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Rescue of Sturgeon Species in the Ural River Basin

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THE URAL RIVER STURGEONS: POPULATION DYNAMICS, CATCH, REASONS FOR DECLINE AND RESTORATION STRATEGIES

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Abstract The Ural river, the third longest river in Europe, has the only remaining spawning habitats in the entire Caspian basin for all sturgeon species. Unlike other large European rivers the river's ecosystem has not been altered and the natural hydrological regime is still intact. The Ural sturgeon yield-to-fishery relative to river discharge was the highest in the Caspian Sea till recently. The environmental conditions to secure natural reproduction are still satisfactory for successful sturgeon reproduction. However, nowadays the catch in all regional sturgeon species is negligible. The Ural sturgeon population dynamics are analyzed along with some anthropogenic and natural factors affecting them. It is argued that legal overfishing (including all legal means of fish removal), based upon (a) faulty estimations of sturgeon stock and catch limits and (b) inappropriate fishery policies are the principal reasons for the stock decline in the Ural. The maintenance of the natural reproduction in the Ural is considered to be the primary strategy for the stock replenishment. If used at all, artificial propagation should be used only as an additional secondary option exclusively at the historical sturgeon habitats upstream the Ural river and not in the river delta, where the hatcheries are located now. Transboundary cooperation of basin countries with active international involvement is essential to prevent further deterioration of the situation.

Keywords: Caspian sea, Ural river, beluga, Huso, Sevryuga, ship, Russian sturgeon, Persian sturgeon, bioindicator, overfishing, impoundment, Cossacks, CITES, hatchery, total allowable catch

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Introduction

Sturgeons are among the most interesting species in the world. They have successfully survived from the time of the dinosaurs. Extremely high plasticity helped them to adapt to the changing environment through all these millions of years. The historic range of sturgeon species are the main rivers of the Northern hemisphere. Each river basin had a stock of its own with specific features and life cycle characteristics. By now they have vanished from most of them (FAO 2007b; IUCN 2007; WWF 2002a).

The sturgeon is an *anadromous* species, whose reproduction takes place in freshwater river basins with the growing and maturing phases occurring in the sea. After maturation in salted water sturgeons migrate back to freshwater for the purpose of breeding. Particular environmental conditions are required for spawning, depending on species: hard substrate (pebble, gravel, etc.), stream velocity (0.5–2.0 m/s), depth (1–20 m), temperature regime, etc. Spawning habitats are located in the upper branches of rivers. The distance to these grounds can be, depending on species, more then 1,500 km from the river delta. The size of adult specimens varies from 0.5 to 6 m and from 0.5 kg to 2 t. The sturgeon is a long-lived fish standing at the top of food webs.

The extinction of sturgeon species is one of the most tragic and representative examples of the destructive influence of humankind on Nature. Sturgeon, sometimes called the “living fossil” or living “dinosaur” of the fish world, is currently on the verge of extinction solely due to anthropogenic impact.

It is estimated that the number of sturgeons in major basins has declined by 70% over the last century (WWF 2002a). Out of 15 sturgeon species known, most are considered critically endangered or vulnerable to extinction worldwide (WWF 2002a). At the same time some regions are suffering more significant and dangerous trends then others (Pitikch et al. 2005). Sturgeons of the Aral Sea are extinct, while sturgeons of the Sea of Azov are on the verge of extinction (AzovBas 2002; Russian State Duma 1995; Lagutov 1995).

Sturgeons are among the world’s most valuable wildlife resources. Gessner et al. (2002) estimate the demand on world export markets for caviar, the delicacy derived from sturgeon roe, at 500 t annually (Gessner et al. 2002). The global caviar trade was a major driving force of the sturgeon fisheries worldwide. The leadership role in international caviar trade shifted from the United States in the 19th century to Russia after the USA’s stock’s depletion (DeMeulenaer and Raymakers 1996; Pitikch et al. 2005). Russia was the main caviar trader throughout the 20th century due to the active utilization of the enormous Caspian sturgeon stock.

The Caspian Sea is considered to be the world's biggest sturgeon habitat, holding at its peak up to 90% of the world's sturgeon stock (CEP 2002a). Most of the caviar consumed in the world during the 20th century originated in this region. Unfortunately, nowadays these estimations should be treated as outdated. Nowadays despite the active fishing efforts, both legal and illegal, by littoral countries, the catch is miserable. The Caspian sturgeon stock has decreased drastically and some authors claim it to be on the verge of extinction (Chivers 2006; Dulvy et al. 2003; Itoh et al. 2004; Pourkazemi 2007; Uralbas 2007b).

During its history the Caspian Sea went through a series of dramatic changes. Sturgeons could adapt successfully to all challenges: geological transformations, sea level fluctuations, salinity, temperature regime changes, etc. But human activities in the region are about to put an end to the long history of this species.

The drastic decrease in the sturgeon population of the Caspian Basin is caused by various factors (sea level fluctuations, pollution, etc.), but the main ones are believed to be blockage of the spawning places and migration routes by dams and overfishing on the main basin rivers (Uralbas 2007a). The historical worldwide overfishing of sturgeon species throughout Europe and Northern America since Roman times (Keysler 1762) as a reason for stock decline cannot be equally applied to the Caspian basin due to the peculiarities of regional environmental and human history. This region was mostly populated by nomads, not practicing fishing, and the initial number of fish was abundant.

Sturgeon catch as an indicator of the size of the sturgeon population strongly depends upon natural river flows. The variations in catch reflect changes in the numbers able to pass up the rivers to spawn (CEP 2002a). In case of complete blockage or severe reduction in the spawning places the sturgeon population is doomed to extinction even without any fishing efforts. The sturgeon is a marker of both ecosystem health and the sustainability of human activities in the region.

Numerous programs have been launched worldwide aimed at sturgeon restoration. Sturgeon population rehabilitation is a long and complicated process. Success in this challenging task depends upon a wide range of environmental and anthropogenic factors. Thus, only an integrated holistic ecosystem approach to both river basin and related human activities can secure sturgeon rehabilitation.

While some of these programs show some degree of success (namely US-based ones), most fail not only to restore degraded habitats (Buijse et al. 2002; Williot et al. 2002a, b), but even to find a couple of productive breeders to start a restocking program in hatcheries as in European basins (Williot et al. 2000). Furthermore, the effect of artificial propagation as a popular measure to sustain wild sturgeon population is dubious and challenged by many researchers.

From this perspective the Ural River, the third longest river in Europe and second in the Caspian basin, is unique since it contains the only self-sustaining, viable sturgeon population capable of natural reproduction. Though more then 100 rivers empty to the Caspian Sea (Pitikch et al. 2005) sturgeons can reproduce only in major rivers. Every significant Caspian river was impounded in the 1930–1970s, cutting off the sturgeon spawning grounds. The Iranian rivers (Sefidroud, Gorganrud and Tajan), minor in comparison to the f.USSR rivers' contribution to freshwater influx and sturgeon reproduction, have also been dammed recently (Abdolhay 2004).

Moreover, the remaining sturgeon habitats, historical or believed to be appropriate for spawning, often do not have proper hydrological conditions. For instance, during the first 40 years since the lower Volga's regulation the environmental flow conditions at the spawning grounds downstream the Volgograd dams were flooded only 13 times (Dubinina and Kozlitina 2000).

Figure 1 depicts the biggest dams on the main Caspian river basins. The Ural is the only river with non-regulated low and middle water course for more than 1,000 km upstream the delta, which is an historic range of sturgeon spawning and nursing habitats.

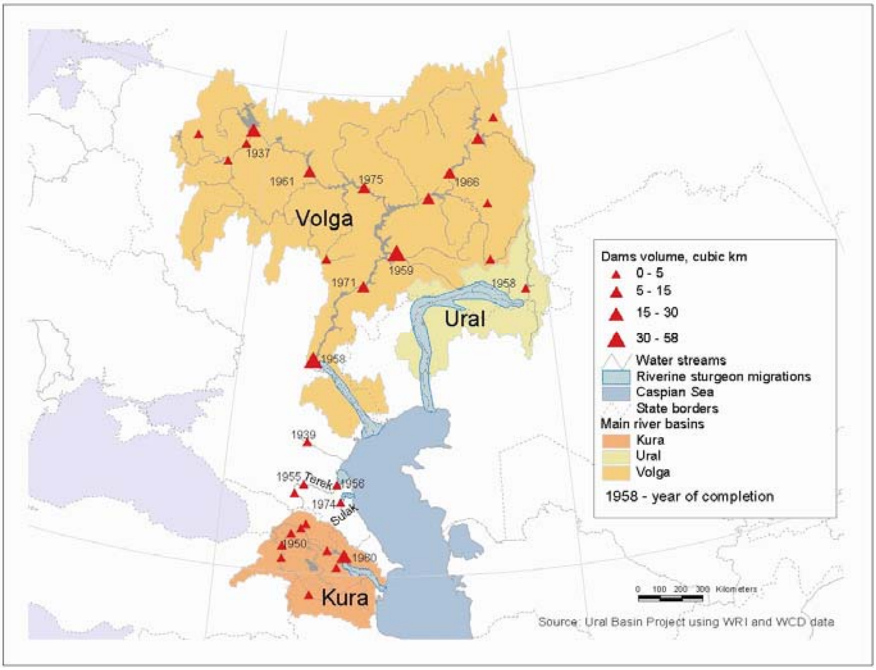

Figure 1. The main river basins of the Caspian Sea with biggest dams and waterworks. The current sturgeon areal in the rivers indicated with dotted areas

The future of the whole Caspian sturgeon stock and worldwide restoration programs depends on the Ural River's spawning and nursing habitats. Till recent times the Ural was able to support abundant sturgeon populations.

However, during the last few decades the catch in the basin has dropped by a factor of 100. Urgent measures are needed to conserve this flagship species and unique ecosystem. Out of six different sturgeon species inhabiting the Ural river basin, five are indicated in the IUCN Red Book as endangered or critically endangered (IUCN 2007). Many authors consider even these conclusions and actions as too optimistic and believe that the "point of no return" towards extinction for most sturgeon populations has been reached (Dulvy et al. 2003; Jonsson et al. 1999; Lagutov 1995; Smith et al. 1993; Stephan and Wissel 1999).

Sturgeon species in Ural

Sturgeons, like other anadromous species, recognize their native river catchments and return there for spawning. Little is known about this phenomenon, called "*homing*". Some theories suggest that homing depends principally on olfactory recognition of streams.[1] As a result, each river basin in the historical range had its own sturgeon stock.

Sturgeon populations in the Caspian's main tributaries possess unique characteristics and life cycle peculiarities. Historically, the specimens originating from different river basins were easily recognized by specialists. Moreover, despite growing and extensively migrating in the sea for 10–20 years upon maturation the sturgeon could identify their own river basins to start spawning.

All sturgeon species living in the Caspian Sea had their distinct populations in the Ural: the Beluga (*Huso huso Linnaeus, 1758*), the Russian Sturgeon (*Acipenser gueldenstaedtii Brandt, 1833*), the Sevryuga (Stellate sturgeon, *Acipenser stellatus Pallas, 1771*), the Ship (*Acipenser nudiventris Lovetsky, 1828*), the Sterliad (Sterlet, *Acipenser ruthenus Linnaeus, 1758*) and the Persian Sturgeon (*Acipenser persicus Borodin, 1897*).

The Beluga Sturgeon or the Great sturgeon is considered to be the most valuable sturgeon species worldwide. The World Wildlife Federation named beluga as the fourth most endangered species on Earth in 2002 (CEP 2002a), but it is still legally harvested and exported from the region.

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[1] Though being challenged by some researchers homing fidelity is the only explanation to the existence of the river-based sturgeon populations and inherent genetic variations among them after 10–20 years of maturation and active migrations in the sea with numerous incoming river streams.

The Ural River plays a special role in Caspian sturgeon reproduction. Today the river contains the only available spawning grounds in the whole basin. Since 1979 the numbers of beluga spawners entering the Ural have exceeded the number of fish trying to spawn in the Volga (Khodorevskaya et al. 1997). The Beluga catch in the Ural in the 1990s was up to 70% of the total f.USSR beluga catch despite the fact that sturgeon hatcheries in the Ural river did not exist (unlike several in the Volga region releasing hundreds of millions fingerlings annually) (KaspNIRH 1999).

However, the Ural River is a unique ecosystem not only due to its current exclusive position. Even before the regulation of the Caspian rivers the productivity of the Ural ecosystem was as high as that of the Volga, even though total water flow is 25–30 times smaller (!). In particular, the mean total flow in the Ural is 9–10 km^3, while the Volga has 260 km^3. At the same time, average total sturgeon annual yield from the fisheries in the Ural and Volga rivers was roughly equal – 11,000 t[2] from the latter, while the yield from the Ural could reach up to 15,000 t (KaspNIRH 1999).

The sturgeon spawning grounds in the Ural River were much more efficient and the sturgeon population was much more productive. This is a very interesting phenomenon which is still not paid due attention in the literature and environmental programs. Most attention is paid to the Volga River, as the biggest Caspian tributary and the habitat for the biggest number of species in the region. For instance, currently, according to research conducted by the Caspian Fishery Research Institute, the contribution of the Volga ecosystem to the sturgeon stock in the Caspian Sea is 69.8%, the Ural's is 29.7%, while the Kura and Terek together only contribute 1.4%.[3] At the same time, total freshwater influx delivered by the Ural is only 3% against 80% by the Volga and a total of 8.8% by the rivers Kura (6.3%) and Terek (2.5%). Based on these official estimates the river productivity ratio (sturgeon catch/water influx) for the Ural river is 9.9, while for the Volga and Kura/Terek it is 0.87 and 0.126 respectively (Figure 2).

In general all sturgeon species share the same life cycle stages and characteristics with variations in terms of maturation, growth, fecundity, etc. (Detlaf et al. 1981; FAO 2007a).

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[2] These estimations correspond to the highest catch in the history of the sturgeon fishery in the region. As a result sturgeon stocks were overexploited and have never restored afterwards.

[3] These estimations by KaspNIRH are based on number of released fingerlings from hatcheries in Volga, Kura and Terek and results of natural reproduction in Ural.

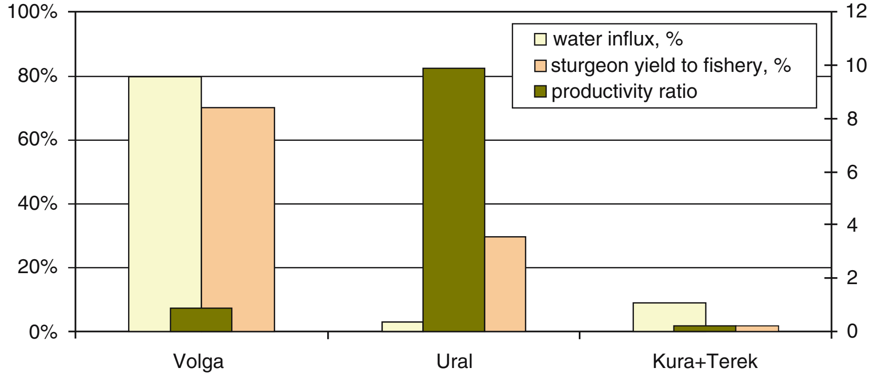

Figure 2. The contribution of main river basins to the Caspian Sea in freshwater influx and sturgeon yield to fishery

Sturgeons have an age-structured population. The development of specimens in every species goes through the same stages:

- Embryonic development
- Prelarvae – until transition to active feeding
- Larvae – able to feed actively (12–14 days after hatching)
- Fry (20–30 days after hatching)
- Juveniles – until maturation
- Adults

Sturgeon species can spawn only in freshwater in the spawning grounds located in upper river branches. Eggs are deposited on hard substrate (stones, gravel, pebble, coarse sand, etc.).The distance from the river delta to spawning grounds depends upon the species. This is an important consideration in the sturgeon life cycle, since larvae and fingerlings migrating downstream, or rather washed down with the water flow, need to reach a certain age to survive in the brackish water of estuaries. Some young sturgeons winter in the river and migrate into the sea in the following year. With regards to mature specimens, sturgeons are mostly euryhaline and eurythermic species.

Sturgeons enter the Ural for spawning in different periods, but in most Ural sturgeon species the vernal (spring) races prevail. Spawners from these races go into the river for spawning in the spring during the flood period. For instance, 80% of the beluga spawning population consists of vernal migrants (Peseridi 1971). It should be noted that spawning itself occurs only once a year. The vernal migrants travel long distances to

Table 1. Some characteristics of Ural sturgeon species (Compiled using materials from CEP 2002b; EPA 2004; FAO 2007a; KaspNIRH 1999; Khodorevskaya et al. 1997; Peseridi 1971)

Species	Maturity		Spawning migrations in Ural (km)	Fecundity (thousand eggs)	Average weight (kg)	Reproductive age	Maximum age	Spawning periods
	Male	Female						
Beluga	12–15	15–20	1,200	680–800	350	11–55	100 and more	Males 3–5 years
Huso huso (Linnaeus, 1758)					Up to 1,500			Females 5–7 years
Russian sturgeon	7	8	1,000	320	50	7–40	50	Males 4–5 years
Acipenser gueldenstaedtii Brandt,					Up to 600			Females 5–6 years
1833 Sevryuga	5–6	7–9		236–253	5–10	5–30	30	3 times in life
Acipenser stellatus Pallas, 1771								
Ship	9–13	13–16	350–650	386–561	20	9–40	32	2–3 years
Acipenser nudiventris Lovetsky,					Up to 80			
1828 Persian sturgeon	7–8	9–10	1,000	320	30	15–38	50	4–5 years
Acipenser persicus Borodin, 1897								
Sterlet	4–5	7–8		4–140	0,5–2	3–17	30	
Acipenser ruthenus Linnaeus, 1758					Up to 15			

spawning habitats from the sea in one attempt. The migrants from the autumn (winter) race enter the Ural in advance, winter in some river bed depressions (“wintering holes”) halfway to the spawning grounds and then join the vernal race for the spawning migration in the spring.

Sturgeons are late maturing species. Females mature at the age of 7–20, males from 4–15 years old depending on the species. Fecundity in adult sturgeon females increases with age. Generally they produce a greater number of eggs during each subsequent spawning run (EPA 2004). Besides that, the frequency of spawning runs also increases with age (Dmitriev and Vasilenko 2007).

The Ural river is the most important spawning habitat for the ship, Sevryuga and beluga (CEP 2002a). The first two species are spawned mostly in the Ural, while beluga spawners can be found in the Ural in higher numbers then in the Volga (Khodorevskaya et al. 1997).

The freshwater subspecies of ship and sterlet traditionally inhabited the Ural River as well. This fish did not go to the sea for maturing, but instead stayed in the river during all stages of their life cycle. However, with the river-based fishing strategy which has prevailed in the Caspian fishery since the 1960s, these species were exposed to much higher fishing pressure and have virtually vanished from the Ural. They are very rare species in the Ural nowadays.

The Ural sturgeons are subject to the same general trends as other Caspian sturgeon populations: decrease in numbers, reduced fertility, reduced body weight, decrease in average age.

It should be emphasized that while they originate in different river basins the sturgeon all spend most of their life cycle in the shallow coastal areas of the Caspian sea, actively migrating along the entire Caspian shore. For instance, during winter when the northern Caspian is covered with ice, most of the sturgeon specimens migrate to the south (KaspNIRH 1999). This peculiarity makes sturgeon a common resource for all littoral countries whatever their river of origin.

The same sturgeon species subpopulations often cannot be distinguished by appearance. For instance, the south sevryuga historically inhabiting the Kura differs from the Ural population only by later maturation age and lower fecundity (KaspNIRH 1999). Moreover, sometimes molecular analysis of the species designated upon morphology suggests no difference in them. So, the Persian sturgeon, despite having a different appearance and reproductive behavior, is sometimes not recognized as a species different from the Russian Sturgeon. This is an important consideration for the catch analysis presented later.

Spawning grounds in the Ural river

Six species, including the Persian Sturgeon (Peseridi 1986), historically had their spawning grounds in the Ural river (CEP 2002a).

According to estimates by the Russian Federal State Department on Fishery and Water Resources, the Ural river contains about 1,000 ha of sturgeon spawning grounds (KamUralRybVod 2007; KaspNIRH 1999). The grounds are equally shared between Russia and Kazakhstan. Most of these grounds, especially in the lower parts, are temporarily flooded, meaning that they are available for spawning only during the high water season (KamUralRybVod 2007). The water depth required for sturgeon spawning here is 2–5 m. Such water volumes are not available every year.[4] In low water seasons these grounds are gravel, sandy or limestone fields along the river stream. The natural hydrological regime with its high level spring flood is required for the normal functioning of these spawning grounds.

The spawning grounds of beluga and other sturgeon species in the Ural basin were historically located through most of the Ural River network starting from approximately 500 km from the delta. According to the Orenburg branch of the Federal State Fishery Department (KamUral-RybVod 2007) on the territory of Russia spawning grounds could be found:

- In the Ural and Sakmara rivers up to Kuvandiuk *raion* (small administrative territorial unit in former USSR countries) of the Orenburg Oblast
- In the lower stream of the Salmiush river, a tributary of the Sakmara
- In the mouth of the river Irtek, a tributary of the Ural
- In the river Ilek, and its tributary river Mazanka

In the mid 1980s the Guriev Branch of the State Fishery Institute[5] carried out an assessment of spawning grounds along the Ural River. The results showed much higher viability and survival rates for the juveniles originating from the spawning grounds in the upper Ural branches on the territory of the Orenburg oblast (Figure 3 shows spawning grounds with high productivity). There are different explanations for this phenomenon such as (a) only strong and well-fed specimens can reach grounds located far upstream, (b) larvae and juveniles from lower spawning sites might reach the brackish sea water too early, prior to the development of salinity resistance (Lagutov 1996; Peseridi et al. 1979).

