from catches by fishermen. Two thirds of the catch records for late juveniles were reported from the continental shelf in water depths of 40 to 100 meters (Rochard *et al.* 1997a, b).

2.3.5 The adults

The large adult specimens are predominantly utilizing marine habitats with only short reproductive phases spent in the freshwater regions of the rivers. Adult European sturgeon have been caught in the Adriatic Sea in water depths of up to 200 meters (Holčik *et al*. 1989). The European sturgeon of the Gironde reaches maturity at ages between 10 and 12 years in males and between 13 and 16 in females (Williot *et al.* 1997). In the Gironde, adults migrate to the spawning grounds between March and May. In the Elbe River spawning migrations were most common in May and June, lasting until July (Quantz 1903). Classen (1944) described the main spawning migration in the Guadalquivir River to occur between February and March. In the Rioni River, migrations into the estuary occurred at level temperatures of river and sea water approximately at 14°C predominantly in April and early May (Zarkua pers. comm.). In Italy the migrations at the mouth of the Po River started at the end of February, early March with the fish reaching the spawning grounds to reproduce from April until June (Paccagnella 1948).

Sturgeon do not reproduce every year and the frequency of their reproductive cycle is not very well known. It is believed that males do participate in reproduction events approximately every second year, whereas females may only take part at 3 or 4 year intervals (Williot *et al.* 2007). These assumptions are well in line with the reproductive behaviour observed in a number of other sturgeon species in the same geographic range (Van Eenennaam & Doroshov 1998; Hildebrand *et al.* 1999; Detlaff *et al*. 1993).

Taking into consideration the extremely limited population size of *A. sturio* and the very restricted year class strength presently available, this may explain why catches of males in the fresh water sections of the Garonne and Dordogne are about 3 to 4 times higher than the catches of females (alternatively selective fishing pressure could also explain the lack of females since similar effects have been observed in populations suffering from overharvest (Gessner & Arndt 2006; Gessner *et al.* 2006).

III. HISTORIC RANGE

The European sturgeon (*A. sturio*) is a anadromous species historically found in the major rivers and coastal waters of Western Europe, in the Black Sea, in the Mediterranean Sea, including the Adriatic and Tyrrhenian Sea along the Atlantic coast, from Portugal (South) to the Scandinavian Peninsula (North), in the North Sea and in the Baltic 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; Holčik *et al.* 1989). Of all sturgeon species in

Europe, A. *sturio* historically had the largest area of distribution (Holčik *et al.* 1989). However, the genetic status of the Baltic sturgeon is quite complicated as Tiedemann *et al.* (2007) have indicated with their hypothesis of a hybrid population between *A. sturio* and *A. oxyrinchus*. The range of the species since the 12th century excluded the Baltic Sea and its tributaries (Ludwig *et al*. 2002). The status of the species in the Black and Mediterranean Seas is uncertain with regard to the species validation (Holčik 2000, Elvira *et al.* 2000).

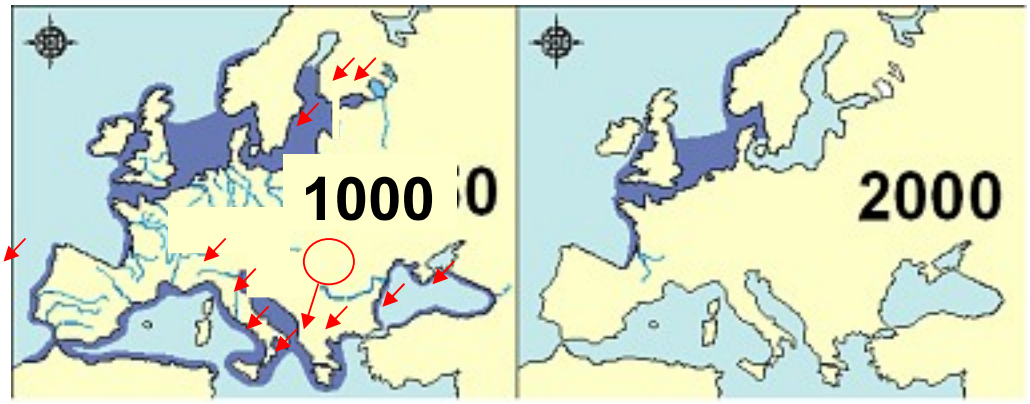

Figure 3 - Range and main distribution area of *Acipenser sturio* at 1000 (based upon the 1850 distribution and confirmed extirpation events) and 2000 A.D. The arrows indicate rivers that have been claimed to carry *A. sturio* populations (modified after various source: Holčik *et al.* 1989, Elie 1997 and Ludwig *et al*., 2002)

Antipa (1909) mentioned the existence of the European sturgeon in the Danube. He considered the species as relatively frequent at the Black Sea coast, near the mouth of the Danube River but the species was caught in the Danube River only very rarely, never occurring upstream of Km 100 – 150. During the 1950s Carausu (1952) noted the capture of a few adult specimens in the Black Sea near Agigea (Romania) and Burgas (Bulgaria). However, it is claimed that the European sturgeon was always rare in the lower Danube (Antipa 1909, Carausu 1952, Banarescu 1965, Manea 1980). The only officially recorded catches in Romania from the years 1947 to 1952 and 1960 to 1965, varied between 9 and 924 kg per year.

The European Atlantic sturgeon was present in Italy, together with *A. naccarii* and *Huso huso*, (Tortonese 1970, Gandolfi & Zerunian 1987et al 1991) in particular in the Po River and its main tributaries coming from the Alps, the Mincio, Adda and Ticino Rivers, and in the Adige, Brenta, Piave, Livenza and Tagliamento Rivers, out flowing into the Adriatic Sea. Its presence was also confirmed, from Venice to the Slovenian border, (Bini 1971) and in the rivers Tiber, Arno and Volturno out flowing into the Tyrrhenian sea. A reduction of sturgeon populations in Italy was firstly evidenced by D'Ancona (1924a), for the *Acipenser naccarii* and *Huso huso. A. sturio* was the dominant species, accounting for 80 % of the total catch in Italy in 1934 (Brunelli 1934). In the lower Po River and in the delta, sturgeons and caviar represented an important economic resource until the middle of 20th Century (Zaccaria & Masini 1991).

In the past, sturgeon entered the larger Iberian rivers from the Minho to the Guadalquivir, although their spawning could only be proven in the Douro, Guadiana, and Guadalquivir Rivers. Until recently it was present, in the Guadalquivir (Elvira and Almodóvar 1993), and apparently reproduced in the Douro. Until the river was first dammed, in 1971, the sturgeon ascended it and was considered a common species in the Tua-Barca d'Alva stretch, mainly at Pocinho and Almendra. It is known that when the first dams were built (Carrapatelo in 1971, Régua in 1973, Valeira in 1976, and Pocinho in 1983) some adult specimens remained landlocked, having been observed and fished until 1984 (Almaca 1988).According to reports from fishermen, sturgeon reproduced in the Guadiana up to the early 1980s (Almaca 1988). At the end of the 19th century, it was considered a common species in the Guadiana, mainly at Mértola, nearly 60 km from the mouth, where it probably found suitable spawning grounds. In the recent past, the abundance of sturgeon in the Guadalquivir exceeded that of

any other Atlantic Iberian river. The last known record of sturgeon in the area is a female (2100 mm) fished near the Guadalquivir River mouth on 14 September 1992.

The Ebro was the only river of the Spanish Mediterranean coast where *A. sturio* was once common. In historical times, the sturgeon ascended the Ebro upstream to Tudela, about 490 km from the river mouth. However, the construction of a weir at Xerta during the 15th century limited the species distribution to about 56 km from the mouth. The last adults were fished in 1965 and 1966; the last juvenile was caught in 1970.

The decline of the species became apparent in the late 19th century. Recognizing the drastic decline in the rivers draining to the Elbe estuary (Germany), local fisheries associations were involved early on in culturing and releasing early life cycle stages from floating incubators placed in sections of the River Stör where previous spawning grounds have been cut off by damming (Elsner 1887). In subsequent years, incubating and releasing many thousands of hatched larvae included other sites also directly in the Elbe River (Elsner 1885; Elsner and Stemann 1886). The occurrence of this species on the territory of the Czech Republic has been confined to the North Sea drainage system, namely to the Elbe River and also to its tributary Vltava River (Baruš *et al*. 1995). However, its occurrence in the Czech part of the Elbe River has always been rare and its presence in Vltava River upstream to Prague has been exceptional (Frič 1872a, b, c). A review of all catches in Elbe River from 1577 to 1933 is given by Flasar and Flasarová (1976).

In the second half of the 20th century probably two small reproductive populations persisted, one in the Gironde estuary (France) and the other in the Rioni river (Georgia) (Castelnaud *et al.*1991; Debus 1997). In the 1990's only one population was still confirmed, revealing a rapid overall decline. All other populations had disappeared within a century (Almaça & Elvira 2000; Fernandez-Pasquier 2000; Van Winden *et al.* 2000). Single catches were recorded in Italy until 1991 (Arlati pers. comm.). The European sturgeon was last recorded in the Danube River in Romania in year 1965 and currently is considered as extremely rare or even extinct (Manea 1980, Bacalbasa-Dobrovici 1991 and 1997). In the Black Sea no reproduction has been recorded in Rioni River since at least 1991 (Zarkua pers. comm.).

The decline was similar in most of the range states. An overview on the status and management of the Eurasian sturgeons has been provided by Williot *et al*. (2002a).