[4] See the article on the Ural river hydrology in this volume.
[5] Now Kazakhstan Fishery Research Institute in Atyrau.

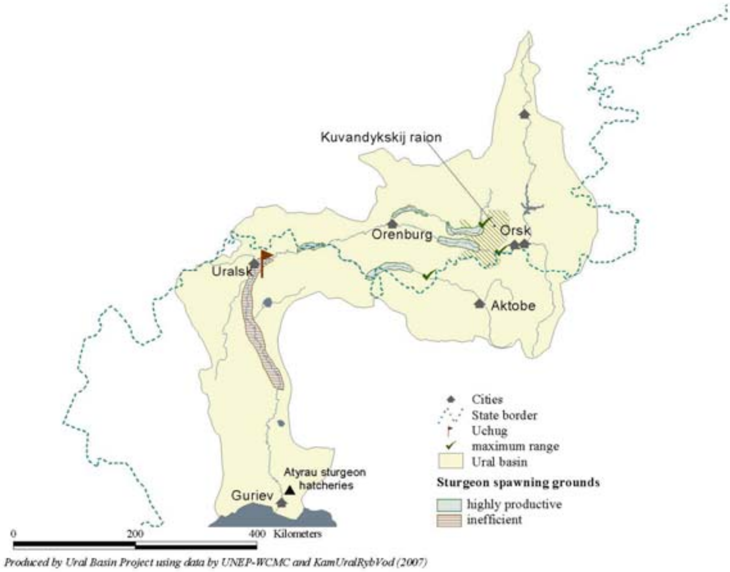

Figure 3. Sturgeon spawning grounds in the Ural river basin. There are evidences on spawning taking place up to Kuvandykskij raion (Orenburg Oblast, Russia)

Due to the high-level floods and preserved self-purification capacities of the Ural River, the precise location of the sturgeon grounds was always changing. In some years historic grounds were silted while other areas appropriate for spawning appear. Systematic monitoring of the spawning grounds has not been conducted for at least last two decades, thus only approximate ranges and upper limits for spawners can be indicated. Most of the available data on the location of spawning habitats is based upon the outdated results of the field research or observations conducted from the 1930s–1970s. Regular monitoring utilizing modern equipment (i.e. spawner tagging) is urgently required to obtain reliable information.

Currently, depending on favorable conditions, only beluga and Russian sturgeon appear occasionally in the spawning places in the middle course of the Ural River (Orenburg Oblast, Russia). The Sevryuga and ship do not reach spawning grounds in Russia. The Sterliad appears rarely in the middle Ural course and has a very small body size.

According to the observations made by the Federal State Fishery Department, the number of sturgeon specimens arriving at spawning grounds in Orenburg in 2004–2005 was around 100. Not a single beluga was seen at the spawning grounds despite the high water levels during the spring flood.

In 2006 the spring flood was characterized by low water volume and not a single sturgeon arrived in the spawning grounds in the middle Ural. In 2007 high water volumes were discharged from the Iriklinskoe reservoir and 10–20 belugas and 50–100 Russian sturgeons were observed in the middle Ural (Dmitriev and Vasilenko 2007). This year spawning has occurred in the Ilek River and its tributaries.

The efficiency of spawning grounds in the Ural in the 1970s was estimated at 11 thousand tons,[6] including 0.3–1.95 thousand tons for beluga, 0.16–0.36 thousand tons for Russian sturgeon, 2.4–8.3 thousand tons for sevryuga and 0.002–0.6 thousand tons for ship (KazNIRH,1999 cited by KaspNIRH 1999).

Sturgeon population as an indicator of the sustainability of watershed management

Apart from its high economic value, sturgeon is a perfect indicator (an umbrella) species for the river basin it inhabits (Lagutov 1995, 1996, 1997; Uralbas 2007a). The presence and well being of the sturgeon population in a river network indicates the "good quality" of a river ecosystem's health.

First of all, sturgeons utilize a variety of habitat types throughout their life cycles: rivers for spawning; rivers, lakes, estuaries, or the sea for feeding and wintering. Depending on the life stage the sturgeon habitats are spread through the whole river network, estuaries and adjacent marine areas. Living in the Caspian Sea and regularly migrating for spawning to the upper river branches in Russia through the territory of Kazakhstan, the Ural sturgeon population links together the marine and riverine ecosystems.

Figure 4 depicts the general Ural sturgeon life cycle with sea and river based stages distinguished. Some factors influencing sturgeon well-being are also indicated. The most influential factors for the Ural sturgeon populations are over-fishing, including all types of fish removal: commercial fishery, scientific, poaching, etc.; changes in river water regime; and certain aspects of habitat degradation. Each of these factors depends on both environmental and anthropogenic factors.

[6] These estimations correspond to the highest catch in the history of the sturgeon fishery in the region. As a result sturgeon stocks were overexploited and have never restored afterwards.

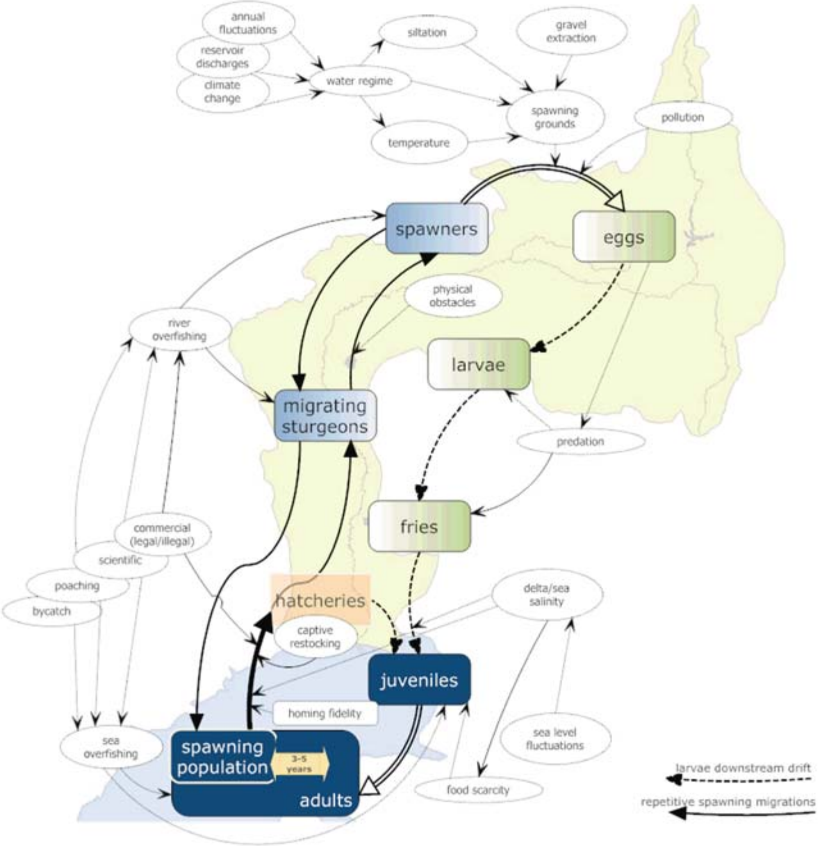

Figure 4. General sturgeon life cycle in the Ural Basin

Second, there is no natural predation for mature sturgeons, so apart from fishing efforts the sturgeon population is a function only of river environmental conditions, which can to a great extent be controlled by Integrated Water Resource Management.

Next, the sturgeon life cycle lasts up to 100 years which is comparable to the expected life duration of a human being. Actively migrating and feeding through all these years sturgeon presents a good subject for bio-accumulation. Taking into account its top position in the food chain (like human beings) sturgeon is a good *integral* indicator of water quality over a long period of time. In case of river contamination the river stream can be self-purified quickly (e.g. Baia Mare case (UNEP 2004)) and water quality tests will not indicate any problems, while living organisms (e.g. sturgeon and human beings) are subjects for the accumulation of harmful substances in their tissues.

Then, similar to a human being, sturgeon is a late maturing species, having an age-structured population. The reproductive age is reached depending on species at 10, 15, 20 years old. By that time harmful substances accumulated in the organism can affect reproductive abilities (Kajiwara et al. 2003; KaspNIRH 1999; Pourkazemi 2007) causing population decline as well.

There is also a positive relationship between sturgeon presence and a river's hydrological regime, which can be altered by damming, channelization or excessive water intakes. Spawning migrations are triggered by spring freshwater influxes to the seas and the entire success of spawning depends upon the water availability in the river, in other words water management strategy in spawning periods. Figure 5 shows the relationship between water discharge and beluga catch in the Ural river over 19 years when mature sturgeons returning for spawning (after Peseridi and Chertikhina 1967).

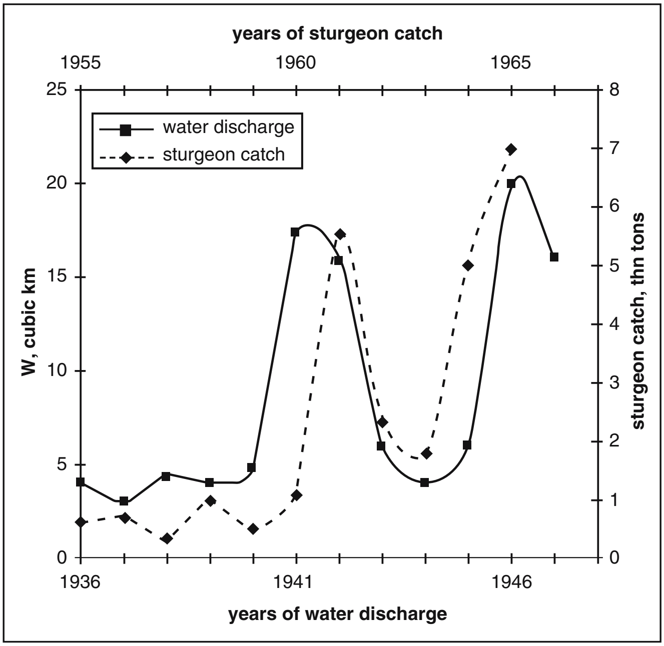

Figure 5. The relationship between river discharge and beluga catch in the Ural river 19 years later (After Peseridi and Chertikhina 1967)

Sturgeon presence in the river indicates the natural character of the hydrological regime, including regular floods and river self-purification service (Figure 6).

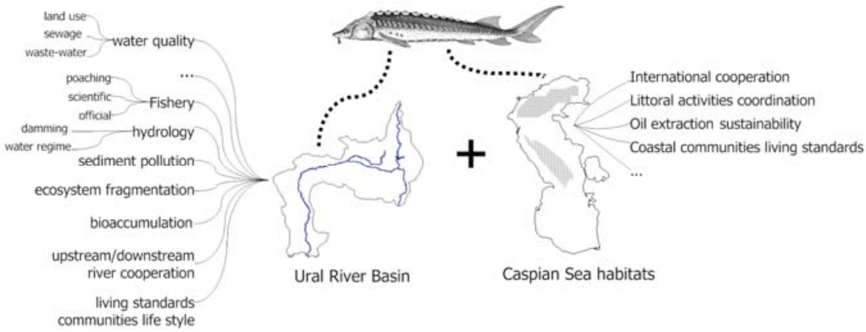

Figure 6. Some sturgeon functions as an indicator species

Apart from that, sturgeon is an indicator of other river physical characteristics: blockage of migratory routes, habitat degradation and fragmentation, siltation, pollution, water quality, etc. Some of these factors directly depend on the land use patterns in the river basin due to water runoff from the catchment area. In this way the terrestrial aspects of human activities are also brought into consideration.

Sturgeons also represents regional economic development and social structure, as poaching and illegal fishing which reduce sturgeon populations develop in areas with a poor unemployed population.

It is obvious that securing of natural sturgeon reproduction, protection and sustainable management of sturgeon stock is directly linked to integrated water resources management in the river basin and sustainable watershed development. These activities influence each other and should be considered only in an integrated manner.

Preserving sturgeon in the region would not only be of pure environmental benefit, but would also greatly contribute to economic and social stability in the region as well as food and water security. Traditionally, sturgeon harvesting was not only a major source of living for local communities but also an essential food resource. Thus, the measures aimed at preservation and sustainable management of the Ural sturgeon population can bring together environmental and socio-economic aspects of sustainable development and underpin the strategies for sustainable watershed development.

Cooperation in transboundary shared international river basins is complicated by the lack of incentives for cooperation. Upstream countries are not interested in securing environmental flows on the territory of downstream neighbors. There is no effective feedback from downstream regions suffering from water pollution or excessive upstream intakes to upper countries. Attempts to introduce feedback on the basis of hydrological cycles are often ineffective due to the large scale of the hydrological cycle and lack of evidence about causality (RAMSAR 2006). Sturgeons can provide such a feedback mechanism, and due to its high economic value all basin countries are interested in sturgeon stock rehabilitation and transboundary cooperation.

The role of anadromous species in general and sturgeon species in particular in integrated watershed management or regional sustainable development is a new concept in the basin-wide sustainability of environment society relations (Lagutov 1995, 1999). However, this idea is becoming increasingly recognized worldwide (Kliot et al. 2001; RAMSAR 2002).

For example, sturgeon species were suggested for the development and implementation of the Basin-based Concept of Regional Sustainable Development in the Don river and Azov Sea basins (AzovBas 2002; Russian State Duma 1995).

The European Freshwater Programme developed by the Worldwide Fund for Nature (WWF) also allocates a special role to sturgeon species. It introduces species classification to be used to secure success of environmental campaigns: *Flagship species, Species of special concern* and *Indicator species* (WWF 2002a, b).

According to this classification,

"**Flagship Species** act as a symbol and 'spokesperson' for their habitat. … major ecosystem programmes can be built around them….

Species of Special Concern are usually threatened species and their protection promotes conservation by safeguarding biological diversity and ecological processes.

Indicator Species are "markers" which help to measure changes or trends within a particular environment" (WWF 2002a, b).

All these functions perfectly suit sturgeon species, while the Ural sturgeon fits them the most (Lagutov 1995, 1996, 1997). The Ural River in general and sturgeon in particular were the main source of living for the Ural Cossack communities living along the Ural River. The sturgeon was depicted on their banners and coat of arms. Moreover, the Caspian sturgeon is world-renowned thanks to its caviar. The Ural River is the only spawning grounds for the "caviar carriers". The *flagship* function is fulfilled much better then in any other region.

Due to the high demand for caviar the Caspian sturgeon has almost disappeared. Its preservation is a matter of a special concern on both national and international levels.

The indicator function of the Ural sturgeon is also well defined and was discussed above.

Sturgeon was also included in the European Union Water Framework Directive, adopted in 2000, as an indicator of "a good status of surface waters" (WFD 2000). However, the situation in European rivers is much worse; all valuable sturgeons have been extirpated, habitats have mostly altered or degraded and now enormous efforts would have to be undertaken simply to try to restore sturgeons. By contrast, Ural River habitats are preserved and all historically available sturgeon populations are still present, though not for much longer if *business-as-usual* continues.

History of sturgeon fishery in the Ural region and catch statistics considerations

Periods in Ural fishery

Several distinctive periods in Ural fishing history can be specified. It should be noted that it is different from any other Caspian river basin, which can probably explain the higher river productivity through the 20th century. Though this history is unique and worth separate detailed investigation it is not well described in the available literature.

Historically, the low streams of the Ural River were populated by Ural Cossack communities, a self-governing paramilitary ethnic group. Cossack troops were traditionally involved in various State services in the Russian Empire. They were either protecting Russia's borders in their areas or serving as combatants during military campaigns. In exchange for military service they enjoyed exclusive rights to control natural resources on their territory (e.g. fish and water) and paid no taxes (Brockhaus and Efron 1898; Semple 1907; Von Harthausen 1972). The Ural Cossack community controlled the entire territory and resources of the lower Ural basin and adjacent sea area.

Living in harsh environmental conditions characterized by low soil fertility the Ural Cossacks had to fully rely on the river ecosystem, in particular sturgeon fishery, to support their communities.

Consequently, all the aspects of water usage and fishery were very carefully described, regulated and enforced. Fishery was limited to specific times in the winter, spring, and autumn. There were fishery and water laws. Out of two elected commanders (atamans) one was a military commander, while the other one was solely responsible for river-related issues (e.g. fishery). Fishing out of season was severely punished and the fisherman-violator lost his right to fish for the whole year. Special troops used to guard the river streams during spawning migrations. Another characteristic feature of the Ural fishery was *uchug*, the metallic or wooden fence constructed through the river stream near the city of Uralsk. The fence prevented sturgeons from going upstream out of Ural Cossack territory.

During this period until the Russian Civil War in 1917 when they were deprived of their privileges the entire water course of the lower and middle Ural was used exclusively for fishery (Brockhaus and Efron 1898). No other kind of activity was allowed, including navigation. Ferriage through the Ural was allowed only in a couple of places through the whole territory in order not to frighten the fish.

Fishery in the Ural was precisely organized and controlled (Borodin 1901). Any sturgeon fishing in the river was prohibited except for a couple of days in winter. During these days Cossacks equipped with special spears took sturgeons out of their wintering holes in the river bed through ice-holes. The catch in the sea was carried out with *okhans*, nets with coarse, more then 0.5 m, mesh (Malecha 2002). Fishing with coarse-meshed nets was allowed only upstream of uchug, and only Cossacks were allowed to fish.

Only three sturgeon species were considered as food fish: the beluga, Russian sturgeon and ship. The targeted species was mainly the beluga, 10% of the weight of which was caviar. Other species were used for fat rendering (Brockhaus and Efron 1898). Fish was used as a food supply for the local population and for trade.

The precise catch size can be estimated through the 19th century and early 20th century. The maximum catch conducted by Ural Cossacks for all purposes was 2.5–3 thousand tons (Lagutov 1995). Annually, the Ural Cossacks Land was exporting 128 tons of caviar, 1 thousand tons of sturgeons and 3.75 caviar in tons of balyk (smoked sturgeons) (Brockhaus and Efron 1898).

The First World War, Revolution and Civil War significantly decreased the pressure on the sturgeon stock due to the fact that most of the Cossacks participated in military campaigns.

After that the trends in fishing history and efforts in the Ural river basin till the late 1950s repeats the general Caspian pattern.

The 1930s was the period of collectivization in the USSR. Before this period fishing was mainly based on fisherman-individuals or small groups joined together (*artel*), but in the 1930s collective fishing artels (kolkhoz) were established. The state intensified its efforts in fishery, took all fishing activities under its own control and opened many dockyards to create and repair fishing boats. By that time the Caspian fishing fleet was extremely old and outdated. Up until 1931 most of the ships were wooden made in the beginning of the 20th century before the First World War. In 1930–1931 the Caspian fishing fleet was actively renovated – 2,305 new wooden made boats were created in the 1930 alone (APU 2000).

In 1928 the Caspian fishing fleet contained 19 trawlers and no seiners, while four years later in 1932 there were already 78 trawlers and 34 seiners. The efficiency of fishery also drastically increased. In 1931 for the first time new nets and fishing strategies were put into practice (APU 2000). According to some estimates the efficiency of fisherman in kolkhoz was two–three times higher than that of individual fishermen. Moreover, individual fishermen were persecuted by the authorities. In 1930s fishing efforts in the Caspian Sea became a subject for the established planned economy. In this way all, either successful or faulty, management strategies and policies in Caspian fishery were pre-developed, approved and controlled by the State (APU 2000).

The Great Patriotic war in 1941–1945 also demanded a lot of efforts and human resources from the local population and resulted in a tremendous decrease in catch. This fact is also considered to be beneficial for the partial restoration of sturgeon population, or rather the short delay in its total expiration. This drop is considered to be the only one (except that during the Revolution and Civil War) caused by reduced fishing efforts. During all other periods fishing efforts (in contrast to catch) were constantly increasing either by introducing new technologies, strategies or fleet increase. Moreover, the Second World War years were characterized by high water availability beneficial for spawning.

In 1951 it was decided to discontinue targeted sturgeon catch with okhans (coarse mesh nets) and harvest sturgeon as a by-catch from net-based fishing of usual species ("*chastik*"). New technologies (nylon fishing nets) were introduced in the region. Such fishing resulted in a high catch of young sturgeon of non-productive age. Despite new technologies a steadily decrease trend in the sea sturgeon catch can be observed through the 1950s in all Caspian regions, except the areas adjacent to the Ural River basin.

In 1955 the sturgeon hatcheries began their activities, gradually increasing the rate of larvae release. Up to 12 million beluga larvae were released every year. The idea of turning the Caspian sea into a big aquaculture fish pond was wide spread (Lagutov 1995), and the feeding grounds in the sea were called "pastures".

The 1950s were also characterized by the simultaneous introduction into practice of the dam complexes in the Caspian tributaries. As a matter of fact impoundment of the Caspian rivers started in the 1930s. Upon its continuation in 1950s the process of river damming continued for the next 20 years. The Volgograd dam was finalized in 1958, blocking the main spawning sites in the Volga River. Before that the Volga River was the main site for natural sturgeon reproduction, though comparable with the Ural River in terms of absolute yield to fishery.