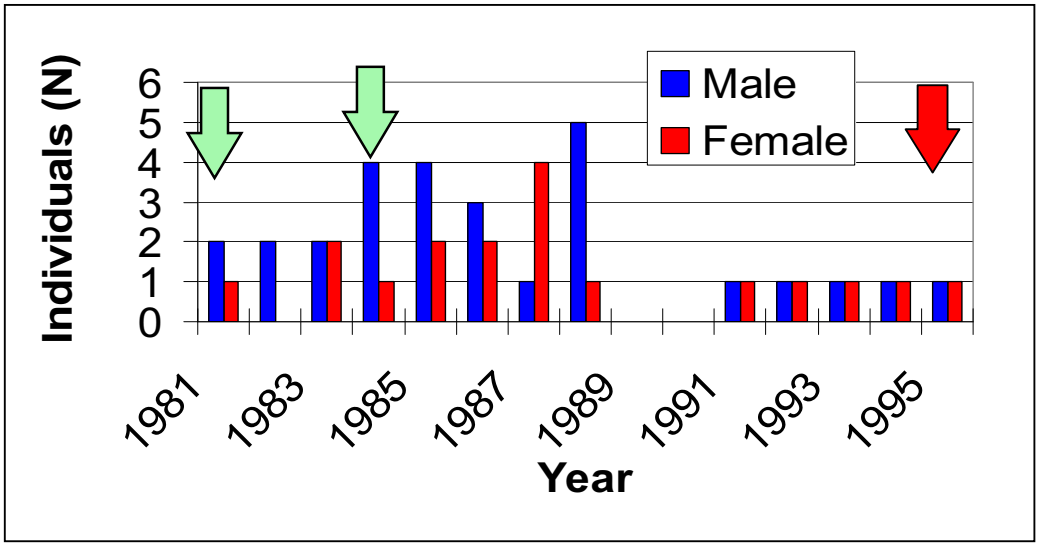

Figure 4: Catches of mature A. sturio in the Gironde/Garonne/ Dordogne with artificial reproduction (green arrows) and successfull rearing of fingerlings (red arrow)

3.1. Reasons for the decline

It has been widely recognized that sturgeon species, including the European sturgeon, share a variety of characteristics that render them very vulnerable also to anthropogenic impact. The size of the fish at maturity restricts the reproduction in freshwaters to specific sites. Due to the late maturation and large size, sturgeons are especially vulnerable to fishing. Overharvest in fact has been identified as one of the key elements that caused the decline of the populations (Ehrenbaum 1913; 1916; 1923; D'Ancona 1924a; Mohr 1952; Trouvery *et al*. 1984; Rochard *et al* 1990.; Elvira *et al.* 1991; Fernandez-Pasquier 2000). However, structures altering the flow regime of the rivers utilized for spawning, or providing obstruction to migration, as well as dredging, and especially pollution, have significantly contributed to the lack of reproductive success and subsequently to the decline of the species (Seligo 1907, 1931, Volk 1910, D'Ancona 1924b, Bauch 1958, Gessner 2000, Kirschbaum & Gessner 2000; Williot *et al*. 2002b). In most cases attempts to protect the species have been taken too late or were ineffective (Ehrenbaum 1916, Trouvery *et al.* 1984, Gessner 2000).

3.2. Current situation

The current situation, with the only known remaining population worldwide in France, in the Gironde, Garonne and Dordogne basin, is dramatic. 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.* 1997b). Natural reproductions were last observed in 1988 and 1994 (Williot *et al.* 1997). Research in genetics strongly suggests that the cohort of 1994 derives from only one mating pair (Ludwig *et al*. 2004), which testifies the very low number of active spawners in nature. All indicators concur: the species is in critical danger of extinction.Between 1951 and 1980, catches of sturgeon on the Gironde, Dordogne and Garonne rivers dropped by 94%, from 2500 fish per decade to only 150. Despite the fact that the species was protected in 1982 in France, the decline in the number of fishes continued. This is reflected in the number of captures for scientific purposes as well as the recorded by-catch, which dropped from under 10 per year in the 1980's to few individuals since the late 1990's. The sturgeon population of the Gironde mainly is originating from the 1988, 1994 and 1995 cohorts. These fish in the meantime are old enough to reproduce but are declining at an alarming rate. Only a few individuals have been recorded in the last two years (males in 2005 and 2007). The juveniles of these year classes were observed in the estuary of the Gironde in thousands in the 1990s. If these year classes were to disappear completely, the future of the wild population would rely only on the two cohorts of 1994 (natural reproduction) and those released in 1995 (siblings from controlled reproduction).

Over a 20 year period of research in the Gironde estuary, 41 accidentally captured fish have been used in artificial propagation trials. Some were released quickly, others after a few weeks. Others were finally maintained in captivity at the biological station of CEMAGREF (Agricultural and Environmental Engineering Research Institute). Among them 10 were females, only two of which were in an optimal state for reproduction allowing induced spawning in 1981, 1985 and 1995 (Figure 4). The largest number of larvae was obtained in 1985 (Williot *et al*. 1997). In 1995 CEMAGREF realized the first induced and controlled reproduction and successful rearing of larvae and juveniles despite the initially poor quality of the broodfish. The resulting offspring were used for stocking the river with feeding larvae as well as fingerlings (Williot *et al*. 2005; 2007). One group was retained for captive rearing in the facilities of CEMAGREF, near Bordeaux (France), and at the IGB (Leibniz Institute of Freshwater Ecology and Inland Fisheries) in Berlin (Germany).

Table 1: Estimated minimal and maximal numbers of *A. sturio* individuals in the Gironde population according to Rochard et al. 1997 and Lepage et al. 2002

Year	N_{min}	N_{max}
1989	14375	17107
1990	8850	11849
1991	5643	9701
1992	3598	7943
1993	2294	6503
1994	1463	5324

1995	933	4359
1996	7596	10570
1997	4812	8442
1998	3068	6911
1999	1957	5659
2000	1248	4633
2001	795	3793
2002	507	3106
2003	323	2543
2004	206	2082
2005	131	1704
2006	84	1395
2007	53	1142
N min	modeling with an instantaneous mortality rate of 0.45	
N max	modeling with an instantaneous mortality rate of 0.20	

Despite the fact that the fish resulting from natural reproduction since 1988 have reached an age to reproduce, only a few individuals have been recorded in the last two years (males in 2005 and 2007). The juveniles of these year classes were observed in the estuary of the Gironde in thousands in the 1990s. If these year classes were to disappear completely, the future of the wild population would rely only on the two cohorts of 1994 (natural reproduction) and those released in 1995 (siblings from controlled reproduction).

In France, three groups of animals are currently reared in captivity at CEMAGREF in brackish or salt water. Two groups of wild origin (23 fish born during the time 1984-1994 originating from accidental captures +19 juveniles resulting from the cohort 1994) (see Table 2), plus one group of 43 individuals resulting from the controlled reproduction of 1995. In Germany, 15 fish originating from the 1995 reproduction are reared at the IGB.

Table 2: Composition of the *ex-situ* broodstock of *A. sturio* (Status: 05/2006)

Origin	Yearclass	Number	Weight (min – max)
Wild	1984-1989	7 (6 ♂, 1 ♀)	11.8 - 23.5 kg
	1994 (probably siblings)	**25** (9 ♂, 12 ♀, 4 ?)	3.7 - 18.9 kg
	probably 1994	**10** (5 ♂, 5 ♀)	13 - 36.0 kg
Artificial reproduction	1995 (France)	**43** (unknown)	3.7 - 14.4 kg
	1995 (Germany)	**15** (10♂, 5 ♀)	4.2 - 10.9 kg

The future of the European Sturgeon today mainly relies upon controlled reproduction and stocking to enhance the wild population. The major constraint on controlled propagation and larval rearing remains the need to obtain males and females from the wild which are simultaneously close to maturity. Reproduction of mature wild broodfish caught and maintained under good conditions is possible (Chebanov & Savelyeva 1999). However, synchronization of maturation with captive fish

seems difficult in case only one sex is caught while the other exists in captive broodstocks. **Therefore, the only reasonable approach to minimize operational risks is to target for *ex-situ* conservation measures.** This approach has recently received much encouragement because of the successful ex-situ reproduction at CEMAGREF in June 2007, resulting in very good and promising survival of larvae and early life history stages up to now. Gametes were obtained from fish ready to spawn and some ten thousand of fertilized eggs were obtained from adults that spent most of their life in captivity since 1995 at CEMAGREF, when they arrived as juveniles. Additionally, sperm was obtained from an older specimen that matured again after several years interval. A high survival rate has been obtained during the first 50 days of rearing. These results are highly encouraging, urging for continued and substantial support for the subsequent rearing and accompanying research programmes, which are key elements to further success of the *ex-situ* conservation measures.

IV. PROBLEM ANALYSIS: RISKS AND THREATS AFFECTING THE NATURAL POPULATION

Today the European sturgeon is close to extinction. The last population is at an extremely low level, mainly present in French waters, with some individuals observed from time to time in the United Kingdom, Belgium and the Netherlands. The species is classified as critically endangered (CR-A2d) according to the IUCN criteria, and considered already extinct in the following countries: Albania, Algeria, Croatia, Denmark, Georgia, Greece, Ireland, Italy, Morocco, Norway, Portugal, Romania, Russian Federation, Slovenia, Spain, Sweden, Switzerland, Turkey and Ukraine.

The threats to existing populations, or those that can be foreseen for new populations to be re-introduced, are similar for all catchment areas. However their impact varies from one watershed to another. They are known to some extent in the Gironde basin (damming, habitat destruction, navigation, fisheries, are well documented, impacts of pollutants and nutrients are not assessed), but are more difficult to estimate in the basins where the species no longer exists. River habitats are particularly crucial for spawning and early life history stages. The deterioration of these habitats is a major threat to reproduction and subsequent survival. Threats in estuarine and marine phases of the life history add to the initial risks.

There are five primary problem areas impacting on survival and reproductive efficiency (ranked in approximate order of importance):

- accidental catch (bycatch) and illegal fishing (poaching) which is particularly detrimental because of inappropriate fisheries management and lack of enforcement of regulations;
- drastic changes of hydrological and hydrodynamic regimes in rivers and estuaries (sand and gravel extraction, dyking and channelization, hydrodams and barriers for navigation);
- environmental pollution (agricultural, domestic and industrial wastes in rivers and estuaries);
- low mating probability due to very small size of the remaining population (Allee effect);
- interspecific competition with allochthonous species;

Four other problem areas are particularly critical for the implementation of European sturgeon conservation actions:

- limited knowledge of species-specific habitat requirements, adverse impacts of habitat alterations and potential counter-measures against habitat loss, in particular in the marine environment;
- dispersal of the a very small population over a very large area from the Bay of Biscay to the North Sea;
- dependance on the only one *in-situ* breeding stock in France and the two *ex-situ* stocks in France and Germany;
- potential risk of altered environmental conditions due to climate change.