Unlike in all other basin rivers the only hydraulic construction built up at the main Ural stream is located in its upper course, 1,810 km from the river delta. In this way the Ural River became the only river where natural spawning grounds were preserved. Because of that, no sturgeon hatcheries were installed in this river. Numerous sturgeon hatcheries were constructed in the deltas of the dammed rivers to compensate for the loss of spawning grounds and to sustain in this artificial way harvesting of the Caspian sturgeon. This fact alone makes the Ural River sturgeon a unique population relieved from the influence of hatchery-based specimens.

At the start of the 1960s (1962) significant changes in sturgeon fishery occurred. A ban on fishing with nets at sea was introduced and the fishery was transferred to rivers' mouth and streams (CEP 2002a). The reasoning behind this change was to protect juvenile sturgeon. Undoubtedly, this policy resulted in a drastic increase in catches. For example, the sevryuga catch in one year doubled in both the Ural and Volga rivers. The river itself and river mouth in particular is a bottleneck for the survival of any anadromous population. Fishing efforts in the river mouth are much more effective. However, annual systematic decrease targeting the spawning reproductive part of the population undermines sturgeon restoration and threatens the species' survival. Nevertheless, some believe that "a ban on sea fishing from 1962 to 1991 positively impacted the number and total biomass of commercial stocks" (Khodorevskaya et al. 1997).

Though not explicitly indicated, this measure seems to prioritize artificial sturgeon hatching over natural reproduction. The primary fishing pressure was put on the self-sustainable viable wild populations instead of the commercial ones fattening in the sea.

While it was claimed to be aimed at fish protection, the change in policy in 1962 could be caused by the decrease in catch and the need to secure food supply to the blooming Soviet economy. Figure 7 shows the gradual decrease in sturgeon catch from the 1950s to 1960s. The drastic catch increase in 1962 indicates not a stock restoration as hypothesized by some authors (KaspNIRH 1999), but the shift in fishery strategies towards a more aggressive river-based system imposing higher pressure on the migratory fish populations. Really, the generation hatched in low fishing pressure years of WWII had to reach maturation and fishing age in 1955–1960. However, these years are characterized by a decrease in total catch.

Also, sturgeon fishery in a river basin can maximize caviar production, the primary source of income from sturgeon, by targeting spawners directly. Moreover, only this fishing strategy can guarantee an industrial scale of caviar production.

This approach to fishery lasted till the collapse of the Soviet Union in 1991. The peak in sturgeon catch was observed in 1970. The peak in "fingerlings release into the basin rivers occurred in the 1980s. During this period fishing efforts were constantly increasing.

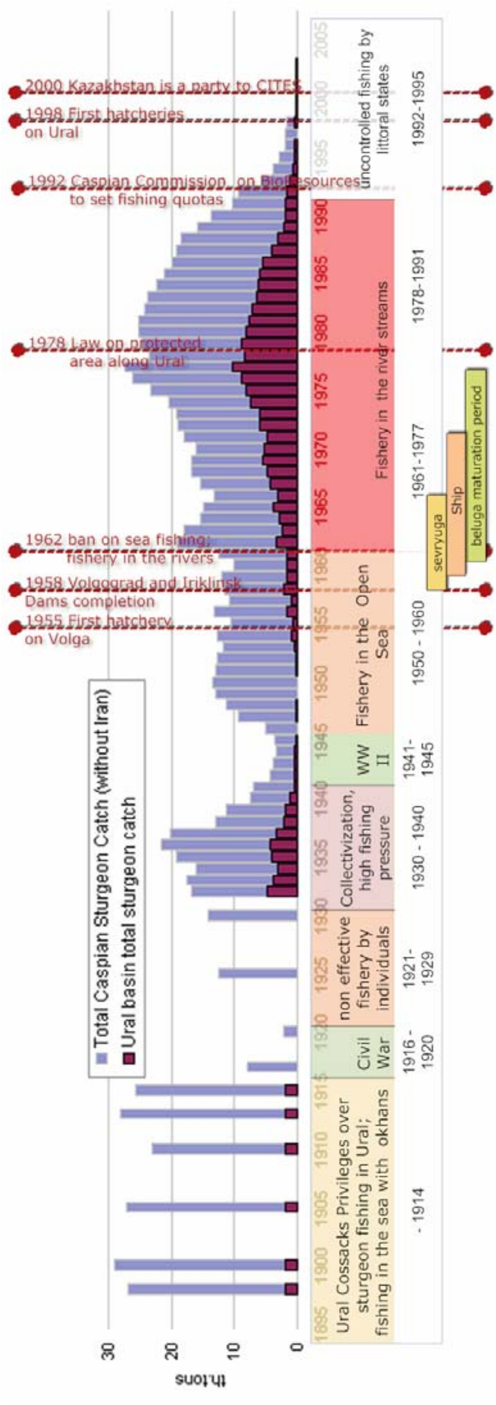

Figure 7. Timeline of Ural sturgeon fishing efforts

In general, Caspian fishery in the Caspian Sea was characterized by a high level of regulation and central planning with approved fish quotas, seasonal closures and gear restrictions.

By the end of this period the Ural sturgeon stock was already exhausted, but contributed a significant proportion of the whole Caspian catch.

The regional fishery in the 1990s was characterized by the collapse of centralized control over fishery (resulting in uncontrolled fishing efforts by littoral states), an outbreak of unemployment and, consequently, an increase in poaching and illegal fishery. By now, the sturgeon has almost vanished from the region. The Beluga catch dropped 750 fold from 1,500 t in 1932 to 2 t only in 2005 (FAO 2007b), while the sevryuga catch dropped 2,450 fold from 9,800 t in 1977 to 4 t in 2005 (FAO 2007b). Nevertheless, fishing efforts are actively continued. The Newly Independent Countries manage their fishing efforts individually through gear, catch, seasonal and regional regulations. The ban on sea fishing was prolonged, though according to some observations it has not been properly implemented (Pitikch et al. 2005). The Ural-Caspian Fishing zone came fully under Kazakh control.

The Caspian Sea sturgeon fishing quotas are distributed during regular meetings of the Commission on the Biological Resources of Caspian littoral states, established in 1992. The quotas are distributed according to the contribution each state makes to replenishing stocks. Kazakhstan's quota is based on the exploitation of the Ural stock and in 2007 it was only 18% of the total Caspian catch by former USSR countries.

In 1997 all commercial regional sturgeon species were included in the Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Since then the international trade of sturgeon and its products is regulated according to CITES provisions. Kazakhstan became a party to CITES in 2000. Unfortunately, CITES' ability not only to stop population decline, but even to provide scientifically sound justifications for still high export rates are challenged by independent researchers.

The first two sturgeon hatcheries were opened on the Ural river in 1998 in Guriev (Atyrau) (RK 2003; World Bank 2004b), though their ability to sustain wild sturgeon populations has been questioned as discussed below.

Data availability on fishing and total allowable catch

Three out of six Caspian sturgeon species are recognized as commercial fish in the Caspian Sea basin and its rivers: the beluga, Russian sturgeon, and sevryuga. There is no standard commonly accepted methodology for estimating total sea fish stocks and commercial stocks in particular (Seijo et al. 1998). For instance, the international techniques are different from the ones used by the former USSR earlier or the littoral Caspian countries now (Lagutov 1995, 1996; Uralbas 2007a).The four former CIS countries use sample trawling to derive total annual catch quotas or total allowable catch (TAC), while the Islamic Republic of Iran uses a catch-per-unit-effort (CPUE) to determine fish abundance (CITES 2004b).

During the USSR Caspian Sturgeon TACs were allocated by the State Fisheries Committee using calculations by scientific agencies such as the Research Institute of Fisheries and Oceanography ("VNIRO") and Caspian Fisheries Research Institute (KaspNIRH) (CITES 2001). Nowadays the annual commercial catch quotas are allocated to Kazakhstan by the Intergovernmental Commission for Caspian Biological Resources which meets annually in Astrakhan. Any fishing activities, such as commercial catch, scientific catch and the catch of mature spawners for reproduction in hatcheries, are included in the TAC (CITES 2001).

Official statistics from specialized institutions are often contradictory. For example, the Caspian Fisheries Research Institute (KaspNIRH) is responsible, as follows from its title, for the research on Caspian fishery, stock estimations, quota establishment, etc. According to the field study results on sturgeon stock evaluation published by this Institute in one source (KaspNIRH 1999) the total abundance of beluga, Russian sturgeon and stellate sturgeon (sevryuga) in 1998 in the Caspian Sea was 42.2 million specimen. Surprisingly, this parameter for the same species next year 1999 was already ten million higher – 52.3 specimens (KaspNIRH 1999). As a matter of fact, the work of this particular Institute and other fishery-affiliated institutions in USSR, i.e. Azov Sea Fisheries Research Institute (AzNIRH), have been criticized by many authors for decades (Lagutov 1995).

The quantitative assessments of fish stocks conducted by USSR fishery institutes and later by littoral newly independent countries are often flawed and have been proved as biased or lacking scientific grounds (Crownover 2004b; Kirby 2002; Lagutov 1995; Morgan 2007; Pala 2004b; Raymakers and Hoover 2002; TRAFFIC 2007a, b; Uralbas 2007b).

There are different reasons to keep this situation running, including political and economic benefits as well as prestige of scientific schools in fishery. However, the discrepancies in estimation techniques provide good background for speculation and TAC establishment depending on the countries' or involved elite groups' interests.

As a result, there is no current commonly recognized Caspian sturgeon population assessment (Pitikch et al. 2005).

In this situation the data supporting population and stock analysis should come from official catch data, rather than from periodic quantitative assessments of fish stock (CEP 2002a; FAO 2007a; Seijo et al. 1998).

On the other hand even if a reliable universally accepted methodology were used, estimating the sturgeon stock would still be a very challenging task. Any methodology is based on the data catch statistics. However, historical statistical data often varies depending on the source.

For example, Figure 8 shows two different datasets for Ural beluga catches. The first one is based on the materials form KaspNIRH (KaspNIRH 1999), while the second one presents data by the Caspian Environment Program (CEP 2002b). Until 1993 both lines match since datasets were based on the same initial database from joint USSR statistics. However, with the Soviet Union's disintegration and the collapse of united basin fishery management, alternative sources for data appeared and discrepancies started to develop.

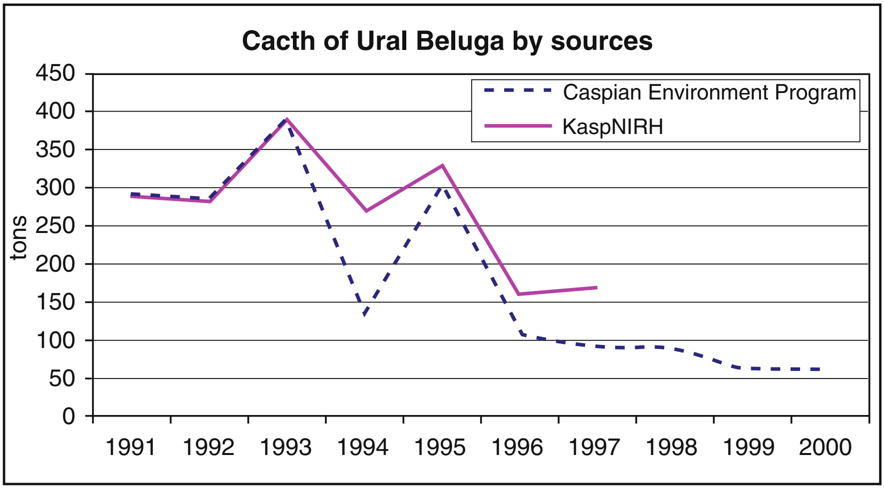

Figure 8. The discrepancy in reported sturgeon catch (KaspNIRH 1999)

Apart from these methodological problems, fishing zones and Fishery Departments were constantly changing and reorganizing.

The Ural Caspian Basin Fishery Department was created after the ban imposed on sea fishery in 1962 and fishing activities were relocated to the river basins. The statistics on fishery in the river basin, delta and adjacent sea area were collected in one center. After the disintegration of the Soviet Union the two basin countries organized independent fishery departments with their own statistical datasets. Furthermore, the fishery in Orenburg oblast was not considered to be part of the Caspian basin any longer and the successor of the Ural Basin Fishery Department on the Russian side was moved under the authority of KamUralRybVod, another basin fishery department in Russia. In this way the statistics on fishery in the Russian part of the Ural basin were excluded from the Caspian statistics. At the same time sturgeon commercial fishery in the 1990s in Orenburg oblast was negligible (KamUralRybVod 2007) and can be omitted from the preliminary analysis of the Ural catch. The analysis of fish stocks in the Ural basin can be based on the historical data before USSR disintegration and data provided by Kazakhstan for the later period.

Having said that it should be noted that the Ural-Caspian fishing zone in addition to the river Ural includes also the river Kigach. Though the catch in the Kigach River is not significant its possible influence should be taken into account while analyzing the Ural sturgeon population dynamics.

The recent problems and discrepancies with historic sturgeon catch in the Caspian Sea can be to some extent explained by the directives to operate only with the percentages of "socialist obligation", the planned level of catch in the centralized economy, but not with absolute catch values (Lagutov 1995). The latest statistics in the USSR were considered to be confidential information and were not distributed by fishery agencies (Figure 9).

As a result the proper analysis of the sturgeon population through the 20th century is complicated.

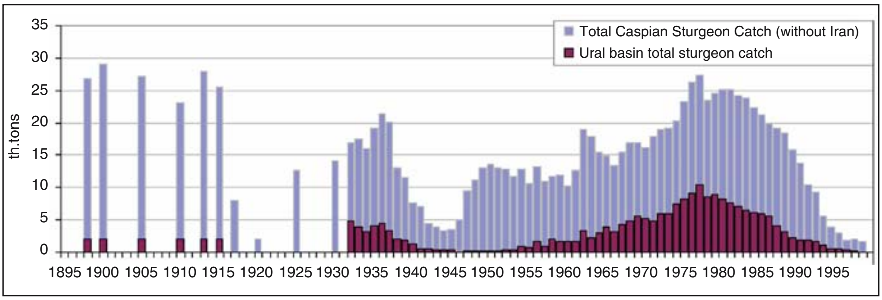

Figure 9. The share of Ural sturgeon catch in the total catch of f.USSR (KaspNIRH 1999)

Ural sturgeon species population dynamics and removal rates

Sturgeon species are late-maturing, slow-growing, long-lived fish and are able to withstand only light levels of harvest pressure. (Lagutov 1995; Uralbas 2007b).

Basic ecological theories claim that maximum harvest removal for this kind of fish cannot be more then 10% (Lagutov 1995). Nowadays the Russian secretariat of CITES claims to use the same principles for quota establishment (CITES 2004b). According to these regulations in the case of beluga, allowable removal is 9.4% of the stock. For Russian sturgeon the allowable removal is 13.7% and for stellate sturgeon 16.7% may be removed.

This approach is based on an estimate that the natural mortality rate for these species is about 10%, allowing the conclusion to be drawn that a reduction of 10% is harmless. The important feature of this approach is that due to the lack of natural predation this natural mortality in the sturgeon's case applies mainly to the old non-productive specimens. The same suggested removal rate in fishery is applied solely to the reproductive sturgeons prior to their spawning, in other words this is additional pressure on the stock, beyond the natural 10% mortality rate. At the same time annual fishing quotas allowed and scientifically approved by USSR fishing agencies and institutes in the 1970–1980s were 30–40% for some rivers in the south of Russia (Lagutov 1995).

The ratio between total species abundance and the catches in the Ural River shows much higher removal rate for some periods. Table 2 shows the official statistics on spawning sturgeon populations entering the Ural and the number of fish reaching spawning grounds. Though the methodology of such precise estimations of fish stocks on a non-regulated river is not described, these results are produced and disseminated by the Caspian Fishery Research Institute responsible for fishery planning and management in Caspian Sea (KaspNIRH 1999). The calculations of the removal rates are made by the authors.

Table 2. Spawning migrations and removal rates for the main sturgeon species harvested in the Ural fishing zone (Authors calculations on the base of materials from CEP 2002a)

		1971–1975	1976–1980	1981–1985	1986–1990	1991–1995	1996–1998
Sevryuga	Spawning migrants (thousand individuals)	1178.6	1227.5	884.3	463.1	184.4	98.7
	Reaching grounds (thousand individuals)	390.4	243.6	173.2	137.4	64.3	53.1
	Removal rate (%)	66.88%	80.15%	80.41%	70.33%	65.13%	46.20%
Beluga	Spawning migrants (thousand individuals)	6	13.1	18.1	16.2	7.7	3.5
	Reaching grounds (thousand individuals)	2.01	6.42	11.1	9.15	3.6	1.7
	Removal rate (%)	66.50%	50.99%	38.67%	43.52%	53.25%	51.43%
Russian sturgeon	Spawning migrants (thousand individuals)	18.14	33.6	37.1	43.5	28.5	10.2
	Reaching grounds (thousand individuals)	15.5	27.6	29.3	38.7	21.5	4.9
	Removal rate (%)	14.55%	17.86%	21.02%	11.03%	24.56%	51.96%
Ship	Spawning migrants (thousand individuals)	3.9	6.1	3.7	11	9.9	5.2
	Reaching grounds (thousand individuals)	2.3	2.64	3.2	9.9	6.5	2.6
	Removal rate (%)	41.03%	56.72%	13.51%	10.00%	34.34%	50.00%

These removal rates are applied to the spawning population annually not taking into account sturgeon life cycle features. Taking into account repetitive spawning periods in 2–5 years, exponential decay in reproductive sturgeon stock should be observed.

The fact that fish are extracted before the spawning occurred is also important for the understanding of population dynamics. Lately almost all of the harvested sturgeons were going for their first spawning, which was not completed. Correspondingly, the size of new species generation would be reduced accordingly.

Not surprisingly, a significant decrease in natural sturgeon reproduction can be observed recently. The decrease in the population with highest removal rates, sevryuga, clearly indicates a rapid exponential decay pattern.

According to other sources (Pala 2004b) the number of spawning belugas in the Ural river was only 3,900 in 1994 and 2,500 in 2002. These specimens were underweight (two times lower then weight needed for effective spawning) and premature, yielding eggs of poor quality.

In 1990s the situation regarding percentages of spawners removal worsened further. Table 3 shows annual removal rates for the Ural beluga and ship for 1991–2000 calculated using official statistics from Caspian Environment Program (after KaspNIRH) (CEP 2002b).

Table 3. Spawning migrations and removal rates for beluga and ship harvested in the Ural fishing zone (Authors calculations on the base of materials from CEP 2002b)

Years	BELUGA			SHIP		
	Total abundance of spawning population (thousand individuals)	Catch (thousand individuals)	Removal rate (%)	Total abundance of spawning population (thousand individuals)	Catch (thousand individuals)	Removal rate (%)
1991	7.5	3.6	48.0	13.6	0.5	3.7
1992	6.2	3.1	50.0	15.1	7.6	50.3
1993	13.2	6.9	52.3	8.06	2.96	36.7
1994	3.9	1.7	43.6	2.7	1.2	44.4
1996	3.2	1.4	43.8	5.6	1.3	23.2
1997	4.3	1.1	25.6	5.6	1.4	25.0
1998	3.1	1.2	38.7	4.4	2.8	63.6
1999	2.1	0.7	33.3	6.55	1.598	24.4
2000	2.66	0.67	25.2	6.28	1.268	20.2
Average	–	–	40	–	–	32.4

The official removal rate by legal catch for the Beluga reaches 50%, and for the ship it is even higher, around 60%. The average values for beluga and ship for 1991–2000 are 40% and 32% correspondingly. Taking into account such phenomena as scientific catch and poaching, the actual removal rate will be even higher. Late-maturing species cannot sustain such a high harvest rate. These facts explain the drastic sturgeon decrease in the river under the condition of available spawning grounds and undisturbed migration routes.

According to the statements by the same Caspian Fishery Institute the ship is not a commercial species (KaspNIRH 1999). Surprisingly, the official removal rate by state fishery for a non-commercial species in the Ural River was as big as 60% of the spawning population during the 1990s. Moreover, the ship is the only sturgeon species listed in both National Red Books as an endangered and protected species. It is somewhat surprising to see such a high level of official exploitation of a protected species.

Sturgeon species composition in the Ural

Insight into catch species and regional composition is important for understanding the dynamics of sturgeon populations and restoration programs' development. Figure 10 represents the Ural basin sturgeon catch by species.

Statistical data on sturgeon catch in the Caspian basin and its tributaries is often available as lumped amounts for the total sturgeon catch without separating statistics by the harvested species. This obstacle undermines proper analysis of individual species populations.

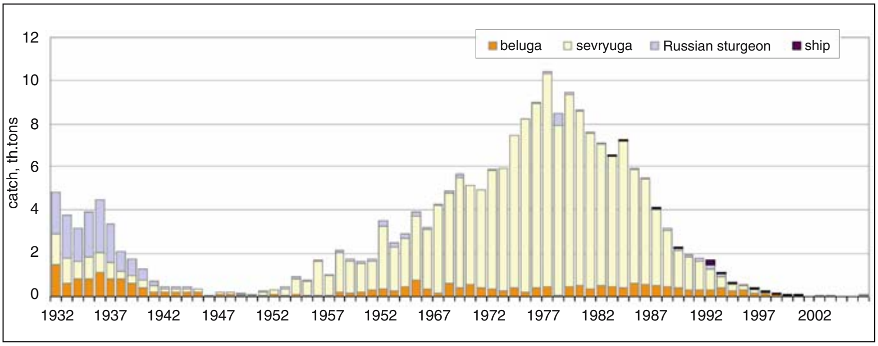

Figure 10. Species composition in total sturgeon catch in the Ural fishing zone (KaspNIRH 1999)

Another feature of catch statistics complicating the population analysis is data on total weight in contrast to number of specimens. For instance, the primary target for fishing efforts in the 19th and first half of the 20th centuries was the beluga (Brockhaus and Efron 1898). Correspondingly, the beluga constituted the biggest share in the catches. In the early 20th century, the beluga accounted for nearly 40% of the sturgeon catch (CEP 2002a).