4.1 Catches

The impacting factors on the decline of different *A. sturio* populations in Europe were case specific (Kirschbaum and Gessner 2000). Directed fisheries, as one of the main impacts, were

effectively targeting the migrating broodstock. Fishery effects such as decreasing average sizes, increasing prices, increasing use of smaller mesh sizes as well as the drastic intensification of the entire coastal fishery to compensate for the reduced catches, all contributed to the decline of the populations (Blankenburg 1910, Ehrenbaum 1913 & 1916, Mohr 1952). Today the lack of appropriate fisheries management and enforcement is still a major problem despite the good intentions and objectives set with the New EU fisheries policy. This holds for many areas. For example, the abundance of the sturgeon population in Italy was compromised heavily and early by fishing. For example, out of approximately 2000 specimens of *A. naccarii*, sold at the fish market between 1981 and 1988, more than 80% of the specimens were weighing less than 3.5 kg, and were therefore fished before the reproductive phase (Rossi *et al*. 1992). A similar effect is expected to have occurred in the *A. sturio* catches in the area too.

Today, catches are considered to be one of the main causes for the decreasing numbers of the European sturgeon, thus reducing the potential of the remaining population to recover by natural recruitment. One source of catch related mortality is directed illegal fishing or poaching. There are no accurate statistics related to this type of fishing. However, it has been estimated that a few fishes are still captured, maybe between 10 and 20 every year, in a very irregular way (Lepage pers. comm.).

The second cause of fisheries related mortalities is by-catch, which corresponds to accidental captures of sturgeon during legal fisheries practice. Most of the fishing concerned involves the use of beam trawlers, trammel nets and gillnets (Rochard *et al.* 1997b), targeting bottom roundfish or flatfish. Mortalities either occurr as fish are brought on board dead, or by keeping it on board as a trophy, or just by curiosity. In 1998, from Spain to England, the number of catches was estimated to be 450, with a rate of 57% not surviving (Rochard *et al.* 1997b). Estimates of losses from the Gironde population are difficult but were assessed to comprise 100 to 400 individuals annually at the end of the 1990's (Lepage pers. comm.). Currently, the annual captures would comprise a smaller number of individuals, mainly reflecting the extremely low remaining abundance. In this situation, even the loss of one single adult specimen would be significant, compromising the future of the species at the currently critical state of the population.

Fishing intensity in the North Sea is so high that it is highly unlikely that any sturgeon will survive until reproductive age without being caught at least once. Despite the fact that the hauls usually last for about 1 hour, most of the caught fish arrive on deck dead being suffocated in the net. For rays and skates it has been clearly demonstrated that several species have almost disappeared from large parts of the North Sea because of the trawl fishery. It is therefore worth re-iterating that survival of re-introduction from reared stocks will only be successful if the by-catch mortality can be largely reduced.

In order to reduce by-catch, the information and awareness campaign launched by the EPIDOR in France in the late 1990s and since 2005 (Mayer & Lepage 2001; Michelet 2006) met with considerable success and has provided a clear and positive example of active participation of the fishery sector to protect the species while recording and releasing by-catch (Mayer and Lepage 2001; Michelet 2006). That such campaigns are urgently needed throughout the historic range to create high awareness among fisherfolks has very recently been demonstrated by the accidental catch and sale of a large *A. sturio* accidentally caught in Dutch waters in June 2007. Such events must be prevented in the future and the fish rather be rescued to serve the *ex-situ* conservation measures.

There are indications from other areas how strict enforcement can notably assist in saving sturgeon populations. For example, the temporary recovery of sturgeon stocks in the Caspian Sea during periods of the past century (Williot 1984; Rosenthal and Gessner 1992; Tsvetnenko 1993) was mainly due to the moratorium and the accompanying rearing and release programme. In constrast the lack of enforcement at the end of the 1980s and after demonstrated the overall impact of marine fisheries on sturgeon populations.

Mortalities caused by water abstraction for cooling or irrigation have been observed but few data are available. In the River Elbe in 1996, approximately 40 individuals of juvenile exotic sturgeons were collected from the rakes of the intake system of a nuclear power plant (Brunsbüttel). A major impact of such systems is postulated for fragile species (shads in particular) for the nuclear plant of the Blayais, in the Gironde estuary. According to the reports, only one specimen of European sturgeon was seen in the clogged material from the inlet rakes which was washed ashore in the 1980s.

4.2 Man-made alterations of rivers and estuaries

Sturgeons are as threatened by pollution stressors and man-made habitat alterations as any other migratory fish species for which an extensive documentary literature exists.

In particular, physical alterations such as the removal of gravel beds by dredging or increased sediment transport caused by straightening of the river for navigation, affect the sturgeon population in similar ways to those documented for other species. This deterioration in the case of the Rhine revealed changes in the river morphology and discharge patterns that contributed to the loss of many spawning grounds (Kinzelbach 1987).

Direct effects are caused by gravel extraction on the spawning sites, reducing the reproductive success. Besides the loss of habitat structures for spawning or early life stages, such alterations also result in the reduction of inriver productivity. Additionally, the loss of surface area due to dyking and dredging as well as the disconnection of side channels and backwaters further reduces the available habitat for juveniles. The extraction of gravel or sand directly disturbs the ecosystems (Castelnaud *et al.* 1981). On the feeding grounds it might cause loss of habitat or if coinciding with the presence of the fish on site, may result in mortalities (Lepage & Rochard, 1997). Effects of dredging and deposition of material were intensively studied in the St. Lawrence River, Quebec, Canada. Negative impacts on habitat utilization of Atlantic sturgeon and benthic invertebrate productivity were reported (Hatin *et al*. 2007).

Deepening of the lower reaches of the rivers to facilitate passage of larger ships resulted in increased influx of salt water. In the Elbe River, the increased salt water wedge today reaches 60 km further upstream compared to the condition in 1880 (Kausch 1996). As a result, the spawning sites at Brunsbüttel and Glückstadt have been rendered dysfunctional.

Chemical changes to the environment, provide direct and indirect impacts upon the species in question. This may involve a chemical change such as an increase in osmolarity or the reduction in the oxygen content as a consequence of dumping organic material. River modification can thereby result in the loss of, or changes to, macro-invertebrate fauna.

Water diversion, for instance in the Rioni river, reduced the water discharge in the main river channel, providing insufficient flow on the spawning sites (Mix and Gessner 2001). Damming prevented passage to the spawning sites in various rivers (Inguri, Kizil Irmal, Jesil Irmak, Po, Rhone, Guadalquivir, Garonne, Dordogne, Rhine, Weser, Eider). Despite the fact that the role of dams - blocking migration routes- has been acknowledged as early as the Middle Ages and has led to restrictions in their construction (summarized in Hoffmann 1996; Beneke 1881) 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 other sturgeon species in several river basins in the world, 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). This impact on access to spawning sites was also demonstrated in the case of the Volga River (Russian Federation), where the majority of spawning sites for *Huso huso* were lost after the construction of the Volgograd dam (Barannikova 1995). For the Danube River and Black Sea populations of migratory sturgeons, the extensive morphological damage to the Danube and its tributaries, together with high levels of pollution, have severely impacted the sturgeon populations of the whole basin (Stamenkovic 1991; Bacalbasa-Dobrovici 1997). In particular, the completion of the Iron Gate dams in the 1970's resulted in the loss of important spawning sites in the Middle Danube River up to Vienna. As early as 1890-1896, the first river regulation in the Djerdap region already partially prevented sturgeons from reaching the upper part of the Danube River (Lenhardt *et al*. 2005).

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 (Kinzelbach 1987; Holčik 1989; Kynard 1997).

On the Garonne and Dordogne basins, there have been no further obstacles to migration since the building of the Bergerac dam on the Dordogne in 1851 and the Golfech dam on the Garonne in 1971. Before that, the European sturgeon went further upstream than nowadays (up to Toulouse on the Garonne, for instance), with spawning sites located beyond the present obstacles. Jego *et al*. (2002) mapped the remaining spawning sites downstream and estimated that they would allow the reproduction of about 200 females every year. However, the effects of these dams on flooding events, migration fidelity and temperature development throughout the spring have not been evaluated. A Spanish study (Fernandez-Pasquier 1999) suggests that the decreasing flow of Guadalquivir could be partly responsible for the disappearance of the European sturgeon in this river.

A thorough analysis of the influence of flow variations on White sturgeon reproduction in the Columbia River shows that ideally reproduction takes place in a period of increased flows providing additional riparian habitat uncompromised by biofilms (Coutant 2004).

Direct impact caused by shipping accounted for numerous losses of juveniles of the year (Seligo 1931). Sheer forces that are caused by the passing ship create current velocities that exceed the swimming capacity of juvenile fish, thereby dislocating them (Engelhardt *et al.* 2004). Inland shipping additionally imposes threats on the fish by direct mechanical impact. According to several US agencies (Status Assessment of *A. oxyrinchus* 2007) ship strikes are a major concern in waters that are used for navigation purposes intensively. This could become a major concern especially for the traffic towards riverine cities and for inland navigations.

4.3 Environmental pollution of rivers and estuaries

Historically, three different effects resulting from pollution have been identified to affect sturgeon populations: a) acute toxicity resulting from direct exposure to soluble pollutants at high concentrations, b) chronic effects resulting from bioaccumulation of lipid soluble substances such as insecticides and pesticides mainly affecting reproductive success, and c) eutrophication effects resulting from excessive nutrient release in freshwater habitats.

Acute toxicity was an important factor in the late 19th century when wastewater purification was virtually absent (Schiemenz 1905). Sturgeon rivers and habitats were not exempt from these stressors as indicated in earlier literature (Bonne 1905). In many areas, the situation has improved due to regulatory efforts to abate pollution but it is still important today in a number of regions of the world.

Insecticides and pesticides such as DDT and its degradation products as well as PCBs and HCBs bioaccumulate over time and affect reproductive success and thus impair recruitment in many species. They primarily influence cell membrane functions and can cause the loss of functional integrity of tissue and/or organs at different developmental stages with subsequent morphological malformations (Akimova & Ruban 1995; 1996, Bickham *et al*. 1998). Sub-lethal effects have been described to comprise behaviour alterations damage to liver and gill tissues, altered enzyme activity, diminished condition (health) index, hermaphroditism, degeneration and absorption of gametes, as well as amitoses in oocytes, leading to the reduction of reproductive potential of populations. Similar effects have been described for contamination with hydrocarbons and heavy metals (Lukyanenko *et al.* 1999). In the Gironde estuary, the concentration of cadmium in the water is 10 to 20 times higher than in the other Atlantic estuaries (Maurice 1994, Durrieu *et al*. 2005). Williot *et al.*(1997), hypothesized a resultant effect on reproduction. However, recent results from Maury-Brachet *et al.*(in press), concluded a low probability of this event due to short exposure times during the final maturation phase. This hypothesis is valid only provided that bioaccumulation is negligible during the juvenile stage. Here a number of open scientific questions require urgent attention.

The third impact is mainly caused by communal and agricultural wastes and the resulting nutrient input into a system. Nutrient rich water has a high productivity, triggering bacterial, fungal and algal growth. The first two groups do generally perform best at elevated temperatures which are typical as spawning temperatures for *A. sturio*. As a result fungal and bacterial pressures in waters with high organic load have the potency to destroy the eggs and kill the embryos. This is considered one of the main reasons for population decline of the European and the Baltic sturgeon in the rivers Elbe, Rhine and Oder during the industrial revolution. These impacts were significant locally, for instance for

wastewater discharge on or above spawning sites (such as the Köhlbrand, Elbe River) but the overall impact increased with rising utilization of rivers for discharge at different historical periods.

4.4 Risks associated with low population densities

A small population is more at risk of extinction than a large one. Continuous environmental change (environmental stochasticity), requires a minimal potential for adaptation. A larger population, representing a larger genetic diversity, provides the necessary adaptive capacity to deal potentially with environmental alterations. The longer a critical situation (genetic bottleneck) lasts, the higher the risk of extinction.

The Allee effect (Myers *et al.* 1995) predicts a negative growth rate at extremely low population sizes even if all environment factors are favourable. Low numbers limit the chances for spawning encounters. This effect is intensified in sturgeons since adults only reproduce at long intervals. It is estimated that females mate only two or three times per decade thus additionally limiting the encounters of mature fish at low population size.

4.5 Introduction of allochthonous species

The release of allochthonous species must also be considered a potential threat, since the introduction of exotic species 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 hybridisation and potentially this can occur between all sturgeon species. As a result, different risks at species level are potentially encountered such as hybridisation in species with similar ploidy, or sterile offspring due to different levels of ploidy in mating specimens (Antipa 1909; Kozhin 1964).

There are four potential sources of introduction of exotic sturgeon in Europe: (a) Fish are released by aquarium and garden pond hobbyists who want to get rid of overly large specimens, (b) sportfishing clubs deliberately wish to add sturgeons to their trophies and release fish deliberately, (c) escapes from fishponds and farms happen accidentally, and (d) illegal stocking by others has also been observed (Britton & Davis 2006). 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 German coastal and estuarine waters has been reported to increase (Spratte and Rosenthal 1996; Arndt *et al*. 2000, Arndt *et al*. 2002).

In December 1999, an accident occurred in a fish-breeding farm on the Gironde. Some thousands of *Acipenser baerii*, Siberian sturgeon, escaped. If there is a risk of competition between *A. baerii* and *A. sturio*, the risk of a genetic pollution is unknown. Their real impact has not been assessed yet, but as yet there is no evidence of reproduction or hybridization. The long term impact in this case will have to be evaluated. These escapes provided a serious difficulty for inland fishermen or anglers, who now have to be able to distinguish between two species of sturgeon, one protected and the other requiring removal.

4.6 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 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 (3 to 30 °C; 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.

V. LEGAL ASPECTS

The European sturgeon is currently protected by a number of legal instruments including:

- International Conventions
- Regional regulations, including EU legislation
- National legislation

5.1. Global instruments

The states responsible for the status of the European sturgeon are Contracting Parties to a number of global biodiversity-related conventions and are therefore bound to apply their provisions to the conservation of the European sturgeon (*Acipenser sturio*).

5.1.1. The Convention on Migratory Species (CMS, Bonn Convention, 1979)

The European sturgeon (*Acipenser sturio*) was included in Appendix II of the CMS in 1999, by the 6th meeting of the Conference of the Parties (COP-6) to the CMS. Appendix II lists migratory species that need or would significantly benefit from international co-operation. The convention encourages range States to conclude global or regional Agreements for species listed in Appendix II, giving priority to those species in an unfavourable conservation status. The main implication of including the European sturgeon in Appendix II is therefore that range States must endeavour to conclude Agreements among them to conserve the species,. In 2005, COP-8 decided to add the *Acipenser sturio* also to Appendix I of the CMS, 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 on the two appendices are different and complementary).

According to the Convention, Parties are to:

- Promote, co-operate in and support research relating to migratory species;
- Endeavour to provide immediate protection for Appendix I species, including the prohibition of taking of animals of that species (exceptions for research purposes are possible).

In addition, range states of Appendix I species must endeavour to:

- Conserve and where feasible, restore the habitats of the species, which are important to prevent their extinction;
- Prevent, remove, compensate or minimise, when appropriate, the adverse effects of activities or obstacles that seriously impede or prevent the migration of the species;
- Prevent, reduce or control factors that endanger or are likely to 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 the development of future agreements, adopted in 2002, called upon the Range States of sturgeons listed in the appendices of the CMS, to take the lead to develop an appropriate CMS instrument on sturgeons. This Resolution has remained largely inoperative until now.

In 2005, Resolution 8.5 was adopted, on the same issue of existing and future agreements under the CMS. Concerning sturgeons, this Resolution urges the resumption of co-operative activities with CITES (see section below) and invited consideration of possible CMS action regarding an appropriate instrument for sturgeons.

5.1.2. The Convention on International Trade in Endangered Species (CITES, Washington Convention, 1973)

The European sturgeon (*A. sturio*) is listed in Appendix I of the CITES convention since its entry into force in 1975. This is the category of species threatened with extinction and it implies that international trade of the species, in any form, is subject to particularly stringent regulations, in order

not to further endanger its survival. Trade can only be authorised in exceptional circumstances, such as for scientific research or if the fish originates from captive breeding.

Resolution Conf. 12.7 (Rev. CoP14) on "Conservation and trade in sturgeons and paddlefish" (adopted in 2002 and amended in 2003 and 2007), urged range States to:

- Encourage scientific research and adequate monitoring of the status of stocks,
- Curtail the illegal fishing of and trade in sturgeon and paddlefish specimens;
- Explore ways of enhancing the participation of the representatives of all agencies responsible for sturgeon and paddlefish fisheries conservation and sustainable use programmes of these species;
- Promote regional agreements between range States of sturgeon and paddlefish species aiming at proper management and sustainable use of these species;
- For 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.

Discussions on trade and conservation of sturgeon held at CITES COP-14, in June 2007, focused on Caspian Sea range States, export quotas for 2008, and the recent caviar-trade database, aspects which are not of critical relevance for this Action Plan. However, it should be noted that CITES regulates imports and exports of live sturgeon (fingerlings, juveniles and adults) as well as of fertilised eggs, which may be relevant in the context of measures aimed at the conservation and restoration of the European sturgeon (*A. sturio*).

The European Community enforces CITES within the EU and provides additional measures for the conservation of species in trade by the European Union Wildlife Trade Regulation, Council Regulation (EC) No. 338/97 which came into effect on 1 June 1997. The aim of the Regulation is to protect wild animals and plants currently or likely to become threatened by international trade, by regulating the trade in these species. *A. sturio* is listed in Anex A of Council Regulation (EC) 338/97. Article 8 of this regulation prohibits trade in *A. sturio*.

5.1.3. The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar convention, 1971)

COP-6 of the Ramsar Convention, held in 1996, adopted Resolution VI-2 adding two specific criteria, based on fish, for identifying wetlands of international importance" (criteria 7 and 8). In addition, the Convention requires Parties to consult with each other about the implementation of their obligations, in particular when a wetland or water system is shared between them. In this case, they must endeavour to co-ordinate and support present and future policies and regulations on the conservation of wetlands, and their flora and fauna (Article 5).

Paragraphs 30 and 34 of Resolution IX-4 on "the Ramsar Convention and conservation, production and sustainable use of fisheries resources", adopted in November 2005, urged Parties to take the necessary measures, within their frameworks for integrated river basin and coastal zone management, to:

- Maintain or reinstate aquatic biota migration pathways;
- Reduce the impacts of point source and diffuse pollution in all its forms; and
- Protect critical spawning and nursery grounds.

In addition, this Resolution strongly urged Parties to:

- Review their policies, laws and programmes for regulating the introduction of aquatic biota for aquaculture and the aquarium industry,
- Control the accidental movement of species; and
- Avoid introduction of invasive and/or alien species.

It should be noted that many of the habitats protected under the Ramsar Convention include also coastal habitats of the littoral zone, an area where most of the juveniles and adults of sturgeons thrive.

In this context the Ramsar Declaration on Global Sturgeon Conservation (May 2005) is mentioned here as it builds on elements relevant to the Ramsar Convention (Rosenthal *et al* 2006)

5.1.4. Convention on Biological Diversity (CBD, 1992)

The 190 Parties to the CBD Parties have the obligations to conserve biological diversity, use its components sustainably, and regulate access to genetic resources. Parties need to adapt or develop national strategies, plans or programmes for the conservation and sustainable use of biodiversity, which can include sturgeon measures. For instance, in the framework of implementing the CBD, the French government has included the European sturgeon in its National Biodiversity Strategy, as a priority species. As such, a national restoration plan needs to be developed and implemented, in line with obligations under other international conventions.

CBD Parties must also integrate the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans and policies. This provision of Article 6 is of direct relevance to this Action Plan, as it implies that biodiversity concerns, such as the conservation of European sturgeon, need to be integrated into the fisheries policies of range States.

Article 8 of the CBD includes provisions for in-situ conservation of biological diversity. Relevant obligations for Parties, as set out in this Article, are:

- to rehabilitate and restore degraded ecosystems and promote the recovery of threatened species, including through the development and implementation of plans or other management strategies (Article 8(f));

- to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species (Article 8(h));

- to develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations (Article 8(k)).