The body weight of the beluga is much higher than that of all other sturgeon species. Official records indicate up to 1.5–2 t per fish with an average weight around 350 kg, while the average weight for other species varies from 5 to 50 kg depending on species (Table 1). During the 20th century the targeted sturgeon populations were changing: after the beluga stock's depletion the Russian sturgeon, Sevryuga or Ship was subsequently actively harvested. All these species have different body weights, which definitely should distort population analysis on the base of total sturgeon catch in tons. Operating with catch weight statistics might be a good approach for commercial fishery to estimate food production and other important living standards, but it is not very useful to evaluate population viability and extinction risk. Unfortunately, most Caspian sturgeon stock estimates are presented in total tons.

The Caspian sturgeon catch over the 20th century seems to be very stable up until the 1990s. In particular, the decline in catch at the end of the 1980s was often explained by usual multiyear fluctuations in catch and treated as a normal natural phenomenon (KaspNIRH 1999). However, the analysis of the species regional dynamics suggests a different explanation. The stable total catch seems to be the result of sequential overexploitation of various sturgeon populations. For example, Figure 11 presents the shares of Ural sevryuga catch in the total USSR sevryuga catch and total USSR sturgeon species catch.

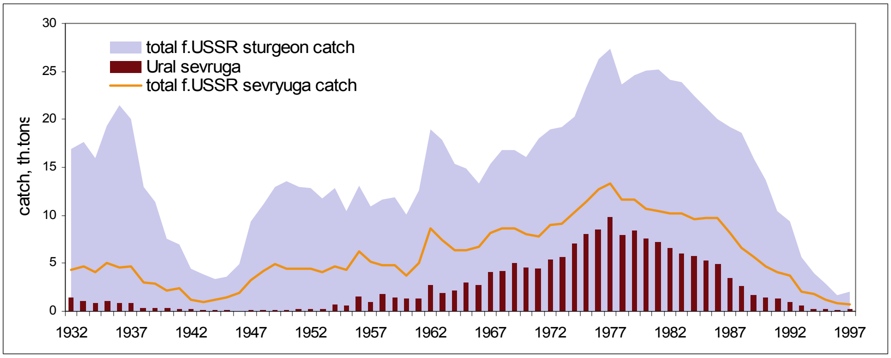

Figure 11. The dynamics of sevryuga catch in the Ural river against total USSR catch (KaspNIRH 1999)

The Ural sevryuga was not the primary subject for harvesting till the mid-1950s. Its contribution to the total Caspian sturgeon catch was only about 5%. In 1953 the fishing pressure on this population started to grow. After that time, the Ural sevryuga population, to be more precise the sevryuga catch in the Ural River alone, in some years constituted up to 75% towards the total sevryuga catch in the Caspian Sea. In the 1970s the share of the Ural sevryuga in total USSR sturgeon catch was up to 40%. The maximum sevryuga catch in the Ural occurred in 1977 and was equal to approximately 9,800 t, while total USSR sevryuga catch that year was 13.35 thousand tons (KaspNIRH 1999).

After this short term maximum the catch of sevryuga in the Ural River showed a steady decline. Unlike the 1930s when (1) the sevryuga was not a primary subject for fishing and (2) fishing in the Ural River stream was limited, the situation in the 1980s is characterized by active fishing of all sturgeon species in the river basin. The Ural sevryuga population was exploited until its total depletion in one approach. In 2005 the catch dropped to 4 t only (by 2,500 times) (FAO 2007a). No fluctuations or stock restoration periods can be observed.

This observation suggests that the total more or less steady sturgeon catch through the 20th century in the Caspian basin consists of a sequence of similar one peak total exploitation patterns for a particular sturgeon population in a particular region.

The analysis of catch in different sturgeon species in different Caspian basins supports this idea, as the same dynamics are repeated in other populations. For example, Figure 12 shows the catch in Russian Sturgeon by region. The regions/republics/countries correspond to the river basins and fishery areas: the river Kura – Azerbaijan, Volga – Astrakhan, Dagestan – Terek and Sulak, etc. Thus, the dynamics of sturgeon populations endemic

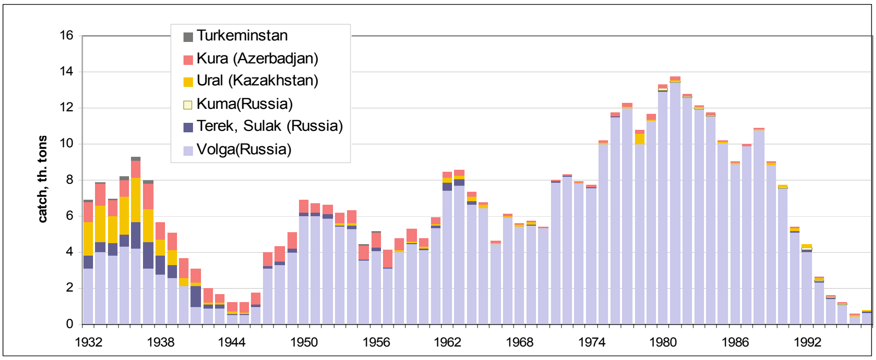

Figure 12. Russian Sturgeon catch in Caspian basin by regions (KaspNIRH 1999)

to the particular river basin can be estimated on the basis of the regional statistics. In the beginning of the observed period in the 1930s Russian Sturgeon populations were available in all fishery areas. Most of these populations vanished before dam construction, migration routes blockage or other factors could play a role. The scale of pollution, habitat degradation, sea level fluctuations and massive water intakes in rivers was negligible. The single factor which played an important role up to that time was overfishing. A Russian Sturgeon population remained only in the Volga, due to the excessive initial fish abundance in it. This single population was exposed to increasing fishing efforts and overexploitation and also collapsed in due time.[7]

In the Ural the catch of Russian Sturgeon was most intensive in the 1930s. At its peak the maximum catch was 2.5 thousand tons (KaspNIRH 1999). Since that time it has never recovered. Only occasional specimens of Russian sturgeon have entered the Ural for spawning in recent years, while in other rivers – the Terek, Kura, and Sulak – spawning has not been observed since 1983 (KaspNIRH 1999).

Next, the current trend in Caspian sturgeon catch towards younger and lighter individuals should be taken into account. The average age in the commercial catch for every sturgeon population has been steadily decreasing. This fact means that in order to sustain the same level of reported catch in tons a higher number of specimens should be collected. In sum, on the one hand, by observing the stable total sturgeon catch in tons the conclusion of stock exploitation sustainability can be drawn, but on the other the real pressure on the stock has increased many folds. From this perspective the analysis of catch statistics in tons for the discussion of population sustainability should be applied with reservations.

The sturgeon catch itself, even in absolute numbers, is not a sufficient and adequate indicator of the real sturgeon stock size. To be closer to the real situation the sturgeon catch should be compared against fishing activities.[8] This aspect is often missing from sturgeon population analysis.

Population structure

The population structure of all sturgeon species in both the Volga and Ural River basins has changed, causing additional concern over population sustainability. Over the past 30–40 years the average age for all commercial species has decreased by more than 10 years: the beluga's average age has

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[7] Another important factor for the Volga stock was lack of recruitment and natural stock replenishment due to the damming of major sturgeon spawning habitat – the Volga river.

[8] The fishing efforts in the Ural basin were discussed earlier.

declined from 40 to 20, the Russian sturgeon's from 33 to 20, the sevryuga's from 28 to 11–12 (Baimukanov 2007; Khodorevskaya et al. 2000). Not a single beluga older than 50 years has been recorded in catch lately. The predominant age of spawning fish has also decreased from more then 26 years to 11–17 years (Khodorevskaya et al. 2000). Female Sevryuga specimens older then 25 years males over 21 years cannot be found in the catch in recent years. Often, no specimens of reproductive age could be found (Khodorevskaya et al. 2000). Some authors believe that this is an indicator of maturing of hatchery-originated sturgeons and proof of success in sturgeon stock rehabilitation programs (KaspNIRH 1999). In reality, this fact can be better explained by total depletion of older age groups by systematic fishing of spawners in the river basins.

An additional indicator of the significant changes in the beluga population is the changes in female proportion in spawners in Ural from 50% in 1980s to 21–24% in the early 1990s (CEP 2002a; KaspNIRH 1999). This phenomenon is usually explained by targeting of productive sturgeon females for caviar harvesting and traditionally attributed to poachers' activities (EPA 2004). However, in the late 1980s poachers (as opposed to state fishery companies) were not the significant problem for the region. These facts rather characterize fishing efforts (legal and illegal) by state companies in the 1980s prior to the collapse of the Soviet Union.

It should also be noted that the CITES version of statistical data on fishery in Kazakhstan the ratio of males and females caught is not regulated or monitored (CITES 2001).

Beluga

A maximum catch of the Ural beluga population of 1.4 thousand tons was registered in the 1930s. Since then the river-based fishery has yielded only 0.4–0.6 thousand tons and a steady decrease in Ural Beluga population can be observed from 1985. The number of spawning belugas going up to the Ural river steadily declined to 2,500 individuals in 2002 (Pala 2004b) from 3,900 in 1994 (CEP 2002b).

Figure 13 depicts the beluga catch in the Ural-Caspian fishing zone in absolute values and as a proportion of the total f.USSR beluga catch. As can be seen from the figure, the Ural catch gradually grew from 5–10% in the 1950s to 50–70% in the 1980s–1990s. Comparing this result with absolute values it can be concluded that the Ural River sustained more or less equal catch through the 20th century and was exposed to smaller fluctuations than in other Caspian regions.

The catch in the Volga and Ural fishing zones, combined in one graph (Figure 14), supports this statement and suggests the influence of the Volgograd Dam construction on the catch levels in both rivers. The manifold increase in beluga catch in the Ural fishing zone can be observed during and after the completion of the Volgograd dam and is accompanied by a two fold decrease in the Volga catch. It might be explained by massive beluga migrations to the undisturbed landings in the Ural River.[9] It also could be argued that this rapid increase can be explained by the introduction of the aggressive fishing strategy due to fishery reallocation to the rivers. However, this change occurred only in 1961, several years later. The effect of that policy can be very well traced in the case of the sevryuga catch (Figure 11).

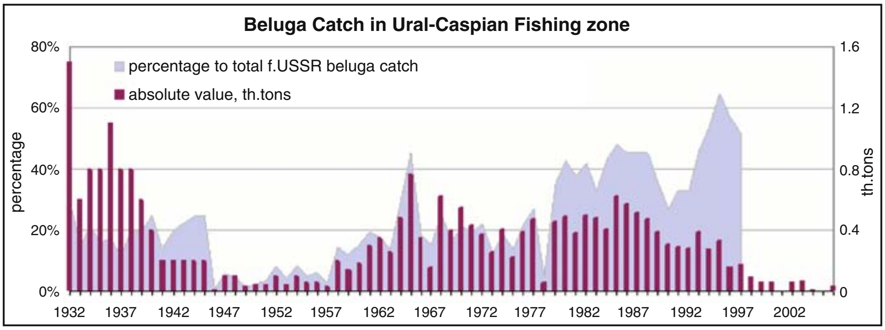

Figure 13. Ural Beluga catch in absolute values and as percentage in total USSR Beluga catch (KaspNIRH 1999)

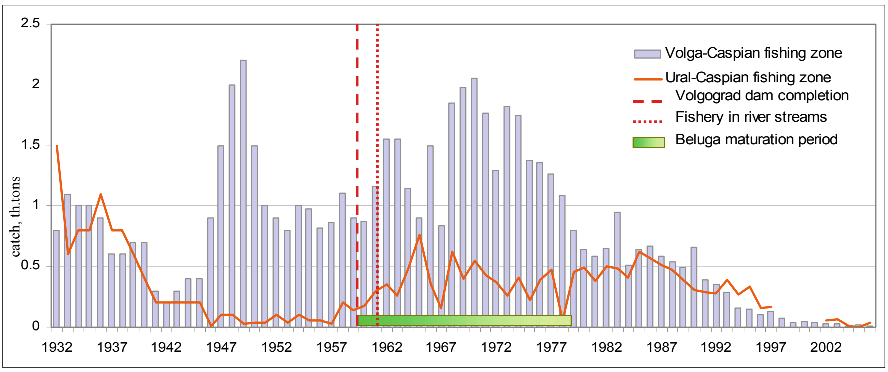

Figure 14. Ural and Volga beluga catch (KaspNIRH 1999)

[9] This speculation is a subject for biologists investigation. However, there are some indirect evidences to support this idea. For instance, molecular analysis often indicates cases of mislabeling of products from the different sturgeon species (Birstein et al. 1998).

Another interesting conclusion can be made by superimposing the beluga maturation period, the time before the beluga goes back to the rivers for first spawning (~20 years), over the catch graph. The abrupt substantial decline in the Volga beluga catch can be observed starting one generation after the damming, at the end of the 1970s. At the same time the beluga catch in the non-regulated Ural River stayed more or less stable till the end of the 1980s. Thus hatchery-based restocking programs, intended to mitigate the consequences of Volga impoundment, failed to substitute natural reproduction and to sustain beluga population.

Some researchers believe that the beluga is no longer naturally reproduced in the Caspian Basin (Birstein et al. 1997). As of 1997 the beluga population in the Volga region was considered by some authors to consist of 96.3% hatchery-reared fish (Khodorevskaya et al. 1997). This situation is explained by the fact that 100% of beluga spawning grounds were cut off by the Volgograd dam in 1958. The grounding assumption was that since that time no successful natural reproduction for the Beluga has occurred. Correspondingly, the few available beluga specimens in the region are believed to be hatchery originated. At the same time in the Ural river beluga spawning in the wild was monitored by the Russian Federal State Fishery Department even in 2007 (Dmitriev and Vasilenko 2007). According to the statements by the Russian Fishery Inspections, beluga spawning occurs in the Ural tributaries at the territory of Orenburg Oblast occasionally during the high flood years even now when total abundance is negligible. Twenty years ago, when the current adult beluga population would have hatched, spawning in the Ural occurred regularly.

The brief analysis suggests the close relationship and interlinkages in the Ural and Volga ecosystem and sturgeon populations. This line of reasoning justifies the point of view that the Northern Caspian should be considered and treated as one ecosystem (Dmitriev and Vasilenko 2007).

Ship

The ship in the Ural in the 20th century was spread through the low and middle river courses up to the city of Orsk. This species was not a fishing target in the Ural Cossacks Land, while its catch upstream was 16.4 tons annually (ORB 1998). The Caspian Fishery Research Institute, where data on sturgeon catch was collected and analyzed to develop further fishing strategies in the USSR, reports the ship stock's decrease in the early 1960s (KaspNIRH 1999). On the basis of this conclusion its fishing, according to KaspNIRH, was forbidden until 1994. Surprisingly, official statistics, including the very same source and others (CEP 2002a; Dmitriev and Vasilenko 2007; KamUralRybVod 2007), on its catch in the Ural river, exist starting from 1978 to 2000, while catch data on other sturgeon species is available from 1932. After the ban was removed in the 1990s the ship catch was only about 20–30 t. Moreover, by that time the ship was protected by national Red Books in basin countries. It should be noted that ship was available only in the Ural and Kura River. The catch in the Kura even in the 1980s was only 4–5 t per year. Now it has vanished from the South Caspian and is available only in the Ural.

According to the official statements by the Caspian Fisheries Research Institute (KaspNIRH) the catch of Persian Sturgeon was never officially monitored due to the low level of catch and no such statistics are available (CEP 2002b; KaspNIRH 1999). Nevertheless, Persian sturgeon contributed up to 23% of the experimental catch in the area downstream the Volgograd Dam (Artiukhin 1979). According to CEP data in both Volga and Ural the Persian sturgeon comprised around 5% of total catch in the 1980s (CEP 2002b). The total sturgeon catch in both regions in the 1980s was more then 20 thousand tons, which makes Persian sturgeon catch in that period equal to 1,000 t. This catch is more or less equal to the beluga catch for the same period. This fact can be used for various speculations over commercial catch statistics, e.g. Persian sturgeon, having characteristics similar to Russian sturgeon, might be accounted in Russian sturgeon catch in Volga or Ural-Caspian fishing zones. Despite the official statements on the absence of statistics on Persian sturgeon there are some claims about its stock increase (Pitikch et al. 2005) reflected in the contemporary trade quota increase for this species (CITES 2007).[10]

Having observed this evidences of the drastic decrease in Caspian sturgeon stock, the statement by the Sturgeon Management Authority of Russia that by 2004 “sturgeon stocks in the Caspian Sea as a whole appear to have stabilized or are beginning to increase” (CITES 2004b) sounds strange to say the least. The Authority’s document, prepared for the justification of higher export quotas distributed by CITES, indicates that the estimate of the stock size is done based on the number of released fingerlings one generation ago and the trawl surveys in the open sea. The trawl surveys conducted by joint efforts of littoral states through the Caspian Sea were able to catch only 56 mostly pre-mature belugas (CITES 2004b). Based on this result, the Russian Sturgeon Management Authorities believed that the belugas are abundant in the sea and demanded higher export quotas of sturgeon products under CITES. To do so they announced that numbers of beluga sturgeon in 2002 rose to 11.6 million from 9.3 million in 2001, 25% in one year. In other words, the total sturgeon abundance in 11.6 millions was derived from 56 specimen (Pala 2004b). These conclusions were

[10] The increase in Persian Sturgeon is to be attributed to Persian sturgeon populations endemic to Iranian rivers thanks to high efficiency restocking programs and precise regulation in fishing.

challenged by many specialists claiming the annual 25% rate of increase is biologically impossible for late-maturing species such as sturgeon (Uralbas 2007b). The "miracle" is probably better explained by the corruption in Russian (as well as other former Soviet Union) fishery-affiliated authorities and research institutes.

Such data provision deficit and discrepancies often result in a situation when decision–makers operate with outdated or falsified data. For instance, the TRAFFIC secretariat, the wildlife trade monitoring network, in one of its publications states that "the Caspian Sea sturgeon population has been reduced by 40%" by 2007. In other words more than half of the historic sturgeon stock is still available for further exploitation (TRAFFIC 2007b).

Factors affecting the Ural sturgeon population

Its high economic value, the characteristic features of the sturgeon life cycle and the low priority of environmental issues and habitat preservation measures caused a situation where the significance of the problems related to sturgeon stocks were greatly underestimated not only within former Soviet Union countries (Lagutov 1995), but also in European countries and the USA (Bachmann 2000).

According to Reid and Miller (1989), threatened species are often characterized by one or more of the following: large body size, high trophic level, small population size, restricted geographic distribution, poor dispersal and colonizing abilities, colonial breeding habits, dependence on specialized habitats or ecosystems, migratory life history, dependence on unreliable resources, and inability to respond to environmental change or disturbances (Reid and Miller 1989).

Almost all of these risk factors are applicable to sturgeon species and can cause sturgeon extinction. All of them are migratory, large and at the top of food webs. Due to their bony exterior sturgeons do not have non-human predators in nature (Williamson 2003). Sturgeon species were distributed over the Northern Hemisphere, but local populations occupy restricted areas (river basins) and may be strongly isolated (Bachmann 2000; Waldman and Wirgin 1998; Williamson 2003).

Both anthropogenic and natural reasons can trigger the negative influence of these factors and affect sturgeons. Natural Caspian Sea fluctuations, climate changes or natural spread of invasive species in the Ural River courses may cause unfavorable conditions for the sturgeon population. Having lived in the neighborhood for more then 200 million years sturgeons have proved themselves to be highly resilient species which are resistant to various natural disturbances; nevertheless, during the last few decades sturgeons have been brought to the edge of extinction.

Historically, the sturgeon species' extirpation is attributed to overharvesting of sturgeon species worldwide (Cohen 1997; Hensel and Holchik 1997; Pourkazemi 2007; Qiwei et al. 1997; Zhuang et al. 2002). As a matter of fact, the absolute values of catch in the second half of the century do not exceed the harvest levels in the 19th century. On the contrary, according to the Caspian Fishery Institute (KaspNIRH 1999) the total Caspian sturgeon catch in the beginning of the 20th century was 39.4 thousand tons. The highest catch in the second half of the century was 27.4 thousand tons, followed by immediate and abrupt decline. Facing higher fishing pressure the sturgeon population did not collapse till the end of the 20th century, when other important factors started to play a major role. Overfishing as a total catch cannot be the primary reason for the sturgeon's extirpation from the Caspian region, but rather a combination of negative factors played a crucial role.

All researchers agree on the list of the factors causing sturgeon extinction, though the order of the impact magnitude for a particular factor is still actively discussed (Williot et al. 2002b).

The traditional list of negative anthropogenic factors includes blockage of migration routes, overfishing, pollution, habitat degradation, loss of spawning grounds, siltation, changes in hydrological regimes, sea salinity changes etc. The importance of these factors varies for different sturgeon species; they are considered in turn below.

Spawning migration blockage

Blockage of migration routes is the most significant anthropogenic impact on the sturgeon population (AzovBas 2002; Craig 2000; Lagutov 1995, 1997; McAllister et al. 2000).

Dozens of dams were constructed on the Caspian tributaries in the 20th century from the beginning of the 1930s to the 1970s (Figure 1). The dams have blocked the migration routes for both anadromous and semi-migratory fish types. Being deprived of their spawning grounds sturgeon populations became absolutely sterile, incapable of any reproduction and doomed to extinction in 1–2 generations even without any influence from other factors such as overfishing.