Each Contracting Party must, as far as possible and as appropriate, and predominantly for the purpose of complementing in-situ measures:

Article 9 of the CBD is also relevant for this Action Plan, as it includes the following obligations for Parties, in the field of ex-situ conservation and "predominantly for the purpose of complementing in-situ measures":

- adopt measures for the ex-situ conservation of components of biological diversity, preferably in the country of origin of such components;

- establish and maintain facilities for ex-situ conservation of and research on plants, animals and micro- organisms, preferably in the country of origin;

- adopt measures for the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions.

5.1.5. United Nations Convention on the Law of the Sea (UNCLOS, 1982)

The Convention entered into force in 1994, and it lays down the fundamental obligation of all States to protect and preserve the marine environment, including the need to prevent, reduce and control pollution of the marine environment from land-based sources.

It is important to note that UNCLOS extended the sovereignty of coastal States to an adjacent belt of sea, described as the territorial sea, to a limit not exceeding 12 nautical miles. The Convention also granted coastal States sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources of their Exclusive Economic Zone (EEZ), as well as jurisdiction for the protection and preservation of the marine environment of their EEZ.

UNCLOS urged all States to co-operate at the global and regional level to formulate rules and standards for marine protection, which has been taken up by a number of organisations, including IMO, UNEP and the FAO (see below).

Obligations under UNCLOS which are relevant in the context of this Action Plan include the need to take all measures necessary to prevent, reduce and control pollution of the marine environment,

including from the intentional or accidental introduction of alien or new species (Article 196). Furthermore, this Convention states that specific obligations assumed by Parties under other specialised conventions regarding the protection and preservation of the marine environment, need to be carried out in a manner consistent with the general principles and objectives of UNCLOS (Article 237).

Further developing UNCLOS, the Agreement for the Implementation of the Provisions of UNCLOS relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks was adopted, although it only entered into force in December 2001. This Agreement introduces a number of innovative measures, particularly in the area of environmental and resource protection, as it obliges Parties to adopt a precautionary approach to fisheries exploitation and gives expanded powers to port States to enforce the adequate management of fisheries resources.

5.1.6. The United Nations Food and Agriculture Organisation (FAO)

The necessity to combat the degradation and depletion of fish stocks, both in the zones under national jurisdiction and in the high seas, as well as its causes, such as overfishing and excess fishing capacity, by-catch and discards, has been tackled by the FAO through the 1995 Code of Conduct for Responsible Fisheries. The Code provides a framework for national and international efforts to ensure sustainable exploitation of aquatic living resources in harmony with the environment. The FAO Committee on Fisheries (COFI) is charged with monitoring and updating the Code. A set of technical guidelines have been produced by FAO in support of the implementation of the Code.

In the context of the Code of Conduct for Responsible Fisheries and its overall objective of sustainable fisheries, the issue of illegal, unreported and unregulated (IUU) fishing is of serious and increasing concern, as it undermines efforts to conserve and manage fish stocks. The International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing was adopted in 2001 and, as the Code of Conduct, has a non-legally binding nature.

Another tool developed within the framework of the Code of Conduct is the 2003 Strategy for Improving Information on Status and Trends of Capture Fisheries. The Strategy is a voluntary instrument whose overall objective is to provide a framework and plan for the improvement of knowledge and understanding of fishery status and trends as a basis for policy-making and management for the conservation and sustainable use of fishery resources within ecosystems.

In 1999 the FAO published its Strategic Framework for 2000-2015, including objectives supporting the conservation, improvement and sustainable use of natural resources for food and agriculture such as fisheries.

There are a number of legal and policy instruments that may have future implications on the populations of *A. sturio*, including the Codex Alimentarius, the EU Regulation No 338/97, of 9 December 1996, implementing CITES issues in EU law, as well as many others. As an endangered species covered by CITES, the European sturgeon is listed in Annex A of this regulation.

5.2. Regional instruments

5.2.1. The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)

The European sturgeon is listed as a strictly protected species (Annex II). Each Contracting Party shall take appropriate and necessary legal and administrative measure to ensure its conservation and in particular prohibit (Article 6):

- its deliberate capture, keeping and killing;
- 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 even if empty;

- the possession of and internal trade in these animals, alive or dead, including stuffed animals and any readily recognisable part or derivative thereof, where this would contribute to the effectiveness of the provisions of this article.

Parties have to coordinate their efforts to ensure the species conservation throughout its range (Article 10). They commit themselves to:

- Co-operate whenever appropriate and in particular where this would enhance the effectiveness of measures taken under other articles of this Convention, and to encourage and co-ordinate research related to the purposes of this Convention.
- 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).

The Convention's Standing Committee has approved the initiative of developing an action plan for the Western European sturgeon (*Acipenser sturio*) and Recommendation No. 59 (1997) provides guidelines on this issue.

In addition, the Standing Committee of the Bern Convention has adopted 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.

5.2.2. The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)

The OSPAR Biological Diversity and Ecosystems Conservation Strategy comprises four elements: ecological quality objectives, protection of species and their habitats; the creation of an ecologically coherent network of well-managed marine protected areas, and programmes to reduce the potential detrimental effects of human activities in the maritime area covered by the Convention.

Acipenser sturio is listed in the OSPAR List of Threatened and/or declining Species and Habitats as a threatened species, specifically for the OSPAR regions "North Sea and Bay of Biscay."

The working group on Marine Protected Areas, Species and Habitats (MASH) is responsible for overseeing the list of threatened and/or declining species and habitats. Germany and France have been leading the development of measures for the protection of *A. sturio,* and will be putting forward a (draft) monitoring and assessment strategy to MASH in November 2007. To date, France and Germany have supported the following measures:

- *ex-situ* conservation measures to protect the genetic resources/genetic diversity of the last natural population;
- controlled reproduction programmes that take into account genetic aspects;
- release of young specimens into two appropriate hydrologic schemes in order to at least reduce the risks of species extinction;
- effective protection and restoration of recognised or potentially threatened habitats of the species;
- prohibition of the release of non-native sturgeon species;
- improvement of the coordination and cooperation of national sturgeon restoration programmes, integration of sturgeon restoration into other protection and restoration activities (ex : salmon, eel, habitats, protected areas, etc.);
- monitoring programmes to detect the status of the species and alterations to its habitats;
- education, outreach, and training programmes for fishermen.

5.2.3. The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention, 1976)

Part of UNEP's Regional Seas Programme, the Barcelona Convention is relevant for all Mediterranean countries. For the purposes of this Action Plan, the Convention is relevant for Spain, France, Greece and Italy and other adjacent countries One of the main objectives of the Convention is to set up a list of Specially Protected Areas of Mediterranean Importance (SPAMI), including sites showing a "particular importance for the conservation of the constituent elements of the biological diversity of the Mediterranean Sea, comprising ecosystems that are specific to the Mediterranean region or endangered species habitats or representing a particular scientific, aesthetic, cultural or educational interest". The programme of activities of the Convention for the 1996–2005 period included two priority fields of action concerning the sturgeon: the management and protection of genetic resources, and of marine biological resources.

5.2.4 European Community laws and regulations

All range States for the European sturgeon along the Atlantic coast are members of the European Union, as it is also the case of relevant Mediterranean countries, such as Spain, France, Italy, Greece, Malta, Cyprus and Slovenia.

The European sturgeon is a species for which the European Community has a particular responsibility since the whole range of the species lies to a very large extent within the limits of the European Community. This is especially true for France as it hosts the only known reproductive population of *A. sturio*. The relevant Community law in this matter is the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992).

5.2.4.1 Community legislation for species and habitats

The European sturgeon is listed in the Habitats Directive among the priority animal species of Community interest (Annex II) and its conservation requires the designation of Special Areas of Conservation (SAC). As regards European sturgeon, eleven areas have been designated up to now and six others are in the process of being approved (see Table 2, which includes some of the NATURA 2000 sites). The species is also included in the list of animal species of Community interest in need of strict protection (Annex IV).

Article 6 is the main provision of the Habitats Directive targeting species conservation measures. It provides that Member States must take appropriate steps to avoid the deterioration of natural habitats and of the habitat of species for which the habitat has been designated, as well as disturbance of those species if such disturbance could be significant in relation to the objectives of the Directive.

The transposition of this Article into the national legislation of the Member States constitutes a strict obligation. Nevertheless, lack of transposition does not free those States from their obligations derived from this legal instrument.

The Habitats Directive has traditionally been better implemented on terrestrial and aquatic habitats. However, the peculiarities of natural marine habitats and marine species or, as in the case of sturgeon, anadromous species, have to be considered. Discussions were conducted within the European Commission to improve the implementation of the NATURA 2000 network in the 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/SPAs;
- Guidance on issues related to the management of such areas.

5.2.4.2 Community regulation concerning Common Fisheries Policy (CEP)

The Common Fisheries Policy (CFP, Council Regulation (EC) No 2371/2002 of 20 December 2002) allows the exploitation of living aquatic resources that ensures the sustainability of economic, environmental and social conditions, taking into account the impact of fishing activities on the environment. 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. For further information consult the website: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2002/l_358/l_35820021231en00590080.pdf

The fact that the European sturgeon remains highly threatened despite its status under these international instruments reinforces the urgent need for significantly enhanced Europe-wide cooperation and action, as laid out in this Action Plan. Furthermore, the instruments themselves provide important tools and mechanisms for the delivery of such actions on the ground.

The Common Fisheries Policy of the EU allows the exploitation of living aquatic resources, including anadromous and catadromous species during their marine life, providing that the precautionary approach to fisheries management is followed strictly, taking sound management measures to conserve target species, associated or dependent species, as well as non-target species. Sturgeons should not be neglected in these considerations and management measures.

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

5.2.4.4 European Commission Communication on Biodiversity 2010 and beyond

According to the Communication of the European Commission entitled “Halting the loss of biodiversity by 2010 and beyond”, adopted in May 2006, the reformed Common Fisheries Policy, when fully implemented, will reduce fishing pressure, improve the status of harvested stocks and better protect non-target species and habitats. The European Community also plans to develop a strategy to address alien species. For further information, consult: http://ec.europa.eu/environment/nature/biodiversity/comm2006/index_en.htm

5.2.4.5 Community regulation concerning the ecological quality of water bodies

The EU Water Framework Directive (WFD) (Directive No. 2000/60/EC of 23 October 2000) requires that all underground and surface waters, including coastal waters, should be of “good ecological status” by 2015. It requires in particular the adoption and implementation of management plans and measures adapted to each watershed.