Figure 15 depicts the remaining spawning grounds in the Caspian rivers after impoundment (CEP 2002a). After the construction of the Volgograd Dam 100% of beluga spawning grounds were lost, 80% for the Russian Sturgeon and 40% for the Sevryuga. It is estimated that the total area

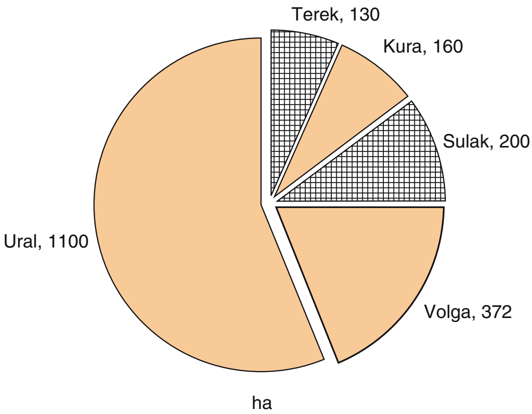

Figure 15. Remaining sturgeon (total for all species) spawning grounds in the Caspian basin. Checked slices represents rivers were no spawning was observed since 1980s

of spawning grounds in the Volga river decreased by 85% (AzovBas 2002; Russian State Duma 1995; Lagutov 1995). The beluga spawning grounds in the rivers Terek, Kura and Sulak were also lost completely.

Most of the constructed dams are high pressure dams constructed for hydropower generation purposes. The high level water drop does not allow the dam to be equipped with effective fish passing facilities. Though most of the dams are equipped with fish-passing devices of various designs, aimed at enabling migratory fish (in particular sturgeons) to pass through the dams, the overall efficiency of fish passage is extremely low due to a combination of factors (AzovBas 2002; Russian State Duma 1995; Lagutov 1995). As a rule fish-passages are costly, massive constructions requiring substantial operational and maintenance costs and resources. Yet despite their presence no sturgeon species spawning upstream of dams in the Caspian has been observed or described in the literature. Ichthyologists and fishery specialists agree that dams have "effectively cut off the spawning grounds upstream" and do not contribute to sturgeon population reproduction (Lagutov 1995). Some researchers deem that even in the case of successful sturgeon transfer to the dam's upper water sturgeons will not be able to find their way through to the spawning grounds upstream, if any is available in the impounded river segment. The former spawning habitats were either permanently flooded, silted or do not have proper environmental conditions (i.e. stream velocity and temperature regime).

At the same time "forced" spawning grounds downstream of the dams are believed to play some role in sturgeon spawning.[11] These grounds are located out of the historical spawning range and have a "forced" character

[11] See AzovBas 2002; Lagutov 1995 for the discussion on this topic.

of functioning. The migrants which are not able to overcome the dam to reach the upper river branches accumulate under the dam. If not collected by fishery, poachers and for scientific or hatching purposes different sturgeon species spawn jointly on any available substrate when the time of spawning comes. The survival rates for this kind of embryos and larvae are questioned by some authors due to many factors (Lagutov 1995, 1996). For example, the proximity to the sea might result in high losses of larvae/juveniles migrating downstream due to exposure to brackish sea water at early stages of the life cycle (Peseridi et al. 1979).

In addition, the environmental conditions in the habitats below dams are often unsuitable for spawning. The spawning grounds in the major sturgeon habitat, the Volga, were flooded only 13 times during 40 years after the Volgograd dam's completion in 1958 (Dubinina and Kozlitina 2000).

In any case, no natural reproduction was observed downstream the dams in most of the impounded rivers (except the Volga) during the 1990s (KaspNIRH 1999), 1–2 sturgeon generations after river damming.

The migration routes in the Ural River are still not obstructed. *Uchug*, used by Cossacks in the 19th and beginning of the 20th century to prevent big sturgeon from migrating upstream the Uralsk city, was an obstacle only for sizeable mature specimens. Moreover, every spring during the spawning migrations it was dismounted. The entire historic range of sturgeon habitats in the Ural is available for migrants and spawning with no reservations.

It is believed by some fishery-affiliated officials that one of the reasons for the decline in sturgeon appearance at the effective spawning areas in the Orenburg oblast was sinking of a barge in the middle of the Ural river close to the lake Indera (around 200 km from the Ural delta). There is some speculation that this occasion was used, or even intentionally created, to prevent sturgeons from going upstream and to maximize the catch in the area. Surprisingly, after the barge was lifted and evacuated exactly several pontoon bridges were constructed at the same location. Their removal due to obstructing the sturgeon migration routes was a matter for discussion between Russian and Kazakhstan regional authorities (Korina 2006). Being bottom-feeders sturgeons always swim near the river bottom, so a sunken ship across a medium sized river can be as an effective obstacle for sturgeon migration as a permanent *uchug*, and far downstream of the latter's historical location.

Habitat degradation, loss of spawning grounds

Traditionally, loss of spawning grounds for sturgeon species is understood as a consequence of river habitat fragmentation by the construction of dams and the blockage of migratory routes (Marmulla et al. 2001).

This is a major problem for all Caspian sturgeon stocks, apart from those in the Ural River. The Ural sturgeon spawning grounds are historically located up to the territory of the Orenburg Oblast and branches of the rivers Ilek and Sakmara. The results of the field studies conducted by Kazakhstan Fishery Institute (Guriev, Kazakhstan) in the 1980s showed that the most productive and viable sturgeon juveniles appear at spawning grounds in the middle Ural course close to Orenburg (Dmitriev and Vasilenko 2007). Moreover, historically the spawning grounds of the valuable sturgeon species (beluga, Russian sturgeon, Persian sturgeon, sevryuga) were located more then 1,000 km upstream the Ural delta (CEP 2002b; Peseridi 1971, 1986; Peseridi and Chertikhina 1967). Lack of a barrier complex on the Ural guarantees free access to spawning grounds for a hypothetical spawner.

However, due to the general decrease of sturgeon stock and active fishing efforts on the territory of Kazakhstan only a few sturgeons have been observed in this area lately.

At the same time changes in hydrological regime due to water intakes, climate change or water discharge regulation during the flood period may cause the spawning grounds to be unavailable for spawning even if migration routes are not obstructed. For instance, more then half of the spawning grounds in the Ural River are temporarily flooded, and to secure their proper functioning certain environmental conditions are required. Some mention the level of irrevocable water consumption from the Ural River as being 50–60% of the annual flow, resulting in 90% of larvae and young sturgeon perishing on their way to the sea (Fashchevsky 2003). However, this level of water intake seems to be overstated,[12] and the survival rate for juveniles from the deposited eggs to the sea may even be higher than natural levels.

Siltation, cover of spawning grounds with mud, is often mentioned as a problem for sturgeon spawning grounds' destruction. As a result of siltation the survival rate for sturgeon eggs will be low, because (1) eggs do not stick to the rocky bottom and (2) eggs are suffocated by silt/sand at the bottom of the river. There are some claims that from 1970 to 1994 a third of historical spawning grounds in the Ural was covered with mud, a sign of habitat degradation.[13] Siltation of some river intervals and cleaning of others is a natural dynamic process in the free-flowing steppe rivers depending on the water discharges in the river. The Ural's natural hydrological regime with high level floods maintains river self-purification services. High water

[12] See the article on the Ural river hydrology in this volume. The hydrological regime of the Ural river did not have drastic changes over the last century.

[13] According to other estimations 50% of the Ural's spawning grounds are lost due to the habitat degradation and pollution (cited by Pitikch et al. 2005).

flows, occurring in the Ural once 3–5 years in general, clean the potential spawning sites easily or create new ones. Since it flows through a wide valley the Ural River has a dynamically changing river bed shape with a high number of meanders and old river beds. In comparison to other European rivers, located in highly developed areas and limited by artificial channels and dams, the Ural River is a “living” water course, exposed to constant natural changes, including siltation and vegetation growth.

On the other hand higher then usual siltation rates can be caused by dredging works for navigation and extraction of sand and gravel conducted lately in the lower courses of the Ural on the territory of Kazakhstan. But these works obviously can affect only spawning grounds downstream and not productive sites upstream at the Orenburg oblast.

At the same time the very nature of dredging works suggests the erasure of gravel and pebble-formed rifts, where sturgeon spawning sites are located, causing direct irreversible destruction of spawning habitats.

Besides this, the mining of sand-gravel results in habitat degradation, loss of feeding grounds, siltation, and alterations in hydrological river regime. According to USSR Fishery Regulations in the Caspian Sea the mining of sand-gravel was prohibited in the Ural River stream up to the village Borodinsk in the Orenburg Oblast. However, these regulations are no longer enforced. For example, since 2000 Kazakhstan has been conducting sand-gravel mining in the watercourse of the Ural River near the village Priuralnoe, where many sturgeon wintering and spawning grounds are located. The specialists in the Orenburg Oblast claim that this has a strong negative effect on the sturgeon population.

Siltation cannot significantly affect spawning sites in the temporarily flooded areas, which is a substantial proportion of all available spawning grounds.

In this way, spawning habitats in the Ural River are abundant and underutilized and in case of the producers’ availability can sustain numerous sturgeon populations. Unfortunately, due to the fact that the Ural River is outside the scope of many Caspian sturgeon restoration programs a systematic specialized study of the river’s conditions has not been conducted. However, the underexploitation, or lack of any exploitation, of the Ural spawning grounds is well documented by the Orenburg Branch of the Russian State Fishery Department (KamUralRybVod 2007).

River’s hydrological regime

Changes in the river’s hydrological regime altering the volume and timing of the river flow have substantial direct and indirect impacts on successful sturgeon spawning.

The optimal conditions for sturgeon reproduction in the Ural river are created when the total annual flow is more then 9 km^3 (KaspNIRH 1999). Figure 16 presents the total Ural flow for the observation period 1915–2000. The optimal value of total flow in 9 km^3 is slightly less than the mean total flow for the period of observations. However, frequency of the favorable floods is approximately once per three years.

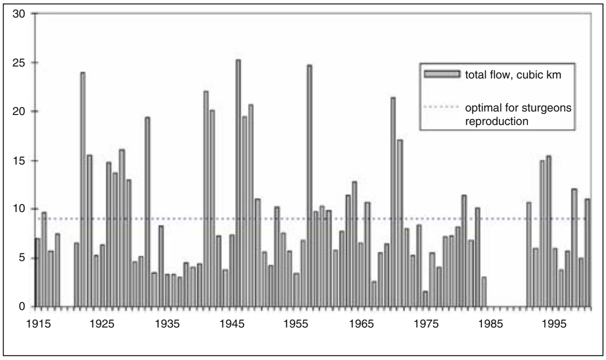

Figure 16. Total Ural flow for 1915–2000 (KaspNIRH 1999)

The comparison of sturgeon abundance/catches and total annual flow shows a very good correlation taking into account the time delay needed for sturgeon to mature in the sea before returning to their rivers for spawning. Figure 5 depicts a combined graph for total flow for 1936–1947 and beluga catch for 1955–1965. It should be emphasized that the higher total flow under the conditions of a non-regulated snowmelt-fed river, such as the Ural, means mainly higher spring floods, taking up to 80% of total flow. As has been indicated by several authors, spring (vernal) sturgeon race plays an important role in reproduction in the river Ural (Peseridi and Chertikhina 1967).

Unfortunately, proper statistical analysis of this correlation on the basis of the later data is not possible due to the intensive fishery in the river and sturgeon disappearance. Though the precise relationship between the total Ural flow and sturgeon spawning is hard to establish, the causal links between river flow and certain aspects of the spawning process are well known:

- First, ichthyologists claim that water salinity in the river delta changed by spring flood is one of the triggers for the sturgeon spawning migrations (Dmitriev and Vasilenko 2007).
- Next, the water salinity in the Northern Caspian directly depends upon the Ural River's hydrological regime.[14] The water salinity influences juvenile survival rates and food composition and availability.

[14] See article on the Ural river hydrology in this volume.

- Third, environmental conditions at the spawning grounds (current velocities) and their availability (water depth at temporarily flooded spawning grounds) are defined by water discharges in the river.
- Temperature regime in the river is also a function of the water level.
- Another factor of hydrological regime influence on the sturgeon population is the higher exposure of the migrating spawners to fishing efforts in low waters in the river stream. The record-breaking sevryuga catch in the low water years of the 1970s prove this statement (Figure 18).
- A number of other factors depending on the river's hydrological flow and influencing sturgeon population can be mentioned. Among them are fish-kill (oxygen-deficit), river self-purification service and fish exposure to pollution.

The existing water reservoirs in the upper branches of the Ural River do not have significant influence on the river's hydrological regime.[15] However, an appropriate management scheme of water discharges can improve the spawning conditions downstream the dams. The facilitation of sturgeon stock restoration was one of the main reasons for the creation of the Iriklinskoe reservoir, the biggest water reservoir in the Ural River. Unfortunately, nowadays this reservoir is also used as a pond for inland fisheries. The favorable conditions for inland fishery often contradict the interests of sturgeon migration. Taking into account the low number of specimens reaching Russian territory nowadays and the related lack of financial motives, the Russian fishery managers are not interested in providing good environmental conditions for hypothetical sturgeon migrations and spawning at the expense of inland fisheries' stable financial profit.

Sea salinity

Though sturgeons are euryhaline (salinity tolerant) species, the sea salinity level is an important factor in sturgeon population dynamics.

Sturgeons utilize a number of distinct habitats through their life cycle, but most of the time they spend in the sea for growing, feeding, fattening and maturing.

The well-being and survival rate of most species of Caspian sturgeon depend upon the conditions in three basin ecosystems:

- Rivers (freshwater)
- Estuaries with a salinity level of 0–4‰ and desalinated shallow waters of the Northern Caspian region (4–7‰)
- Northern Caspian Sea ecosystem (5–7‰ to 10‰ salinity)

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[15] This influence is analyzed in the article on the Ural river hydrology in this volume.

According to the regional fishery officials the current salinity changes are having a dramatic impact on the sturgeon species' population spawning in the Ural river (KamUralRybVod 2007; Uralbas 2007b).

Sea salinity affects the Ural sturgeon population in several distinct ways:

- Feeding grounds are shrinking. Due to high salinity highly productive benthos and small fish are disappearing from the region.
- Non-freezing sea water of high salt concentration with negative temperatures can result in severe damage to fish.
- Survival of juveniles entering the sea for the first time after hatching rapidly decreases with salinity increase.

While all sturgeons are euryhaline species, larvae and juveniles are less tolerant to a saline environment than adults; water salinity of 8‰ is lethal to larvae at early stages of development (CEP 2002b; KaspNIRH 1999; Lagutov 1995, 1996). Fry and larvae need freshwater or brackish waters during the first few weeks. Depending on the water amounts delivered by rivers, the North Caspian estuaries' salinity can cause high mortality in sturgeon larvae.

Historically, before the creation of the Volgograd Dam, the juveniles in the Volga river used to stay in the river freshwaters after hatching for up to three months and on entering brackish salted water had an average weight of 171 g and length of 36 cm. Currently, larvae reach only a weight of 4.2 g and length of 5–9 cm (KaspNIRH 1999). Russian Sturgeon juveniles also often stayed in the river freshwaters for 3–4 years after hatching (Chugunov 1968). Current trends towards salinity increase in the Northern Caspian suggest the need for the usage of historical spawning places located in upper river branches. Due to the construction of high pressure dams on most of the Caspian basin rivers the Ural river is the only river stream with spawning habitats in their historical range.

Even in the Ural river 95% of Russian sturgeon, 98% of sevryuga and 65% of beluga juveniles appear in the delta at an age sensitive to high salinity exposure (Peseridi et al. 1979). In the case of water salinity close to 8‰, most of the new sturgeon generation will be lost. Such high salinity occurs in the Ural River delta during years with low water availability. Also the changes in the Volga river's annual stock have caused a rapid increase in the salinity of the Northern Caspian. The closer the spawning grounds to the river delta, the higher the risk of significant larvae and fry losses and a further decrease in Caspian sturgeon stock.

Overfishing

Commercial fishery

The problem of overfishing in the Caspian fishery is a very interesting phenomenon. Traditionally, the sturgeon, once abundant in all European rivers, was harvested by many different states, local communities, kingdoms or dukedoms. Though there were some attempts to regulate sturgeon fishing (Keysler 1762) at the beginning of the 20th century sturgeons have since disappeared from European rivers in commercial quantities. The second half of the century was characterized by a drastic increase of environmental awareness, international conventions and scientific approach to natural resources exploitation, which presumably should have helped sturgeons to survive. However, the Caspian sturgeon stock vanished exactly at this time. Though severely overexploited in the 1930s–1940s the Caspian sturgeons still inhabited the sea and rivers in great numbers.[16] In order to preserve available stocks several institutions were created to give scientific-sounding grounds for the establishment of fishing quotas. The Caspian sturgeon was driven to extinction despite all the activities aimed at its preservation and the new scientific approach (CEP 2002a).

According to the official records (FAO 2007b; KaspNIRH 1999) the legal beluga catch in the Ural basin dropped by a factor of 750 (from 1,500 t in 1932 to 2 t in 2005), while the sevryuga catch decreased by 2,500 (from 9,870 t in 1977 to 4 t in 2005). It can be argued that this tremendous decrease in catch is caused by introduction of quotas and thorough compliance with these regulations by fisheries.

As it is known, quotas are calculated as a percentage of the available fish stock (CITES 2004b; Seijo et al. 1998) to limit the catch with the purpose of securing sustainable stock reproduction. From this perspective the official statistics of the quotas/catches in the Ural River basin reveals very interesting dynamics. Figure 17 plots sturgeon fishing quotas and reported catches in the Ural-Caspian fishing zone by Kazakhstan. During 15 years from 1992 to 2007 the quotas gradually decreased by a factor of 10. However, even these small quotas cannot be utilized. So, the sturgeon fishing quota in Kazakhstan in 2007 was 184 t and it was only 70% completed (Uralbas 2007b). For the same period of 1992–2007 the reported catch in the Ural dropped by a factor of 15, which exceeds the drop in quotas by 50%.

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[16] There are some sources stating that the peak in sturgeon catches in the Caspian Sea was 50 thousand tons (Pitikch et al. 2005). In this case the Caspian sturgeon stock was already overexploited in 20th century.

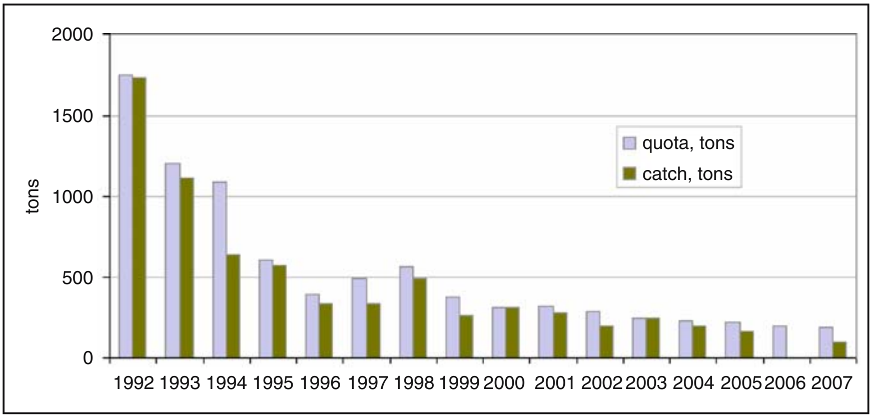


Figure 17. Sturgeon quotas and reported catch in Kazakhstan (RK 2003. Reported catch for Kazakhstan in 2006 was not found by authors)

The failure to utilize the sturgeon harvesting quotas is often treated as kind of sturgeon-protection measure. At the same time it should be taken into account that efforts to utilize the quota are more or less the same as decades ago, when the catch was 10–20 times higher. The only credible reason for the failure is the diminishing number of the specimen in the region. Nevertheless, official – constantly shrinking – quotas are still distributed. The reasoning to explain the existence for more than a decade of quotas which are higher than the maximum possible catch can be hardly found. Moreover, according to the Sturgeon Management Authority of Russia (CITES 2004b) the estimated sturgeon abundance in the Ural river for the period 1998–2001 was 197.6, 183, 226.7 and 226.7 t correspondingly. This is a much smaller than the quota or the real catch in this period. In 1998 the total estimated abundance was almost three times smaller then quota.

Another interesting observation concerning these statistics is connected to the fact that sturgeons are long-lived late-maturing species and considerable time period is required for the population rehabilitation. Surprisingly, there are significant annual fluctuations in the official quotas, including an increase in 1996–1998. Sturgeon stock cannot be restored in 1–2 years to satisfy higher fishing pressure.

As already discussed above, by fishing in the river basins the state fishery, as well as poachers, has for decades targeted the spawners in order to secure caviar production. For decades the fish of reproductive age were systematically removed from the stock. As a result, fishery nowadays aims at sturgeons returning to the Ural spawning grounds for the first time (Dmitriev and Vasilenko 2007). The average age of species in the sturgeon spawning flock in the Ural river during 2001–2006 was around 20 years for the beluga (Huso Huso) and 11–12 years for the Sevryuga (Acipenser stellatus) (Baimukanov 2007). Taking into account sturgeon species' age of maturity in fact suggests that these sturgeons were first-time spawners. As noted above, the reported catches of the state fishing companies are considered to be understated by 2–3 times (World Bank 2004b). Thus, the scale of the first time spawners' removal is much higher than claimed. If caught they could not complete even one spawning cycle. If even these spawners are removed then the sturgeon population is doomed to total extinction within a few years.