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 European sturgeon population maybe 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 Portugese, 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.

5.3.3 National Regulations

The legal status of the European sturgeon at the national and sub-national level differs among countries. Here is an indicative list, with varying degrees of detail, providing information on the legal protection of the *A. sturio* in several relevant range States.

- ***Belgium***

In the early 19th century, the European sturgeon was abundant in the Meuse river until Liege (De selys Longchamps 1842; Gens 1885; and Maes 1898). Its disappearance from the Meuse basin apparently pre-dates the years 1840-1850, which makes of *A. sturio* the first extinct species in Wallonia (Phillipart JC 1982).

In the Wallonian region, the species is entirely protected by Law of 12 July 1973 on the conservation of nature, as amended by Decree of 6 December 2001. This legal protection implies the prohibition of intentionally capturing and killing wild individuals, as well as disturbing them, destroying or collecting their eggs, damaging or destroying their reproduction sites, stuffing, keeping or selling wounded, sick or dead individuals. The same law also bans keeping, transporting, exchanging, selling, buying or donating specimens of this species taken from the wild, and display them in public places.

Concerning the releases of exotic species, this law provides for the prohibition of introducing into the wild of non-native species, and of non-native stocks of native species. The law also bans the reintroduction of native species. Exceptions to these rules are possible and permits can be issued in accordance with the Decree of 6 December 2001. The release of non-native sturgeons is clearly prohibited in the territory of the Wallonian region but nevertheless the legislation is not always respected and accidental or intentional releases occur frequently – although it is impossible to quantify these events.

In the Flemish region, the European sturgeon is protected by law, as there is a full prohibition of any capture, according to the Decision of the Regional Government of 20 May 1992, which transposed the Law on River Fishing of 1 July 1954. The Decision of the Regional Government of 21 April 1993, related to the introduction of non-native species, prohibited the introduction into the wild of any species which had not been present in Belgian territory for at least 50 years, but this Decision has been abolished.

The 1954 Law on River Fishing also bans the introduction of fish in waters of public use. If other types of sturgeon are present in Flemish public waters, it will be as a result of an accidental release coming either from a fish breeding plant or a garden lake. It would be unusual and exceptional for a non-native sturgeon to be captured in Flemish waters.

- ***The Czech Republic***

The species is considered extinct or missing in the territory of the Czech Republic in 1933 the last specimen observed in Elbe River at Střekov, TL over 200 cm, identified according to fins by fishermen (Flasar and Flasarová, 1976), while its previous occurrence was regular and extensive. *A. sturio* and it is strongly protected according to EU regulations, and trading in the species is subject to CITES, Appendix I.

- ***France***

Fishing and sale of *Acipenser sturio* are prohibited by cross-ministerial decision since January 1982. This protection was extended by cross-ministerial decision from December 2004 to that of the particular habitats of the species by prohibiting their destruction, their deterioration and their degradation. Any accidentally captured sturgeon must be returned to the water. The proper administrative authority can deliver exceptional exemptions from prohibitions and obligations, for particular reasons. When there is a research programme for the restoration of the population, an accidentally captured sturgeon can be used for this restoration objective, with appropriate authorisation.

- ***Germany***

A. sturio has been abundant in the tributaries to the North Sea in Germany. It was a major commercial species in the Rhine, Ems, Weser, Elbe and Eider Rivers as well as their main tributaries until the onset of the 20th century. Its decline started in the 1870s in the Weser River and subsequently in the Stör River a tributary to the River Elbe. The last reported reproduction dates back to 1957 in the River Oste. The last catches in rivers were reported in 1969 in the Eider River and 1972 in the River Ems. In coastal waters the bycatch of *A. sturio* continued until 1994 when the last fish was caught off the island of Helgoland.

Acipenser sturio is listed in the Red List of endangered species since 1976 (Blab & Nowak 1976). It is strictly protected by the Federal Nature Conservation Act as well as the Nature Conservation Acts of the Federal States. Fishing of *A. sturio* is prohibited by Fishing Laws of the Federal States. Sales and transfers of *A. sturio* are legally prohibited by ministerial decision since June 1976.

A national program for the protection and remediation has been initiated in 1996. River habitats for reproduction and early life stages have been identified in the Rivers Elbe, Oste, Stör and Rhine up to date. The verification and characterization of the habitats for juveniles is planned for the first releases with fish tagged telemetry transmitters. In accordance with the legal framework for Natura 2000, no sites have been specifically designated under the Habitats Directive for Germany, because of its absence from the rivers and its extreme scarcity in German marine waters.Until today *A. sturio* has not been proposed as an indicator species under the WFD because of its extreme scarcity and unknown status.

- ***Greece***

Fishery of *A. sturio* has been reported to be present until 1975. Officially, the species is protected.

- ***Italy***

The catch, hold, transport and trade of *A. sturio* have been banned since 1980 (Ministerial Decree Mercantile Marine on Cetaceans, Turtlse and Sturgeon catch regulation, 21 March 1980), reinforced by the Ministerial Decree DM of May 3, 1989.

Italy transposed the Habitats Directive through DPR no. 537, of 8 September 1997, subsequently modified and integrated by the Ministerial Decree DM January 20, 1999 and by the DPR no. 120 of March 12, 2003.

At the regional level, the *A. sturio* and all other autochthonous sturgeon species have particular legal protection in Lombardia, Veneto and Emilia Romagna, where catching is prohibited all year round for all sizes under the regional laws and regulations. A number of historical sites important for *A. sturio* either spawning or nursery grounds are identified in Table 4, although at the present time the species is considered as "missing" in the area. The last specimen of *A. sturio* was caught in Italy in November 1991 in the Livenza, locality Quinto di Treviso, is conserved in the Museo di Storia Naturale di Venezia (MSNV) N° 14038.

- ***The Netherlands***

Acipenser sturio seems to be considered as extinct in Dutch waters, especially in Dutch rivers. Nevertheless, the fish is strictly protected under the Fauna and Flora Act. Anybody planning an activity which may be detrimental to sturgeons must request a licence, which in almost all cases will be refused. However, at present there is no knowledge available on whether sturgeon still exist in Dutch waters and therefore it can presently not be demonstrated that a planned activity will interfere with sturgeons.

- ***Portugal***

The conservation status of the species is: extinct. Its legal protection is as follows:

- Decree-Law n° 140/99, of 24 April 1999, Appendices B-II and B-IV, transposing Habitats Directive (92/43/CEE) of 21 May 1992;

- Decree-Law n° 316/89, of 22 September 1989, transposing into the national legislation the Bern Convention, Appendix III;

- Decree n° 103/80, of 11 October 1980, transposing the Bonn Convention, Appendix II;

- Decree-Law n° 114/90, of 5 April 1990, transposing CITES, Council Regulation (EC) n° 1332/2005 of 9 August 2005 (modification of Council Regulation (EC) n° 338/97 of 9 December 2005), Appendix I-A.

- ***Romania***

The species is currently strictly protected in Romania (Law No. 13 / 1993 for the ratification of the Bern Convention of 19 July 1979. Monitorul Oficial al Romaniei nr. 62 / 25.03.1993, Bucuresti).

- ***Spain***

Acipenser sturio is included in Spain's National Catalogue of Threatened Species (*Catálogo Nacional de Especies Amenazadas*) since 2000, in the category of "endangered species") by Decision of the Ministry of Environment of 21 October 2002 (Order MAM/2734/2002, published in Official Bulletin n° 2065, of 5 December 2002). This decision modified the list or the category of threatened species included in the previous version of the Catalogue implemented by the Law n° 4/1989 of 28 March 1989 for the conservation of natural sites and wild flora and fauna, and its Royal Decree n° 439/1990, of 30 March 1990. The inclusion of *A. sturio* in the National Catalogue implies that regional governments ("Autonomous Communities") have to adopt Restoration Plans for this species, which have not been developed yet.

- ***United Kingdom***

The species has complete protection under Schedule 5 of the Wildlife and Countryside Act, 1981. This Act consolidates and amends existing national legislation to implement the Bern Convention and the Birds Directive in Great Britain. The Act makes it an offence (subject to exceptions) to intentionally kill, injure, or take, possess or trade in any wild animal listed in Schedule 5, and prohibits interference with places used for shelter or protection, or intentionally disturbing animals occupying such places. *Acipenser sturio* was listed under Schedule 5 in 1992.

No Special Areas of Conservation have been proposed under the Habitats Directive for the UK, because of the sporadic occurrence, and the degree of uncertainty as to whether *Acipenser sturio* is a vagrant or migrant in UK waters.

The UK Biodiversity Partnership is responsible for implementing the UK Biodiversity Action Plan (BAP), in pursuance of the CBD. The Partnership conducted a Species and Habitat Review, reporting in June 2007. The current list of UK BAP priority species, identified nearly 10 years ago, includes 577 species through a combination of species action plans, grouped species plans and species statements. The new proposed list of 1149 species put forward for Ministerial consideration, includes *Acipenser sturio.* The criterion for selection was "international threat". Proposed elements of an action plan include "international level agreements and plans", "survey for new sites" and " research into conservation action". If the new list is fully ratified, the action plan elements listed above would tend to fully support this Action Plan under the Bern Convention. It should be noted that of the freshwater fish species that migrate through estuaries, the existing list includes only *Alosa alosa* and *Alosa fallax*. Other than *Acipenser sturio*, the new list also includes all of the remaining species in the UK, including *Anguilla anguilla, Lampetra fluviatilis, Osmerus eperlanus, Petromyzon marinus, Salmo salar* and *Salmo trutta*. Ratification as listed would provide a new stimulus in the UK to protect freshwater and estuarine habitats and their connectivity, given the range of BAP species present.

Edward II granted the sturgeon "royal" status. Since the 14th century, the species has been regarded as a Royal fish. Tradition dictates that any captured fish be offered to the monarch in the first instance. This also applies to the Prince of Wales as the Duke of Cornwall, if the capture is made in that county. The last fish known to be accepted by the Crown was in 1969.

VI. OBJECTIVES AND MEASURES

6.1 GOALS AND OVERALL OBJECTIVES

The Action Plan aims at preventing *A. sturio* from becoming extinct in Europe while building on a step-by-step reconstitution of viable populations of the European sturgeon in its historic range through

close national and international co-operation of range States, at all organisational levels. **The sequence of actions listed in this chapter does not present BY ANY MEANS a priority listing. Many of the issues require simultaneous implementation of several actions while also some range states would need to place priorities in a different sequence than others**. (priorities might be selected by the planning and coordinating committee to implement the AP as outlined under 6.2.4 Component 4 and Table in Annex 1, Action 7).