Taking into account the complex long-term sturgeon life cycle, a minimum level of population needed for reproduction should be established. Until reaching this level a total ban on fishing should be imposed (Jonsson et al. 1999; Lagutov 1995, 1996; Uralbas 2007a). There are numerous indications that the Ural and Caspian sturgeon have crossed the threshold after which population recovery is hardly possible. Furthermore, the hatcheries' inability to find enough producers to carry out artificial propagation is another indicator of the species' extermination from the region.

Nevertheless, the constantly decreasing quotas are still granted officially. The inefficiency of the sturgeon fishing quota system to revive dwindling sturgeon populations was also confirmed by the analysis made within the framework of the Caspian Environment Program (CEP 2002a).

The high intensity of open-sea fishing in the 1950s is proclaimed as one of the biggest overfishing-related causes for the sturgeon's decrease. The official statements by the Caspian Fishery Research Institute indicate this fishing strategy as one of the main reasons for the sturgeon stock's depletion in the 1990s (KaspNIRH 1999). According to these sources "high intensity" sea-based sturgeon fishery Sturgeon catch in this period is characterized by high number of young fish of non-productive age and small body weight (Marti 1972).

At the same time, reallocating of fishery to the rivers (i.e. Ural) resulted in a two fold increase in catch within a year. This strategy focused fishing efforts exclusively on spawners entering the rivers with a removal rate up to 80% on some species prior to spawning. These estimates do not take into account illegal fishing, poaching and removal for scientific or reproduction needs. Though claimed to be aimed at sturgeon stock preservation and protection, the limitation of sturgeon spawning in rivers should cause significant decrease in spawning and stock replenishment. Such a fishing strategy should be scientifically grounded, precisely regulated and controlled. Instead, the fishing strategy focused on annual systematic removal of spawners has undermined natural sturgeon reproduction and caused the drastic stock decline which can be observed recently.

By now the total removal of the productive spawning population (repetitive spawners) is confirmed by the same authors. Surprisingly, this statement was recently also supported by the Caspian Fisheries Institute (KaspNIRH) working on justification of fishing in deltas and rivers earlier. In 1999 the KaspNIRH report on the state of Caspian sturgeon stock and reasons for its decline states “the fishery in … delta and river was extremely intensive during the spawning period… The most valuable and productive part of spawning population was annually extracted…” (KaspNIRH 1999). However, the shift towards fishery in the rivers is still called a fish-protection measure in comparison to open sea fishing, even in the face of the Caspian sturgeon’s extinction and the collapse of sturgeon fishery.

A deeper insight into the problem can be gained by observing fishing efforts coupled with other factors. For instance, the decrease in total sturgeon numbers in the 1990s in the Ural could be mainly caused by such a combination of several factors. In particular, according to the observations by the Caspian Fishery Research Institute the period from 1973–1979 is characterized by a *drastic* decrease in natural spawning in the Ural river (KaspNIRH 1999). Unfortunately, the authors do not pay proper attention to this fact. Nevertheless, this period is exactly the period when the generation of the 1990s was supposed to be incubated. Depending on species sturgeons have 10, 15, 20 years to reach reproductive (and commercial) age. In other words, the drastic decline in abundance and low catches of sturgeons in the 1990s is the result of the low level of spawning one generation ago.

The low level of spawning in the 1970s seems to be a combination of both environmental and anthropogenic factors. Figure 18 depicts a combined graph of the total Ural flow and sevryuga catch.

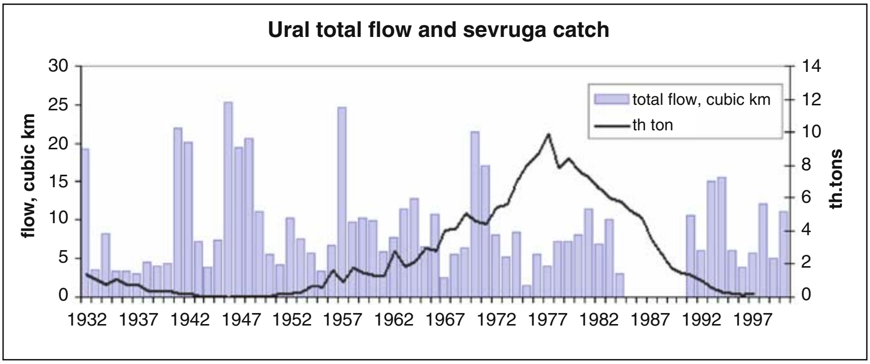


Figure 18. Sevryuga catch in the Ural River and total annual flow of the Ural River. There is no data on the Ural River flow available for the period 1985–1990

As can be observed from the graph an extremely low level of total water flow in the Ural River coincides with the highest catch during the whole history of fishery in the region. The catch of 10 thousand tons is the maximum catch observed for a single sturgeon species in the 20th century (Pitikch et al. 2005). It should also be noted that this enormous catch was removed out of only one spawning population in one river in one year. Most probably this high level of catch is the result of low level water when the fishing efforts are more efficient. As a result just a few spawners managed to pass to the spawning grounds. The reiteration of the same situation during several consecutive years resulted in total extermination of the reproductive population fraction accompanied by the lack of incubation of a new generation. Indeed, the sevryuga population could not recover after such a pressure.

Analysis of the population dynamics based on the catches without consideration of other factors such as scale of fishing efforts can also produce a distorted picture. In particular, the gradual increase in catches in the 1950s is often explained by population restoration during the years of the Second World War, characterized by lower pressure on the stock. These conclusions are true for fish populations with a short life span, but not for the sturgeon, which is a long-lived late maturing fish. Overexploited stock of this kind of fish cannot be restored in 4–5 years (Jonsson et al. 1999). Instead, the increase in catches in the post-war period should be explained by increasing fishing efforts. During this period more efficient and aggressive fishing technologies and equipment were introduced (KaspNIRH 1999).

This line of reasoning suggests that official "legal" fishery and fishery-affiliated institutions played a leading role in the sturgeon population's decline in the non-regulated Ural River.

Poaching

Poachers are traditionally recognized as unemployed local population, collecting sturgeons out of fishing zones and seasons with banned gears, processing their products and selling them on the black market. Some authors suggest that poaching is the primary factor for sturgeon species' (in particular the beluga's) decline in the Ural river in the 1990s (DeMeulenaer and Raymakers 1996; EPA 2004). The most significant role in this process is attributed to large-scale organized poaching mafia believed to arise after the collapse of the Soviet Union. Coastal population in Newly Independent Countries in the beginning of 1990s after the collapse of regional economy desperately needed new sources of income. In many coastal areas the fisheries, including poaching, appears to be the major source of income and jobs even now. Poacher communities are making their source of living out of fishery using available equipment (boats, nets, ammunition), often better than that in the possession of state inspectors.

Undoubtedly, poaching has significantly worsened the situation with sturgeon stock. The scale of poaching and its strength in the 1990s in Dagestan (Russia) was high enough to undertake military campaigns against state border guards, and called for sturgeon stock protection. There were numerous reports on machinegun attacks and exchange of fire between fishery inspectors/border guards on one side and poachers on another. The same problems were reported by the Kazakhstan Fishery Inspectors in 2007 during the First Ural Basin Sturgeon Workshop (Uralbas 2007b). The poachers sometimes even attack official sturgeon warehouses on the sea coast to take away the official catch (Uralbas 2007b).

However, the drastic decline in catch in the Ural basin started from the beginning of the 1980s (Figure 7), ten years before the disintegration of the Soviet Union. At that time poaching was severely punished by the authorities and was not a large scale problem.

A significant change in Ural sturgeon populations occurred in the 1990s, namely that the male-female proportion in spawning populations drastically changed. The historical proportion in the flock entering the Ural River for the migration upstream was 55:45. According to the latest observations, this proportion shifted to 75:25 (CEP 2002a; Dmitriev and Vasilenko 2007). Such a population structure results in lower number of new larvae to be hatched at the spawning grounds.

This feature is usually assigned to poachers hunting only for the caviar. They often capture only sturgeon females running for spawning, cut them open right on the boats, remove the caviar and throw the sturgeon bodies back to the sea. The caviar has much higher market value and does not burden the boat much in case of chasing by the state fishery inspectors.

By capturing the spawners the poachers cause a decrease in the abundance of future generation numbers. If the poachers significantly damaged the spawning population in the 1990s the effect would be revealed 10–15 years later. However, according to the official story poaching has only bloomed after the collapse of Soviet Union in the 1990s, which was already characterized by a tremendous decrease in sturgeon abundance and catch. Moreover, there are some suggestions that official fishery itself targets the reproductively mature females (EPA 2004).

In any case, poachers cannot compete with state fisheries in catch size and cannot significantly undermine their efforts and drastically decrease their catch. The influence of this kind of poaching by local communities on sturgeon stock decline may therefore be overstated.

According to the most widely spread estimation of poaching activities it takes up to 11–12 times the volume of the official catch (CEP 2002a; ZIN 2006) In other words, having the legal catch in 1995 in approximately 550 t the total catch (without scientific, productive and official unaccounted ones) in the Ural should be 7 thousand tons (550*12 + 550). Such a high level of catch corresponding to the maximum catch in the 1970s and at least four times as big as the catch by the Cossacks in the beginning of the 20th century, when sturgeon numbers in the Ural were plentiful. This obviously contradicts the situation when enough producers cannot be found even to perform captive breeding in hatcheries (Khodorevskaya et al. 2000).

This estimation migrates from one report on Caspian sturgeon to another without explanation how the calculations were made and referring to the source as “some Russian experts”(CEP 2002a; ZIN 2006). It seems that the origin for this estimation is the Caspian Research Fishery Institute (KaspNIRH 1999). In the report prepared by KaspNIRH within the framework of Caspian Environment Program the methodology for this estimation is described. The authors state that these poaching rates are calculated using mathematical models based on the difference between the expected level of catch and the real catch. This difference is then somehow distributed between poaching and “illegal” (unaccounted) official catch (KaspNIRH 1999). The expected level is derived using a set of assumptions, which in fact might not be correct. In particular, one of the main assumptions suggests the maturation of millions of the released fingerlings from the Russian hatcheries since 1955. The survival rates (if any) for these fingerlings are unknown since no proper estimations were carried out and no tagging technology used. Next, if there are any survivals they are not expected to appear in the rivers, the fishing zones, due to the peculiarities of release technology.[17] Consequently, they will not contribute to the legal catch in the rivers upon their maturation. On the other hand, the announced size of the real catch itself is influenced by the value of the “illegal” unaccounted official catch. These and other founding principles of the poaching estimation methodology are questioned by experts and provide wide opportunities for manipulations depending on the experts’ beliefs and biases.

These considerations suggests that the well accepted rates of poaching during the last decades as calculated now are very unreliable figures and require careful examination and revision.

At the same time, new poaching technologies were detected lately in the Ural river (Dmitriev, personal communication, June 14, 2007). Some individual poachers use electric rods powered by portable generators,

[17] According to the USSR hatching technology fingerlings were supposed to be delivered by the ship to the “pastures” in the brackish waters and released there.

paralyzing and killing fish. The fish that survive electrocution are believed to become sterile, reducing future fish populations. Though infringers are severely persecuted by both fishery inspectors and local communities this way of fishing is believed to cause serious damage to fish stocks in the shallow Ural tributaries.

With regards to poaching activities in the open sea, adjacent to the Ural delta, numerous international poaching groups are actively hunting for the sturgeon here, utilizing modern equipment and ammunition (Uralbas 2007b). The numerous poaching boats from Dagestan, Kalmikiya and Azerbaijan fishing in this region might be an indication of the greater sturgeon availability in this area in comparison to other Caspian regions.

Indeed, poaching does exist in the region and causes serious damage to the vanishing population. However, this is rather a social phenomenon which is hard to solve by prohibitive acts and occasional patrolling. There are numerous reports on close cooperation between poachers and fishery inspectors. For instance, selling of confiscated poacher's production through official shops seems to be an excellent loophole for such cooperation. Both sides, poachers and fishery inspectors, benefit from this situation. Local communities should become interested in long-term sturgeon stock preservation. Significant changes in society are required as well as technical solutions to secure sturgeon preservation. In case of the Ural River the reviving Cossacks communities, which have a high regard for sturgeon and the Ural River, can serve as a foundation for grassroots anti-poaching campaigns.

It should also be noted that drastic declines in sturgeon stock lead to greater fishing efforts to make poaching in the sea profitable. This should result in a decrease of regional poaching activities.

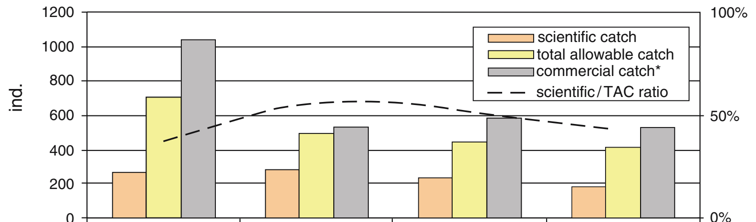
Catch for scientific and reproductive purposes

While commercial fishing catch is monitored in one way or another and some, though sometimes controversial, statistics are available, so called scientific catch and removal for reproductive purposes are not properly counted (Lagutov 1995). Nevertheless, uncontrolled removals of reproductive sturgeons for these purposes have contributed considerably to stock decline, especially in the situation when sturgeon populations are already threatened and fewer specimens are available.

Although the return rate of hatchery-reared sturgeons is dubious, high number of producers have been collected for hatcheries in an uncontrolled manner (Lagutov 1995), diminishing the already depleted stock. This activity is not under CITES or any other kind of agreement and gives ground for various data manipulation and unreasonably high producer collection.

The same considerations are applied to scientific fishing, the catch intended to supply researchers with study materials.

In Russia the commercial fishery of the beluga has been closed since 2000. However, according to a resolution of the Russian State Committee on Fisheries this species can be caught for scientific and reproduction purposes and the meat and caviar can be sold afterwards (RF 2000b). In accordance with this regulation in 1998 in the Volga river alone 266 belugas were caught using drag seines, while the overall total allowable catch limit (TAC)[18] was only 710 specimen for the whole of Russia (CITES 2004b). Figure 19 shows the ratio between announced scientific catch, official TAC and commercial catch. The commercial catch was obtained from FAO fish database (FAO 2007b) in tons and converted to number of specimen using average beluga commercial weight (75 kg) provided in the very same CITES document (CITES 2004b) and KaspNIRH report (KaspNIRH 1999). The beluga catch for scientific purpose alone contributed up to 52% of total allowable catch even according to the official KaspNIRH data. Taking into account the low number of spawners and high number of hatcheries in the region the scientific and reproduction catches can exceed TAC even without considering impacts from poaching, commercial or illegal fishing. However, legal commercial fish reported to FAO is even higher then TAC. In any case, all these values are of the same order of magnitude. The catch announced as scientific is comparable to the legal commercial catch.



	1998	1999	2000	2001
scientific catch	266	281	236	180
total allowable catch	710	500	450	419
commercial catch*	1040	533	586	533
scientific/TAC ratio	37%	56%	52%	43%

Figure 19. The proportion between scientific catch and total allowable catch (CEP 2006; KaspNIRH 1999; Uralbas 2007b)

In Kazakhstan fishing for scientific purposes is allowed not only in the river, but also in the sea. It is limited by a certain annual quota. The scientific quota for Russian sturgeon alone is 20 t (CITES 2001), while commercial catch quota for the same species was 52 t for 2000 and 41.3 for 2001. In other words, the scientific catch adds almost 50% to the commercial catch quota.

[18] As it was already discussed the total allowable catch (TAC) is calculated based on questionable assumptions and should be considered as overestimated value.

The trend is also well represented by the scientific catch in the Volga River. Figure 19 shows the ratio between the number of beluga specimens caught for scientific purposes in the Volga (by using drag seines in the delta) and Russian Total Allowable Catch (CITES 2004b). According to this data, presented by the CITES Management Authority for Sturgeon of the Russian Federation, scientific catch comprised more then 50% of the TAC. Special attention should be paid to the scale of catch. Such a high scientific catch occurred in the situation when TAC, whatever reasoning is used for its calculation, is only 500 individual beluga specimens.

Despite the high level of scientific catch most of the available data on high-profile sturgeons is a compilation based on studies conducted a long time ago (1930s, 1960s–1970s) under different conditions. These statements are especially true for the river basin aspects of sturgeon life cycle.

Hybridization

The regulation of rivers resulted in spawners of all sturgeon species accumulating in the areas downstream the obstacles. The changes in water temperature regime force fish to spawn in the same areas as other species. This results in the appearance of hybrids with unknown characteristics. This also applies for the hatchery-reared sturgeons, often using producers from different populations resulting in mutations (Brown 2002; Kirby 2002).

Pollution

Due to the life cycle characteristics and long time span sturgeons are subject to *bioaccumulation* and *biomagnification* processes. During bioaccumulation a sturgeon absorbs some toxic substances at a rate higher than the substance is lost. The longer the organism's life span the greater the risk of chronic poisoning, even if environmental levels of the toxin are very low. Biomagnification is the process of the increase in toxin concentration in the organisms on higher trophic levels that occurs through a food chain. In this way low concentrations or occasional high level pollutants can be accumulated in sturgeon tissues, affecting its health and reproductive abilities.

Fortunately, the water pollution level in the Ural River is not high due to low population and industry density in the region. Nevertheless, some pollutants concentration and impacts on sturgeon health (i.e. reproductive behavior) were detected in sturgeon tissues (CEP 2002a, b; KaspNIRH 1999).

Some researchers indicate concern at the increasing rates of oil extraction in the Northern Caspian in general and the sea areas adjacent to the Ural delta in particular (CEP 2002a, 2006).

Other

Though there is no natural predation on adult sturgeons, sturgeon eggs are subject to predation by some river fish, such as catfish, pike, or bream (CEP 2002b).

The influence from invasive and introduced species on sturgeon populations should be insignificant due to the lack of natural predation on sturgeons (except for earlier life stages in the rivers), the wide range of food resources and underexploited food abundance in the historical sturgeon habitats. There are indications of some changes in the sturgeon food chain caused by some invasive species (CEP 2002b).

The reduction in the Ural water level has resulted in changes in water temperature regime. The sturgeon spawning behavior, dates, duration and larvae survival strongly depends on water temperature regime (Dmitriev and Vasilenko 2007).

Changes in population characteristics were detected during the last decades. In particular, mean individual weight for spawning beluga population was 110 kg in 1970s, while in the 1990s it has decreased to 75 kg (KaspNIRH 1999). Though according to KaspNIRH the relationship between population size and food availability was not discovered, such loss in weight is often explained by food scarcity due to climatic changes and sea level fluctuations. However, nowadays the total abundance of beluga and other sturgeon species is negligible in comparison to the prior size of the stock on the same grounds. Furthermore, even if there is a link between sea level fluctuations and loss of weight in sturgeon species, changes in food availability are of a much smaller scale than the catastrophic decrease in fish utilizing this resource. Fewer sturgeon individuals cannot compete for the available food sources. On the contrary, the food resources in the Northern Caspian Sea are underutilized by fish stocks (CEP 2002b). This fact is often used by the Fishery Institutes to justify usage of Caspian Sea as a fishing pond for commercial sturgeon harvesting by establishing sturgeon hatcheries in the river mouths (KaspNIRH 1999).

There are different plausible explanations for the decrease in individual weight. First of all, many researchers indicate decrease in average age of the sturgeon population. No belugas older then 25 years old have been caught lately, while they are reported to live for more than 100 years. Another possible reason in weight decline is sturgeon hybridization and influence of artificially hatched sturgeons.

Climate change does not have a direct affect on sturgeon populations. During more then 250 million years sturgeons proved themselves to possess a high level of flexibility with regards to changing environmental conditions.

In case of extremely low population size any, otherwise insignificant, factor may play a crucial role. So, according to the representatives of fishery agencies (Dmitriev, personal communication, June 14, 2007) massive beluga specimen death was detected in the 1990s in one of the traditional beluga wintering habitats in one of the Ilek river meanders (aged river bed linked to the main river course) due to the complete freezing up of the entire water body right to the bottom. Though the reasons for this phenomenon are unknown, some practitioners link these occasions with underground explosions conducted nearby in the 1980s to create gas storage reservoirs. At the same time this phenomenon can be the result of natural geomorphological changes of the river bed. If the beluga population in the river were abundant it would spread through numerous wintering habitats and escape the negative effects of the changes in one particular habitat.

Another environmental factor limiting sturgeon population is a fish-kill (oxygen deficit) in lower reaches of the river during the winter period, when sturgeon are hibernating in river depressions (Uralbas 2007b).

As one of the factors limiting sturgeon spawning migrations some authors indicate shallowing of the river delta due to siltation and sea fluctuations (Caviaremptor 2004; EPA 2004). As the Ural river delta has become shallower, fish cannot enter the stream for spawning. Several internationally-funded projects were launched aiming at dredging of the channels through the Ural river delta to facilitate sturgeon movements to hatcheries (World Bank 2004a). On the other side, the Caspian Sea level has been constantly fluctuating. In the last 15 thousand years it has varied from -20 to +50 m relative to current levels (Asarin 1997). These sea level fluctuations, far more significant than can be observed recently, and related changes in the sea ecosystem did not cause sturgeon extinction. By contrast, dredging for so-called sturgeon passage purposes can increase access of salted sea water to the estuary and increase mortality rate for the fingerlings and larvae sensitive to salinity.