The Action Plan specifically targets on the implementation of effective conservation measures for *A. sturio* while simultaneously contributing to global biodiversity conservation and the sustainable management of aquatic resources, including the fulfillment of the 2010 target to halt the loss of biodiversity agreed upon at the fifth Ministerial Conference "Environment for Europe", held in May 2003, in Kiev, Ukraine where Environment Ministers and Heads of delegation from 51 countries in the UNECE region adopted the Kiev Resolution on Biodiversity including their commitment to "*halt the loss of biodiversity by 2010*".

At the EU level, the Heads of States of EU countries committed themselves to the 2010 target as an objective in the EU´s Strategy for Sustainable Development. Further, a proactive implementation of the required measures may well lead to the improvement of the general ecological conditions of marine, riverine and estuarine ecosystems, thereby fostering the conditions also needed for recovering sturgeon habitats.

This Action Plan, together with the Action Plan for Danube River sturgeons and any future plans, is therefore expected to contribute to the improvement of protection and restoration of sturgeon species and other anadromous fish in Europe and beyond.

6.2 Actions and expected results

A range of measures has already been taken for the conservation of the European sturgeon. However, these have so far proved to be only partially successful, so more efforts are needed to secure the survival of the species.

The mortality from poaching and by-catch remains a continuous threat to the remaining individuals, and has to be largely reduced.

Appropriate ex-situ measures are an essential prerequisite for the conservation of the species.

Remediation of the population will require supportive stocking activities including the initiation of restocking in other watersheds than the Gironde. Migration routes and habitats for all life-cycle stages should beprotected and restored, since habitat loss prevents the natural recovery of the populations.

The plan has seven main conservation objectives which may be grouped under four general components. Details on the required measures for each of the actions are listed in Annex 1 of the Annex under each of the objectives along with the respective agencies, institutions and organisations to which actions are mainly addressed while also the indicators of success are also listed with the specific milestones to be reached. These components are:

- ✓ **Component 1** : *In-situ* conservation of *A. sturio*
- ✓ **Component 2** : Protection and restoration of essential sturgeon habitats
- ✓ **Component 3** : *Ex-situ* conservation and re-introduction of *A. sturio*
- ✓ **Component 4**: International cooperation

The specific objectives and related actions for each of these components can be summarized as follows:

6.2.1 Component 1: *In-situ* conservation of *A. sturio*

Objective 1: significant reduction of fishing mortality

The support of fishermen to a programme of reduction of accidental captures and of *in-situ* monitoring of the species is critical to success of the Action Plan. The experience in France demonstrates clearly that this is both practicable and possible.

Actions

- Intensively involve professional and recreational fisheries to significantly reduce mortality due to accidental catches and through poaching Engage with and educate recreational and other fishermen to significantly reduce mortality due to accidental catches
- Raise public awareness about the status of *Acipenser sturio* as "protected species" and the state of international and community law Raise public awareness and the willingness to co-operate among fishermen and fisheries' inspections about the status of *Acipenser sturio* as "protected species" and the state of international and community law
- Enhance co-operation of fishermen and fisheries inspections to increase awareness on the protection status of the species
- Develop and introduce selective fisheries techniques
- Develop incentives to promote release and accurate reporting
- Monitor *A. sturio* by-catch and by-catch mortality
- Develop and introduce selective fisheries techniques
- Exclude non-selective clearly adverse fishing techniques in critical habitats of *A. sturio* (spawning sites, juvenile aggregations, nursery grounds)
- Consider incentive schemes to promote release and accurate reporting

Objective 2: effective control of allochthonous species

The introduction and transfer of non-indigenous species poses a critical threat to changes of biodiversity, a fact of equal importance to the loss of native species. The present rate of increasing reports of exotic sturgeon species (including hybrids) within the native range of *A. sturio* is alarming, as these non-native species may negatively affect the integrity of ecosystems in which the native sturgeon thrives, mainly competing for habitat and food resources.

Actions

- Prevent escapes from fish farms and ponds as well as from live transport systems (especially sturgeon)
- Prevent illegal and accidental introductions of alien species (including sturgeons) into the wild
- Aim towards greater consistency of European regulations on pet fish trade
- Inform the general public about the risk of allochthonous sturgeon introductions
- Encourage removal (eventual eradication) of exotic species, in accordance with national laws and promote to improve national laws in line with existing inter-governmental and international codes and guidelines

6.2.2 Component 2: Protection and restoration of essential sturgeon habitats

Objective 3: Protecting and improving the quality and continuity of essential riverine and estuarine sturgeon habitats

Habitats previously used by *A. sturio* as spawning and nursery grounds in riverine and coastal waters have deteriorated and information on their status and option for rehabilitation is scanty to non-existing. There is an urgent need to improve the knowledge base on the subject while also seriously addressing issues on habitat fragmentation and needs for interconnections ("ecological footholds").

Actions

- Identify, map and analyse the functionality of present and potential essential *A. sturio* habitats

- Protect or restore critical habitat functions
- Identify and map barriers to sturgeon migration in rivers of the historic distribution area where reintroductions are foreseen
- Re-open and reconstruct sturgeon migration routes, including construction of suitable fish passes (in existing and future constructions): (a) Conduct feasibility studies for fish passage to potential upstream spawning sites; (b) Remove or open dams if feasible; (c) Monitor the efficiency of fish passes
- Monitor habitat status and utilisation
- Designate and manage protected areas to integrate essential sturgeon habitats into relevant networks including marine habitats of *A. sturio*.

Objective 4: improvement of water quality

Water quality objectives certainly play an important role in habitat restoration and species recovery programmes. Our knowledge on requirements of various life cycle stages of sturgeons in terms of chemical and biological water quality criteria is fragmentary and needs urgent attention.

Actions

- identify water quality requirements for spawning and nursery habitats to the extent possible
- Identify and register sources of pollution which can directly have an impact on water quality of critical sturgeon habitats
- Integrate the identified needs in the setting-up of river basin management plans, as appropriate, while implementing locally the EU Water Framework Directive

6.2.3 Component 3: *Ex-situ* conservation and re-introduction of the *A. sturio*

Objective 5: Ex-situ conservation of A. sturio

As outlined above, there seems to be presently no alternative but pursuing ex-situ conservation to save the common European sturgeon from becoming extinct while building up a broodstock sufficiently large for mass reproduction and pursue rearing programmes for release of produced juveniles into restored habitats. A sequence of actions is required to achieve the objective.

Actions:

- Develop a contingency plan and establish receiving facilities for accidentally caught *A. sturio*
- Establish and expand existing broodstock as a founder population
- Ensure characterisation of all individuals of the broodstock (including gene bank)
- Establish a breeding plan to maximise effective population size and genetic diversity
- Guarentee continuous and urgent improvement of cultivation methodology
- Optimise diet composition and feeding regimes according to the requirements of life cycle stages
- Implement appropriate risk management systems to safeguard cultivation
- Attempts towards large-scale rearing of juveniles in sufficient quantities for release
- Establishment of cryopreservation of gametes and/or embryos
- Develop methods for gamete quality assessment to allow optimal control of the maturation processes

Objective 6: Release of A. sturio for re-establishment or enhancement

The ultimate goal of the objective is to re-establish self-sustaining populations in as many areas of its natural range as possible. These releases have to be (a) substantial in number because of the high natural mortality, (b) long-lasting (for decades) because of the slow growth of the species and its

extreme longevity, (c) at the right "time-size-release window" and (d) at habitats of strategic importance to nursing and imprinting (homing).

Actions:

- Develop a management plan for the enhancement of the *A. sturio* population in the Gironde catchment area as well as in other areas with suitable sturio habitats in several range states
- Set up a distribution plan for restocking material to selected river basins in Europe (within historic range)
- Prepare management plans (including responsible authority, monitoring, surveillance of success), for the re-establishment of populations in those rivers:
- Guarantee gradual adaptation of reared stocking material for fitness of survival under natural conditions: (a) Establish appropriate rearing facilities and procedures for rearing of stocking material; (b) Establish the optimum time-size-release-window for juveniles allowing best survival
- Develop and apply marking techniques to monitor the success of the release programmes

6.2.4 Component 4: International co-operation

The six conservation objectives above have to be complemented by the establishment of an appropriate co-operation mechanism between all stakeholders, including governmental agencies, research institutions and NGOs in range states actively involved in sturgeon conservation projects and long-term programmes. Therefore, it is proposed to set up a European Group possibly comprising such active members from range State, to specifically discuss and co-ordinate the implementation of the Action Plan and relevant national actions. The composition of the group may vary, depending on the number of ongoing projects and programmes in participating range states.

It is further proposed that such a Group should be established with close linkages to the Bern Convention and operate in accordance with its rules of procedure. The task of the Group shall be to facilitate through communication and co-ordination of national activities the implementation of the six conservation objectives by as many of the range States as possible. The WSCS (World Sturgeon Conservation Society) is proposed to be used as the technical meeting platform for the steering group because of (a) the continuity of available infrastructure at the home office while composition and numbers of group members will change with short-term projects, (b) the global sturgeon expertise of WSCS which can easily be tapped whenever guidance and scientific knowledge is needed to foster the group decisions.

The Group should hold its first meeting in early 2008 and decide on the further frequency and procedure of future meetings, which can be called in at the volunteering invitation of individual host countries. This is considered to be a matter of utmost urgency in the light of the status of the species *A. sturio*.

VII. OVERCOMING GAPS IN SCIENTIFIC AND PRACTICAL KNOWLEDGE NEEDED FOR A SUCCESSFUL IMPLEMENTATION OF THE ACTION PLAN

As already outlined in several of the sections above, certain gaps in science and technology need to be filled to properly implement the Action Plan for sturgeon conservation and some of the required knowledge base has an over-arching significance for several of the Actions and their required measures. While they are mostly included or implied in the proposed measures presented in Annex 1, these knowledge gaps can be addressed flexibly and directly within the proposed measures and/or independently carried out by national, international and EU-supported research projects, greatly assisting to reach certain milestones. Because certain research issues can serve several Actions they are not specifically listed in the table but flagged out here separately with the respective Action, measure and milestone indicated for ease of orientation.