A combination of these factors can also result in decrease of sturgeon feeding grounds, such as siltation of the stony substrate, low water level in the river, disappearance of temporary spawning grounds, change in food availability and composition, etc.

Restoration activities

The terrible situation with regard to sturgeon stock and the galloping price of caviar caused international discussion of the ways to restore the Caspian sturgeon (Williot et al. 2002b). Different measures are suggested to preserve sturgeon species: from "an absolute ban on uncontrolled fishing for sturgeon in the sea" (Luk'yanenko et al. 1999) to avoid buying caviar in the shops (WWF 2004). These recommendations often depend upon the perception of the problem: unique ancient species extinction or decrease in the stock of a valuable delicacy source. Moreover, the suggested strategies are often biased by experts' vision of the problem's roots and their professional affiliation.

Two primary alternative strategies are considered for restoring sturgeon population:

- Stop harvesting and allow natural rehabilitation and recolonization.
- Hatchery-based re-stocking in parallel with commercial exploitation of the resource.

The first approach requires a long time till population restoration occurs, if any, depending on the current population status. The second one is risky due to the possibilities of genetic modifications and other factors.[19]

The second one is advocated by fishery-affiliated institutions trying to maximize short-term food production through catch.

Both approaches can be accompanied by other activities assisting the main strategies: fishery limitations, quotas introduction, spawning grounds monitoring, establishment of protected areas, etc.

Combination of these two approaches is possible as well as their total incompatibility, when artificial re-stocking has negative effects on natural restoration.

Until now the second approach has prevailed in the Caspian basin in general and in the Ural river in particular. The best proof for this statement is the location of the sturgeon hatcheries in the Ural river delta, while the entire historic extent of sturgeon migrations is not only freely available and natural spawning habitats are accessible, but also has the status of protected territory according to the national legislature. If the aim of the restocking program is to restore wild population and to secure natural reproduction abilities the hatcheries should at least be placed close to the historic spawning grounds.

The most productive sturgeon spawning grounds are located in the Ural's upper branches on the territory of Russia, while the migration

[19] The complications of hatchery-based sturgeon restocking are discussed below.

routes, nursing and feeding habitats are in Kazakhstan. Thus, in both alternative sturgeon restoration strategies only joint efforts of the basin countries can secure success. Thus, the sturgeon can be preserved only by joint efforts and transboundary cooperation in river basin management. Taking into account the high economic value and worldwide demand for both sturgeon products and gene pool for restoration programs, maintaining its natural reproduction and sustainable extraction is a genuine interest of the basin countries. In order to secure this possibility integrated sustainable management of water resources in the basin should be ensured.

Sturgeons are high on the international political agenda nowadays and this region increasingly attracts attention from international and national institutions. For example, from August 1, 2007 Russia has introduced a total ban on sturgeon caviar production to facilitate sturgeon restoration programs. In August 2007 a Russian State Council presidium took place in the Caspian region and focused mainly on fishery and sturgeon restoration. Special attention in these efforts has been paid to cooperation with neighboring countries, in particular Kazakhstan.

Though the importance of the Ural river basin sturgeon habitats for the conservation of the Caspian Sturgeon population is increasingly recognized, practical measures which have been undertaken so far in this area are not satisfactory. For instance, the Russian National Action Plan developed within the framework of the Caspian Environmental Program (RF 2002) does not mention the river Ural even once, even though the restoration of the spawning habitats is one of the Caspian Strategic Action Programme's primary objectives.

During the last decade a number of bilateral summits devoted to Russian-Kazakhstan cooperation in the Ural river basin have been conducted. Unfortunately, transboundary cooperation on sturgeon species conservation in the Ural river was not an issue for the discussion until the First Ural River Basin Workshop conducted in Orenburg in 2007 (Uralbas 2007a). The basin countries are trying to undertake sturgeon-protection measures, if any, independently – a strategy which is unlikely to be effective.

Endangered status and ban on fishery

Formally, the territory of the Northern Caspian adjacent to the Ural river Della was recognized as unique ecosystem from the biological and sturgeon commercial point of view in the 1970s. A protected area including the Ural delta and adjacent sea was established in 1974 in accordance with Resolution N 352 by the Government of Kazakhstan Soviet Socialist Republic "On the establishment of the protected area in the Northern Caspian Sea". After four years (by the Kazakh Government Resolution N284) the protected area was extended to the Ural river floodplain from the river delta to the mouth of the river Barbastau (near the city of Uralsk next to the border with Russia). The current status and anthropogenic activities in the protected area are defined by the Law of the Republic of Kazakhstan "On Protected Areas" (from 15.07.97), article 48. According to this Law, the main function of this protected zone is the preservation and conservation of the sturgeon species (RK 2002). The economic activities are limited within these protected areas. The extent of application and status of this zone is not clear since not only sturgeon fishery takes place in this area, but many other dangerous anthropogenic activities, such as extraction of sand and gravel from the river bed and oil production. In particular, drilling for oil extraction has been conducted in the areas adjacent to the Ural delta since 1993 (Bolshov 2000). The Northern Caspian protected zone is basically represented by sparse patches of small reserves with limited economic activity.

Paradoxically, despite the formal existence of the specially designated zones aimed at sturgeon protection the sturgeon species themselves are not protected under the national legislatures.

Listing of sturgeon on national endangered species lists (Red Books), ban on their catch and preventing trade and export of their products is considered to be a crucial step if not to restore, then at least to conserve the vanishing species. Any restoration activities should start by providing the species with protected status.

The Table 4 shows recognition of Ural sturgeon status by main lists of endangered species: IUCN Red List, National Red Books of basin countries

Table 4. Status of sturgeon species in national and international Red Lists (IUCN 2007; ORB 1998; RF 2000a; RK 1996)

	IUCN	Red Book of Kazakhstan	Russian Red Book	Orenburg Red Book
Ship *Acipenser nudiventris (Lovetsky, 1828)*	Endangered	Protected (only Aral Sea population)	Protected	Protected
Sterlet *Acipenser ruthenus (Linnaeus, 1758)*	Vulnerable		Protected	Protected
Sevryuga *Acipenser stellatus (Pallas, 1771)*	Endangered			
Beluga *Huso huso (Linnaeus, 1758)*	Endangered			
Russian sturgeon *Acipenser gueldenstaedtii (Brandt, 1833)*	Endangered			
Persian sturgeon *Acipenser persicus (Borodin, 1897)*	Endangered			

and Orenburg Regional Red Book. The classification accepted in IUCN Red List distinguishes the following classes (in order of threat decrease):

EXTINCT – EXTINCT IN THE WILD – CRITICALLY ENDANGERED – ENDANGERED – VULNERABLE – LOWER RISK

The endangered and vulnerable statuses were assigned to Caspian sturgeons by IUCN in 1994 when the situation was not as catastrophic as now. Recently, IUCN Red Book (IUCN 2007) recognizes these classifications of sturgeons as outdated. Nevertheless, according to this classification almost all sturgeon species were enlisted as endangered, while only one, the Sterlet, is seen as vulnerable.

The appropriateness of these classifications to anadromous species, i.e. sturgeons, is questioned by many researchers. Measuring extinction threats is not a straightforward process. So, the common practice used, for example, by World Conservation Monitoring Centre, is to consider a species *extinct* if it has not been observed for 50 years. In accordance with this approach, WWF Factsheet on endangered species published in the framework of CITES convention claims that only 13 species of sturgeon are threatened, and two species located in Aral Sea are "close to extinction" (WWF 2002a).

It might be too late to restore sturgeon population in case a few specimens are seen in the wild on the occasional basis. The few remaining sturgeons are not capable of restoring the population even in case of immediate measures on their habitat restoration and total ban on fishing due to their life cycle characteristics. The sturgeon populations of the Sea of Azov are doomed to extinction with no chance for natural restoration (Lagutov 1997). The European Atlantic sturgeon has been extirpated from main European rivers (Birstein 1993; Birstein et al. 1997; Dulvy et al. 2003; Granado-Lorencio 1991). Some authors believe that the Caspian sturgeon species spawning in the Russian rivers are also not capable of recovering (CITES 2004a; Crownover 2004a). Although there are cases of rare accidental catches of some sturgeons in these rivers, unfortunately natural restoration of wild populations from these spawners is not possible (de Groot 2002; Williot et al. 2000, 2001).

In any case, Caspian Sturgeons have endangered status according to IUCN classification, which presumably should at least raise the regional awareness and facilitate restoration programs.

However, neither Russian nor Kazakhstan Red Books, created to enlist threatened species at the territory of the corresponding countries, list any of the valuable species. Only two species are included, the Ship and Sterlet, which, according to KaspNIRH, do not have commercial value. Moreover, the Red Book of Kazakhstan contains only the ship population of the Sea of Aral, considered to be extinct, and not the Caspian population.

While the compilers of the national Red Books might not be very familiar with the regional situation, local academia and fishery management should be aware of the stock status. The regional Red Book of the Orenburg Oblast, where all sturgeons (except sterlet) mostly disappeared in the 1990s, was compiled by local academia at the end of the 1990s (ORB 1998). According to this book, only two species are protected: Ship and Sterlet. It literally replicates the National Red Book in terms of sturgeon species. None of the formerly commercially valuable fish was included (Uralbas 2007b).

Furthermore, from the beginning of the 1960s until 1994 a ban on ship catch in the Ural river was imposed (KaspNIRH 1999). Surprisingly, though ship has been protected in a number of ways its commercial fishing continued. Official statistics on its commercial catch exist from 1978 (CEP 2002a, b; KamUralRybVod 2007; RK 2002, 2003). Moreover, in the 1990s the catch of the ship exceeded the catch of the Russian Sturgeon in the Ural. On top of that it should be mentioned that Kazakhstan was actively utilizing export quotas obtained from CITES on the Ural ship caviar and meat trade during 2001–2003.

The national and international efforts to limit or suspend sturgeon fishing faced active opposition from the Russian Fishery Authorities, CITES and Fishery Institutes. For example, the demand to impose a total ban on sturgeon fishing to secure population rehabilitation was formulated and announced by one of the authors in the mid 1990s on the highest national legislative level, in particular Hearings in Russian State Duma on the status and reasons for decline in Azov Sea sturgeon stock (AzovBas 2002; Russian State Duma 1995). Despite strong support by environmental experts, these efforts were not successful. In 2002 the US Fish and Wildlife Service proposed to enlist beluga as an endangered species under the US Endangered Species Act. The proposal could result in an outright ban on beluga caviar import to the world's biggest caviar consumer, US, which would decrease pressure on sturgeon populations. However, this initiative was opposed by the Caspian Fisheries Research Institute (KaspNIRH), claiming increasing status of Caspian beluga. The papers were signed by the Directors of KaspNIRH and the CITES deputy secretary general.

Unfortunately, the current total Russian ban on caviar production from 2007 does not have any affect on the Ural stock, since there is no commercial sturgeon fishing in the Ural river within Russian territory. In any case, the Russian ban on sturgeon caviar does not seem to be effective tool in sturgeon restoration either. 2–3 t of the caviar will be allowed to be produced for fishing farms, which will be permitted to do scientific and productive catch for their needs.[20]

[20] The possible amounts of the scientific catch were discussed above.

CITES, quotas and caviar business

Caviar, or Black Gold, is one of the most expensive products on a weight basis on the world commodity markets (CEP 2002a). The most valuable and expensive caviar is derived from beluga roe.[21] Other important species used for caviar production are Russian sturgeon, sevryuga and Persian sturgeon. The price increase from the region where it is produced to the consumers is more than 100 times.

The collapse of the Soviet Union, followed by the appearance of the Newly Independent States competing for the natural reserves of the former USSR caused uncontrolled and unregulated over-exploitation of fish stocks in international waters. With the caviar industry in the Caspian Sea facing possible collapse, connoisseurs turned to Northern American caviar. But North American fisheries alone cannot supply global demand (TRAFFIC 2003).

The global caviar trade is dominated by just a few nations. In 1998 about 99% of the supply came from seven countries, with more than 90% originating from the four sturgeons species in the Caspian Sea basin: beluga, sevryuga, Russian and Persian sturgeons (Pitikch et al. 2005). Almost 100% of the caviar was imported into 12 countries, with 95% going to the European Union (EU), Japan, Switzerland and the USA. (Raymakers and Hoover 2002; WWF 2002a). In 2000 the US alone imported about 15 t of beluga caviar only, Germany 1.8 t, Switzerland 1.2 t, and France 0.9 t (Speer et al. 2000). The statistical data reveals the obvious trend: the US import of caviar is constantly increasing, sometimes doubling every two years (!), and constitutes up to 60% of total world caviar imports (Speer et al. 2000). It should be mentioned that taking into account the internal caviar production at fish-farms in USA or Germany, the size of imports might not reflect the consumption adequately. However, it is widely acknowledged that demand in major caviar-consuming countries is far greater than the caviar supply which can be provided by the newly established commercial aquaculture industry (Williamson 2003).

However, in 2006, after numerous attempts, the import of beluga caviar was banned in the USA. According to TRAFFIC, in 2007 the EU became the biggest consumer of caviar with 591 t imported per annum compared to 300 t per annum by USA (TRAFFIC 2007b). Unfortunately, this ban concerns only beluga-originated caviar, while all other kinds of caviar can be freely imported.

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[21] According to other estimations the caviar derived of the Persian sturgeon eggs are the most expensive (Pitikch et al. 2005).

Decreases in caviar supply and corresponding price increases in the 1990s made the worldwide caviar market more financially attractive than ever. To establish the rules of the trade in 1997 all commercially utilized sturgeon species worldwide were listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) by the World Conservation Union [International Union for the Conservation of Nature (IUCN)]. Despite the catastrophic condition of sturgeon populations sturgeons were and still are listed on Annex II of Convention as a species "currently not necessarily threatened with extinction, but which may become so unless trade is closely controlled" (CITES 2004a).

In reality, the "close control" employed within the framework of CITES does not work towards sturgeon population rehabilitation. Failures in CITES efforts to facilitate sturgeon stock restoration are well known (Crownover 2004a, b; Pikitch and Lauck 2002).

For instance, before Kazakhstan became a party to CITES in 2000 trends in world export quotas revealed a 33% decrease in expected levels of exports for caviar from 1998 to 2001 and a 775% (!) increase of sturgeon meat from 1999 to 2001 (Raymakers and Hoover 2002). These trends are difficult to interpret as compatible with preserving sturgeon populations.

Quotas are calculated depending on a country's contribution to the preservation of the sturgeon stock. So, the approval for the high export quota for former Soviet Union countries in 2003 was based on the fact that these countries proclaimed "a new approach that gives them an economic incentive to reduce poaching, the main cause of a 90 percent decline in stocks of sturgeon over the past few decades" (Pala 2004a). Disregarding the dubious official claim that poaching is the main reason for the sturgeon's decline, the positive role of the hypothetical new approach should at least be proven before granting export quotas if species preservation is the final target.

Having the only natural spawning grounds in the Caspian Basin, Kazakhstan plays the primary role in the natural sturgeon's restoration. However, unlike other regional caviar exporters, it did not have sturgeon hatcheries before 1998. The release of hatchery – reared sturgeon fingerlings is considered to be a substantial contribution to the Caspian sturgeon's restoration and has been awarded by higher export quotas. The Kazakhstan export quotas under CITES for 2001–2007 are presented in Table 5. For most of the years it is explicitly stated that sturgeons for the export should originate from the Ural stock.

Table 5. Ural sturgeon caviar and meat quotas for Kazakhstan under CITES[22] (CITES 2007)

Species	Products	2001	2002	2003	2004	2005	2006	2007
		(in tons)						
	Catch	49.6	47.9	54				
Beluga	Meat	24.8	23.95	27	52.1	27		21.9
	Caviar	3.6	5.616	4.62	2.36	2.555		1.7
	Catch	37.4	41.9	38.5				
Russian sturgeon	Meat	16.5	21.5	19.25	30.35	20		20.25
	Caviar	2.8	4.2	3.41	3.204	2.969		3.07
	Catch	161.5	144.9	121.81				
Stellate	Meat	80.75	70.38	60.545	109.27	73		48.1
	Caviar	18.41	14.5	15.15	11.01	9		8.5
	Catch	26.5	3	3				
Ship	Meat	13.25						
	Caviar	2.1						
	Catch	275	237.7	217.31				
Total	Meat	135.3	115.83	106.795	191.72	120		90.25
	Caviar	26.91	24.316	23.18	16.574	14.524		15.668

In 2006 the CITES deprived Russia, Iran, Turkmenistan, Azerbaijan and Kazakhstan of their quotas for export of sturgeons and black caviar, since the countries did not provide enough information on sturgeon population condition.

However, in 2007 CITES lifted the ban on beluga caviar export. The way these countries could prove good sturgeon population status in order to lift the ban is not clear. This decision shocked environmental experts and agencies, such as TRAFFIC and WWF (TRAFFIC 2007a). These organizations believe that the re-introduced caviar export quotas are not based on catch quotas and do not have scientific and legal basis. For instance, export quotas for Russian sturgeon from Russia were increased from 14 t in 2005 to 20 t in 2007 while the catch for this species decreased from 230 t in 2005 to 11 t in 2007.

The same situation occurred with Kazakhstan export quotas. A comparison between export quotas on sturgeon meat and caviar for 2001 and 2007 (excluding amounts allocated for Turkmenistan) shows that the changes are insignificant, which presumably should indicate a stable population situation. So, in 2001 and 2007 the export quota on Beluga meat was 24.8 and 21.9 t respectively. The export quotas for Russian Sturgeon meat and caviar have even increased: from 16.5 and 2.8 t in 2001 to 20.25 and 2.07 t in 2007 respectively.

[22] The quotas allocated to Turkmenistan as well as unutilized quotas from previous years were deducted from Kazakhstan quotas.

Figure 20 shows the dynamics of the Kazakhstan export quotas under CITES for beluga caviar. As is known, maximum production of the caviar from beluga or any other sturgeon species cannot be more then 10% of the female weight. Currently, this ratio is much lower due to the high proportion of young and pre-mature beluga females in the catch. Taking into account that female share in Ural beluga catch is equal to only 20–25% (CEP 2002a; KaspNIRH 1999) the caviar proportion in CITES export quotas is eight times higher then the amount corresponding to the sturgeon meat export quota. For other species the caviar production per fish is even lower then 10% (Figure 21 and Figure 22).

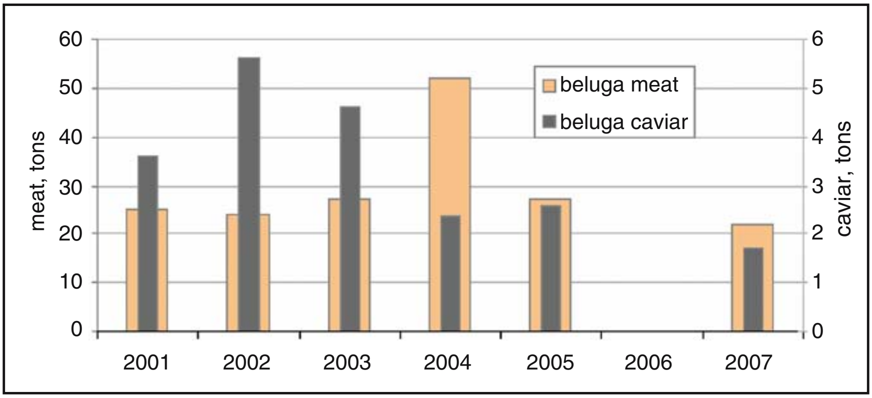

Figure 20. Meat and caviar export quotas under CITES for Ural-originated beluga

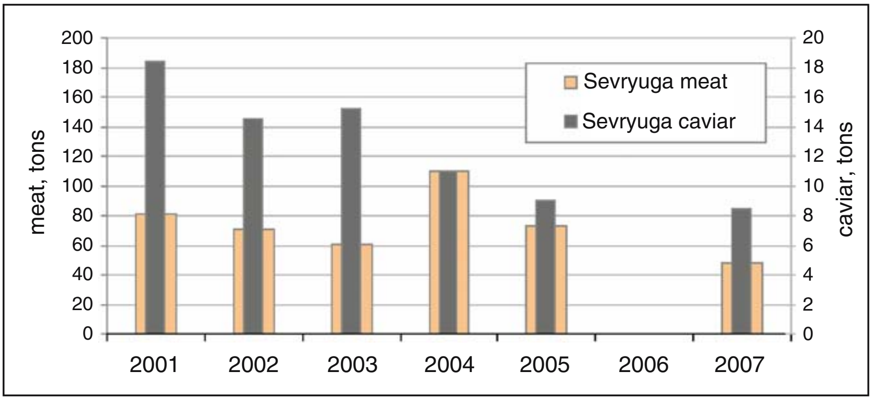

Figure 21. Meat and caviar export quotas under CITES for Ural-originated Sevryuga

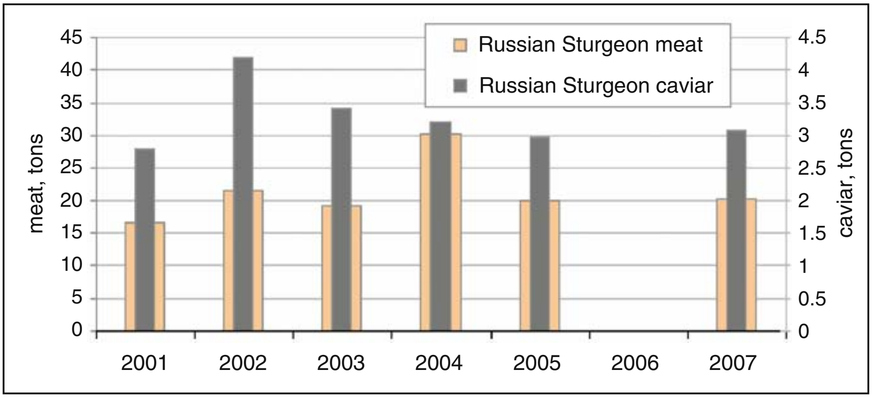

Figure 22. Meat and caviar export quotas under CITES for Ural-originated Russian sturgeon

Though having some regulatory effect on the international caviar trade, the work of National CITES Management Authorities for sturgeon in both Russia and Kazakhstan has been actively criticized. In particular, the management authorities are overstating their contribution to sturgeon restoration (i.e. fingerlings release), hiding the real catch as well as overestimating Caspian sturgeon stock (CITES 2004b; Kirby 2002; Pala 2004b; TRAFFIC 2007a; Uralbas 2007b). In this way the higher fishing and export quotas can be obtained providing a legal background for species extermination.