Although there are many research priority needs, only 8 subject areas are highlighted. Others might gain higher importance in the future as progress in knowledge and insights for long-term

needs has been made. Therefore, the listing below does not exclude other issues but focuses on subjects pertinent to key Actions and their respective objectives and measures.

In-situ protection

- ✓ Improving the protection of the species in marine waters, more detailed knowledge on the habitat utilization and the underlying attractants are required. This knowledge also improves the options for protection measures for essential habitats and the network interconnecting them.
- ✓ No experimental trials concerning the reproductive potential of sturgeon hybrids (F1 of fish with different ploidy levels) have ever been reported. The difference in ploidies (functional 4n versus functional 2n respectively; Williot 2006) does suggest that a hybrid would become infertile being triploid. According to Birstein *et al*. (1998), the genotypes are rather 8n and 4n, in consequence resulting in fertile 6n offspring. There is a need for specific research in this area to close this critical knowledge gap.

Specific research projects in this area should obviously be linked to Component 2 objective but technically to Component 3, Objective 5, (particularly Action 5.3.1, as well as 5.4 while also serving several milestones and indicators).

Habitat protection and restoration

- ✓ Effects of climate change may become important in relation to subsequent changes in environmental conditions in different habitats essential for various life-cycle stages of A. sturio and Action Plan measures should take these into consideration. Some critical issues include:
  a. altered dynamics and timing of spring floods with the subsequent effect of changes in trigger for upstream spawning migration
  b. changes in the temperature regime of the river and the effects upon
     i. migration time upstream to spawning habitats, residence time in rivers and river sections for juveniles, and seaward downstream migration
     ii. changes in food availability in space and time, mainly in nursery areas and habitats for juveniles, potentially affecting riverine (and/or estuarine) residence time and size at outmigration to sea, thereby seriously affecting survival potential and population structure

Specific research projects in this area should obviously be linked to Component 2, Objectives 3 and 4 (various Actions).

- ✓ Effects of the Golfech dam upon the conditions for migration and reproduction in the Garonne (the drastic decline of the population size due to reduced reproductive efficiency became apparent about 20 years after the installation of dams in most river systems with spawning runs such as the Elbe, Eider, Stör and Guadalquivir rivers).

Specific research projects in this area should obviously be linked to Component 2, Objective 3, in particular Actions 3.2, 3.4 and 3.5, serving the respective milestones indicated there under.

- ✓ Sound data on the requirements and key factors determining essential habitat requirement are missing.
- ✓ Channelization, by cutting off meanders, straightening bends, eliminating sand and gravel bars is reducing habitat heterogeneity as well as the presence of suitable spawning sites.
- ✓ This constraint is severe in many of the large rivers in Europe. One example is described for the lower stretches of the Po delta. The last modifications of natural course of the Po River were started in the 1960's and could have had a serious effect on juveniles (Castaldelli, G., personal communication).

Specific research projects in this area should be linked to Component 2, Objective 3, serving specifically Actions 3.3, 3.4, 3.5, and 3.6 in order to achieve the respective indicators.

Ex-situ conservation

- ✓ Although the basic physiological functions are known, a serious knowledge gap exist for captive stocks with regard to the optimum environmental conditions to induce gonad maturation (i.e. combinations of light-temperature and feeding regimes) while producing high quality gametes with good survival potential for the subsequent generation. Historically, some attempts to raise *A. sturio* successfully in hatcheries were undertaken in the lower Elbe River area (Blankenburg 1913) and in Schleswig-Holstein (Germany), however, the reports are very descriptive providing little quantifying information useful for developing a hatchery guideline. More experience will have to be acquired during the controlled reproductions of the *ex-situ* stock to develop hatchery techniques optimizing the quality of the offspring.

Specific research projects in this area should be linked to Component 3, Objective 5 serving all identified Actions (5.1 to 5.10).

- ✓ The optimum feed compositions matching the requirements of various life cycle stages are largely unknown. This knowledge is urgently needed to improve the quality of parent fish with special reference to overall health status and quality of gametes. Because of the longevity and late maturation with time frames 2-4 times longer than known for any of the established aquaculture species, such knowledge is critical for restocking programmes that built on small numbers in the founder population. It should be noted that specific information on the subject exists for other sturgeon species (i.e. *A. naccarii* and *A. transmontanus*).

Specific research projects in this area should obviously be linked to Component 3, Objective 5, serving Action 5.6 and Objective 6, serving particularly Action 6.4.

Release of Juveniles

- ✓ For the purpose of this Action Plan the populations within the historic range have to be considered as *A. sturio,* but additional efforts should be made to verify the species status of the populations under question in the near future.

Specific research projects in this area should obviously be linked to Component 3, Objective 6, serving Actions 6.1 to 6.3.

- ✓ There is a need to identify the proper size of fish for stocking to achieve the optimal conditions between imprinting juveniles to memorize their native river, fitness for competitive size against predation and the rearing costs (fitness for best survival after release). Much can be learned from the experiences made with Salmon ranching programmes, particularly in Canada, indicating that there is an optimum "time size release window" at which the highest return per unit investment can be obtained. Certainly, because of the longevity of the fish and the costs involved, such information is crucial for sturgeon re-establishment projects and extensive efforts should be made to study the optimum release conditions for sturgeons.

Specific research projects in this area should obviously be linked to Component 3, Objective 6, serving Action 6.4

- ✓ Besides these pressing issues there are numerous open questions that also need accompanying research to provide the necessary know how for optimizing the effectiveness of the overall Action Plan for *Acipenser sturio*. Certainly, as clearly stated under Component 4, a concerted and well coordinated effort is required to effectively implement the AP, recognizing the circumstance that there are limited resources available (not only in terms of funds but also in terms of human resources with the necessary expertise on sturgeons). It is believed that following the proposal as outlined under the four principle components of the Plan will allow achievement of the ultimate goal, to re-establish the sturgeon as a viable component in major areas of the historic distributional range. Such development will also allow the sturgeon to serve as a valuable environmental indicator species which responds over longer time periods (because of its longevity) to the effects of environmental stressors and the respective counter measures.

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Annex 2: **List of exemplary critical habitats for *A. sturio* including sites designated or planned to be designated under Natura 2000**

Country	Name of Site	Surface (ha)	Area			Remarks
			Atlantic	Continental	Mediterranean and North Seas	(Code of Site under Natura 2000)
Italy	Basso corso e sponde del Ticino	8564		X		IT2080002
Italy	Spiagge fluviali di Boffalora	172		X		IT2090006
Italy	Po da Golena Bianca a Isola Bianca	616		X		IT4060013
Italy	Lanca di Soltarico	160		X		IT2090007
Italy	Bosco Foce Oglio	306		X		IT20B0001
Italy	Delta del Po : tratto terminale e delta veneto	25362		X		IT3270017
Italy	Fiume Po da Rio Boriacco a Bosco Ospizio	6156		X		IT4010018
Italy	Sacca di Goro, Po di Goro, Valle Dindona, Foce del Po di Volano	4872		X		IT4060005
Italy	Laguna di Marano e Grado	16288		X		IT3320037
Italy	Boschi di Vaccarizza	465		X		IT2080019
Italy	Fiume Po- Tratto vercellese e alessandrino	14107				IT1180028
Italy	Boschi Siro Negri e Moriano	1352				IT2080014
Italy	Boschi del Ticino	20553				IT2080301
Italy	Senna Lodigiana	327				IT2090501
Italy	Castelnuovo Bocca d'Adda	165				IT2090503
Italy	Lanca di Gerole	476				T20A0013
Italy	Bosco Ronchetti	210				IT20A0015
Italy	Spiaggioni di Spinadesco	825				IT20A0016
Italy	Riserva Regionale Bosco Ronchetti	300				IT20A0401
Italy	Riserva Regionale Lanca di Gerole	1180				IT20A0402
Italy	Spinadesco	1039				IT20A0501
Italy	Lanca di Gussola	152				IT20A0502
Italy	Isola Maria Luigia	556				IT20A0503
Italy	Isola Boscone	139				IT20B0006
Italy	Parco Regionale Oglio Sud	4023				IT20B0401
Italy	Viadana, Portiolo, San Benedetto Po e Ostiglia	7223				IT20B0501
Italy	Delta del Po	25012				IT3270023
Italy	Fiume Po da Stellata a Mesola e Cavo Napoleonico	3140				IT4060016
France	La Garonne	5220	X			FR7200700
France	Marais de Brouage (et marais nord d'Oléron)	26142	x			FR5400431
France	Marais de la Seudre	14001	x			FR5400432
France	Estuaire de la Gironde	61080	x			FR7200677

France	Pertuis charentais	155907	x			FR5400469
France	La Dordogne	5694	X			FR7200660
Germany	Lower and middle Eider River, Schleswig-Holstein	?		x		-
Germany	Lower and middle section of the Stör River, Schleswig-Holstein	?		x		-
Germany	Oste River (Elbe tributary), Lower Saxony	?		x		-
Germany	Elbe River (Hamburg area and upstream (Lower Saxony and Schleswig-Holstein)	?	x			-
Germany	Middle part of the Elbe River (Magdeburg – Lauenburg)	?		x		-
Germany	Lower reaches of the River Rhine (Nordrhein-Westfalia ; Germany)	?		x		-
Germany	Lower and middle reaches of the Ems River (Lower Saxony)			x		-
Germany	Helgoland Island (Littoral zone of the rocky Island)	Ca 2000.00		x		-
Germany	Doggerbank, central North Sea)			x		-
Germany	Eastern German Bight	313,512.76		x		-
Germany	Sylter Aussenriff	513,428.39		x		-
Germany	Dogger Bank (North Sea)	169,895,35		x		-
Greece	Delta Achelou, Limnothalassa mesologgiou-Aitolikou, Ekvoles Evinou, Niso I Echinades, Nisos Petalas	35588,73			X	GR2310001
Spain	Rio Guadiana et Ribera de Chanza	1545.81			X	ES6150018
Spain	Andevalo occidental	52901.71			X	ES6150010
Spain	Doñana	112355,2			X	ES0000024
Spain	Bajo Guadalquivir	4113,94			X	ES6150019