Finally, within the framework of CITES there are also some attempts to implement a standard labeling system for caviar exports, which to date is still not operational (TRAFFIC 2007a).

Summing up, the role of CITES in sturgeon population conservation and restoration is dubious. Nevertheless, the national export quotas have been assigned by the CITES Secretariat based on Parties' own estimations of stock populations and quota requests. The CITES secretariat only approves the export amounts demanded by Parties. Consequently, the national authorities should be considered the primary source for unreasonably high export levels.

On the other hand, the national fishing quotas, the basis for export quota calculations, are distributed by the Commission on the Biological Resources of Caspian Littoral States according to the country contribution to sturgeon stock replenishing. The hatchery-based sturgeon restocking is mainly counted as such a contribution. Despite the unique opportunities for natural restoration in the Ural river Kazakhstan‘s fishing quota based on the recently opened sturgeon hatcheries in Atyrau is only 18% of total f.USSR Caspian catch. Correspondingly, the existing quota distribution system prioritizes artificial over natural reproduction and complicates the restoration and conservation of natural spawning habitats.

As a result the quota system is considered to be a rather inefficient tool in sturgeon population conservation and restoration (CEP 2002a; ENS 2007; Uralbas 2007a). From this point of view one of the most common recommendations for sturgeon restoration suggesting "better calculation of national fishing quotas reflecting the real contribution of a particular state to overall sturgeon stocks" (Luk'yanenko et al. 1999) does not seem likely to contribute to sturgeon population sustainability.

Hatchery-based restocking

In order to maintain and restore the diminishing sturgeon's wild stock, intensive hatchery sturgeon production has been used since the mid-1950s (Secor et al. 2000).

Actually, the first trial on artificial sturgeon propagation started in the Volga basin in Russia at the beginning of the 20th century (Secor et al. 2000). However, this phenomenon began on a massive scale only after sturgeon hatcheries were put into operation starting from the 1950s. Thirteen hatcheries were constructed in the Caspian Basin during the Soviet period. Millions of fingerlings were released annually. In the 1980s the release rate was up to 101 millions fingerlings per year (Ivanov 2000). Even nowadays Caspian sturgeon propagation is the world's largest restocking program.

The primary goal for the introduction of artificial breeding and propagation was to support commercial fishery. These activities were carried out in accordance with the prevailing doctrine on converting the Caspian Sea into a fish pond for sturgeons. Numerous theoretical investigations and calculations were carried out to implement this strategy by fishery institutes. The shift of fishing efforts from the feeding grounds in the sea to the naturally spawning populations in the rivers in 1962 also indicates the priority of commercial sturgeon fattening and harvesting over natural reproduction.

There are some claims of an increase of the proportion of hatchery-reared sturgeons in total catch recently. By some estimations of KaspNIRH the share of artificially produced sturgeons in the catches is only 20–25% (KaspNIRH 1999). This is a very unexpected result taking into account the long history of juveniles release by numerous hatcheries. In fact, other estimations provide different shares of hatchery-based sturgeons in commercial catch. In 1997 the beluga, sturgeon and sevryuga had shares of

99.50% and 40% respectively (Khodorevskaya et al. 1997).[23] Unfortunately, the identification and counting methodology of hatcheries-originated sturgeons usually is not well described. No proper tagging system has been introduced even now, not mentioning 20 years ago when the currently caught sturgeons were released.

In this situation it is important to understand how these estimations were obtained. They are the results of mathematical calculations based upon the simple assumption that, after the Volga river's damming in 1958 cut off 100% of the beluga spawning grounds, all new generations of beluga are hatchery-originated (KaspNIRH 1999). The same approach was used for estimating Russian sturgeon and sevryuga stocks taking into account that some spawning grounds downstream of the Volgograd dam for each particular species are still available. Starting from this assumption a particular hypothetical sturgeon stock is calculated and used for deriving hatchery-reared shares as well as estimating poaching activities (11–12 times higher than official catch).

As a matter of fact, the yield to fishery from the millions of juveniles released starting from 1950s was supposed to be tens of thousands tons. The peak of release was observed in the mid 1980s: more then 100 millions were released annually. The sturgeons released in the 1980s should have reached their commercial age and size by the end of 1990s, yet the total sturgeon catch since the end of the 1990s is miserable (several hundred tons in Volga and 100 t in Ural for 2007 in comparison to 20 thousand tons in the 1970s–1980s). The impact from poaching is insignificant since these specimens could not reach maturity and commercial size until the end of the 1990s. According to the calculations, the yield of fishery in this period should have been tens of thousands. Poachers had to dump their catch to the markets. However, even on the black market the price of sturgeon products went up dramatically. Sturgeon products can hardly be found even on the internal market in the Caspian region.

On the one hand there is an increase in the virtual shares of hatchery-reared sturgeons in total sturgeon population, on the other the sturgeon fishing industry has collapsed due to the tremendous decline in sturgeon stock. Coupling these two facts challenges the efficiency of the hatchery-based re-stocking programs.

Though artificially reproduced sturgeon can to some extent be a substitute for the natural one in terms of gourmets' tables, the ability of these sturgeons to sustain a wild population is doubted by many researchers (Craig 2000; Lagutov 1995).

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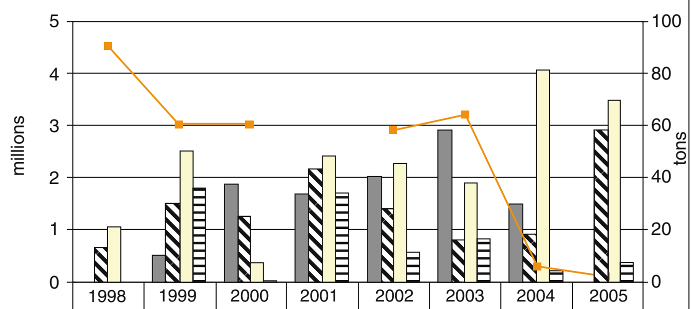
[23] It should be noted that this statement is coupled with beliefs that the sturgeon stock in 1990s is abundant due to the ban on open-sea fishery in 1962 and massive hatchery-based restocking program (Khodorevskaya et al. 1997).

Due to the free-flowing nature of its stream and preserved spawning grounds the hatcheries were not constructed in the Ural river basin until the sturgeon catch had collapsed in the region in the 1990s. In Kazakhstan first two sturgeon hatcheries, Ural-Atyrau and Atyrau hatcheries, were put into operation in 1998 in Guriev (Atyrau) in the Ural river delta (CITES 2001).

Figure 23 shows the fingerlings release by two Atyrau hatcheries to the Ural river. Significant variations in fingerlings release can be observed, which can be explained by various reasons. However, the superimposing of beluga catch in the Ural river basin over the release graph suggests the dependence of the beluga release on the catch. As it is known, artificial sturgeon propagation depends on the wild stock. The spawners (both males and females) are taken from the migrating population and bred in captivity. In other words beluga catch in the region was not high enough even to secure re-stocking. However, as follows from the previous chapter the Kazakhstan quota on beluga caviar export under CITES in 2005, characterized by a lack of beluga juveniles release, was 2.5 t (CITES 2007). Instead of using caught fish for restocking, roe was exported in full accordance with the provisions and quotas of the Convention on International Trade of Endangered Species, created to prevent such an export.

To summarize, the collapse in natural sturgeon reproduction put an end to hatchery-based stocking programs.

Though it might be too early to evaluate the efficiency of hatchery-based sturgeon restocking carried out in the Ural basin, the general trends and shortcomings of this process are identical to the sturgeon restoration



	1998	1999	2000	2001	2002	2003	2004	2005
Beluga		0.516	1.86	1.684	2.016	2.9183	1.4877	
Russian sturgeon	0.653	1.493	1.265	2.156	1.3938	0.8166	0.9064	2.9153
Sevryuga	1.066	2.518	0.375	2.419	2.2663	1.8962	4.0606	3.4727
Ship		1.822	0.028	1.721	0.5722	0.8288	0.2531	0.374
Ural Beluga catch, tons	90	60	60		58	64	6	2

Figure 23. The release of sturgeon fingerlings to the Ural river by two Atyrau hatcheries (CEP 2006)

problems throughout the former USSR countries. Moreover, these inherent problems are further complicated by other contemporary issues (i.e. trans-boundary sturgeon migrations, lack of producers, etc.). The various possible obstacles to the success of Ural sturgeon restoration are speculated on below.

Homing fidelity

There are some theories suggesting that sturgeons released from the hatcheries in the river deltas do not contribute to the wild sturgeon population's sustainability (Lagutov 1995). It is argued that hatchery-originated specimens, if they survive till reproductive age at all, do not have homing fidelity. Homing is needed not only to find the natal river but also to arrive at a particular spawning site at the proper time. The ability of the hatched specimens to do so is not proven. Homing fidelity for the Caspian sturgeons was demonstrated by different researchers (Ivanov et al. 2005). Thus, the above mentioned threat exists and should be carefully evaluated before drafting any restoration strategies. The influence of this factor increases many-fold upon consideration of fingerlings release technology. The fingerlings were deliberately delivered to "pastures" located in the brackish sea waters in the Northern Caspian by special boats (KaspNIRH 1999). In fact, this technology was employed during most of the hatcheries operation years. Only in the 1990s was this policy cancelled due to the lack of state financial support. If the believers in the inherent Caspian sturgeon homing fidelity are right these sturgeons have difficulties in returning to the rivers for spawning.

Rearing technologies

There are three main rearing and fingerlings release technologies utilized by hatcheries (Abdolhay 2004). Correspondingly, there are different associated official mortality rates for the fingerlings. Some technologies employ fingerlings rearing in ponds for 40–60 days before the release with due feeding and fertilizing (Abdolhay 2004). However, the approach utilized by Volga hatcheries was different with much lower survival rates (KaspNIRH 1999). Since the beginning of the restocking program in the 1950s the peculiarities and efficiency of the technological process was constantly changing in Soviet, then Russian and Kazakhstan, hatcheries due to technological improvements, lack of funding, equipment deterioration, lack of producers, etc. Apart from the release numbers the larvae survival rates should also be constantly fluctuating.

According to some sources (Kirby 2002) the Kazakhstan hatcheries release fingerlings when they are two months old and about 10 cm long. These statements contradict well established sturgeon rearing technology used in the USSR for a long time, when fingerlings were released with a weight of 2–3 g and 6–7 cm long, depending on species. According to this technology hatching is conducted without feeding (CITES 2004b, KaspNIRH 1999), while two month old fingerlings are feeding actively.

The release of fingerlings from two Atyrau hatcheries for 2002–2005 according to the Ministry of Environmental Protection of the Republic of Kazakhstan are presented in Table 6 (CEP 2006). Significant fluctuations in the weight of the released fingerlings can be spotted. The weight of beluga fingerlings varies from 12 to 3.5 g within four years. This irregularity suggests drastic changes in technological process and undermines the calculations of fingerlings survival and return rates to fishery. Total annual fingerlings release shows a steady increase and, presumably, indicates active actions towards sturgeon stock rehabilitation, while species composition analysis suggests significant problems of the artificial sturgeon propagation in the Ural river. The overall increase is secured at the cost of two species (Russian Sturgeon and Sevryuga), while hatching of others has been discontinued (Beluga and Ship). This consideration suggests the remaining two species are exposed to increasing fishing pressure for captive breeding.

Sea salinity

Next, as was discussed above, sturgeon fingerlings are very sensitive to sea salinity levels. High salinity is lethal for sturgeon fries. Historically, sturgeon juveniles stayed in the river freshwaters after hatching for up to three months and by entering brackish salted water had average weight of 171 g and length of 36 cm. According to the CITES report nowadays fingerlings are released into the sea brackish waters with a weight of only 2–5 g (CITES 2004b). Apparently, taking into account the evolutionary developed mechanisms for sturgeon life cycle stages, these embryos are exposed to high mortality rates to say the least.

With regards to later practice of fingerlings release into the river stream the same line of reasoning can be applied. Hatcheries are usually located in the rivers' deltas or close to them upstream. Nevertheless, according to the official statements by Caspian Fisheries Research Institute (KaspNIRH 1999) up to 70% of released larvae has perished already on the way to the sea.

Both Kazakhstan sturgeon hatcheries are located at the city of Atyrau (Guriev) in the river delta. The increase of the salinity in the estuary areas adjacent to the Ural river delta observed in recent decades could cause even higher mortality rates among the released fingerlings.

Table 6. Release of sturgeon fingerlings from two Atyrau hatcheries. AH stands for Atyrau Hatchery, while UAH is Ural Atyrau hatchery (CEP 2006)

Species	2002				2003				2004				2005			
	AH		UAH		AH		UAH		AH		UAH		AH		UAH	
	Release (thousand individuals)	Weight (g)	Release (thousand individuals)	Weight (g)	Release (thousand individuals)	Weight (g)	Release (thousand individuals)	Weight (g)	Release (thousand individuals)	Weight (g)	Release (thousand individuals)	Weight (g)	Release (thousand individuals)	Weight (g)	Release (thousand individuals)	Weight (g)
Beluga	1002.7	8.6	1013.3	12.0	1728.6	7.3	1189.7	4.1	932.0	4.1	555.7	3.5	–	–	–	–
Russian sturgeon	987.8	2.3	406.0	2.6	341.7	3.7	474.9	3.0	507.8	3.5	398.6	3.1	1762.3	3.4	1153.0	3.2
Ship	–	–	572.2	3.7	828.8	4.1	–	–	253.1	3.3	–	–	374.0	3.1	–	–
Sevryuga	1090.3	1.6	1176.0	3.5	297.5	3.2	1598.7	2.8	1748.6	3.5	2312.0	2.7	1245.7	3.3	2227.0	2.8
Sterlet	20.1	0.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Subtotal	3101.0	–	3167.5	–	3196.6	–	3263.3	–	3441.5	–	3266.3	–	3382.0	–	3380.0	–
Total	6268.5				6459.9				6707.8				6762.0			

In this way the assumptions of the high efficiency of existing artificial stock rehabilitation and the high proportion of hatchery-originated sturgeon in river catches are severely undermined.

The survival rates for the released juveniles should be reconsidered and carefully estimated by independent experts.

Lack of "producers"

Starting from the beginning of this century the substantial decrease in release of sturgeon juveniles from hatcheries in the Caspian region was reported (Uralbas 2007b; ZapKaspRybVod 2008). Moreover, the quantity of producers (female beluga) was considered to be insufficient to support hatchery production efforts already in 1995 in the Volga River delta (Birstein et al. 1997). This statement on the decline in juveniles release from the mid 1990s was also confirmed during personal communication with hatchery managers. As the primary reason for the decline managers indicated the lack of "producers", wild sturgeons used for breeding. The number of spawners in the river is not sufficient for the hatcheries functioning. This can only be explained by the fact that only naturally reproduced sturgeons are returning to the rivers for spawning.

This is an amazing result considering all the proclaimed success of beluga hatchery rearing. It also presents an interesting point in the entire theory of hatchery-based restocking. If the sturgeon numbers in the sea are abundant as is stated by KaspNIRH (KaspNIRH 1999) and the Russian Management of CITES (CITES 2004b) the logical question is why there are no producers in the rivers. There are only two possible answers:

- The sturgeon stock is depleted and the efficiency of the present-day artificial restocking is miserable at least or a big scale fraud at most; in this case chronic deficit of spawners in the rivers even during high water years indicates population extinction or
- Sturgeons living in the sea cannot return to the rivers due to the lack of homing fidelity or some other reason. Whatever that reason is it jeopardizes not only the sturgeon population's natural reproduction, but also artificial restocking programs.

Both answers urge a review of the current restocking programs and suggest hatchery based restocking should be avoided until the reasons for its failure are clarified and dealt with.

Changes in reproductive behavior

Sturgeon reactions to *stress* and, in particular, the influence of stress on sturgeon reproduction are one of the main practical problems in fish management in general and aquaculture in particular. However, little is known of sturgeon physiological response to stress (Bayunova et al. 2002). Most researchers nowadays agree that general management practices (capture, handling, transportation) negatively affect sturgeon reproduction (Bayunova et al. 2002; Williot et al. 2002b). At the same the time long-term consequences of stress during artificial reproduction are not yet properly studied. Results of some research challenge the ability of artificially reproduced sturgeons to reproduce successfully in the wild (Lagutov 1995, 1997; Secor et al. 2000).

Genetic problems

As a result of some studies *genetic fitness* and impact of the hatchery-reared on the wild sturgeon population is argued as well (Aprahamian et al. 2003; Ludwig 2006). In fact, analysis of the caviar composition from aquaculture shows significant variation from that of wild origin already within the first generation (Gessner et al. 2002). Hatchery-based sturgeon re-stocking is also endangered by genetic risks of interstock transfer and inbreeding depression (Firehammer and Scarnecchia 2007; Grunwald et al. 2007; Waldman et al. 2002). Due to the lack of spawners, producers from different populations are often used, which results in mutations (Arndt et al. 2002; Brown 2002; Kirby 2002).

These considerations question the hatchery efficiency for the rehabilitation of wild sturgeon populations. There are definitely certain risks associated with restocking and all restoration programs should undergo risk screening in order to minimize negative impact on ecosystems and wild populations.

The problems with artificial propagation of anadromous migratory fish were also approached by many authors (Altukhov and Evsyukov 2001; Aprahamian et al. 2003; Arndt et al. 2002; Bachmann 2000; Belanger et al. 2001; Brown and Day 2002; Chebanov and Galich 2002; Jonsson et al. 1991; Jonsson et al. 1999; Schreck et al. 2001; TRAFFIC 2003; Williamson 2003). There is a clear trend on growing scientific concern over the negative influence of fish farming and restocking on natural populations.

Nevertheless, the representatives of sturgeon hatcheries and affiliated institutions demand an increase in juveniles release from hatcheries up to 100–110 million individuals (KaspNIRH 1999). For comparison, in 2007 the plan on juveniles release from six Russian hatcheries was only 23 million, which was already impossible to fulfill (ZapKaspRybVod 2008). Apart from the lack of spawners the aging equipment aging and insufficient financial support are indicated as the reasons for this failure.

Despite the dubious character of hatcheries' influence on sturgeon populations and catch the multi-million release of fingerlings is still a very profitable business. The sturgeon fishing quotas in the Caspian Sea are defined according to the contribution each state makes to replenishing stocks (i.e. number of fingerlings release). Currently the quota of Russia is 70% of the total Caspian catch, while Kazakhstan's is only 18% (ENS 2007).

The short-term profit from hatcheries opening is obvious – the higher the announced release the bigger the quota. In reality, the announced figures often proved to be overstated in order to demand higher fishing quotas (Uralbas 2007a).

Despite all these problems, artificial sturgeon propagation might play a positive role in Ural sturgeon rehabilitation, if certain conditions are met.

First of all, hatcheries should be placed next to the historical spawning ground to minimize possible problems with homing fidelity and negative influence by sea salinity. Indeed, artificial propagation will not lead to recovery and sustainability of the sturgeon population unless the fundamental problems that caused the population declines are properly addressed.

Second, the commercial sturgeon propagation can satisfy the needs of the market to decrease the pressure on the wild stock. However, in this case the Caspian sea should not be used as a "pasture" for the fattening of sturgeons, to avoid disturbance to natural population (Lagutov 1995). There are certain risks and limitations associated with this role of artificial propagation (lack of producers), which should be addressed accordingly.

In conclusion, the following statement from KaspNIRH should be quoted (KaspNIRH 1999):

> Multiyear research conducted by KaspNIRH and other institutes showed that sturgeon population restoration using artificial propagation is not possible without conservation and restoration of natural sturgeon reproduction.

As a matter of fact, this statement acknowledges the failure of the previous fishery management strategies and misleading role of scientific recommendations of fishery institutions aimed at securing artificial sturgeon fattening and harvesting in sea pastures and extermination of the natural spawning population in the river basins.

Unfortunately, this official recognition of basic ecological concepts comes too late since it might already be impossible to restore Caspian sturgeon populations from the consequences of the previous management paradigm. What is much more important is that this discovery still contradicts the practical steps on sturgeon stock rehabilitation suggested in this document, submitted in the framework of the Caspian Environmental Program. The euphoria over the 99% population share of hatchery-originated beluga also obscures the necessity to maintain natural reproduction to secure artificial reproduction.

Priority of natural sturgeon reproduction for the Ural river

The positive contribution of the existing approach to the hatchery-based sturgeon restocking program is questioned. Extensive independent research is needed to confirm its usability and efficiency. Before its efficiency or harmless nature is confirmed primary efforts in sturgeon conservation and, if any, rehabilitation should be made to secure the sturgeon's natural reproduction (AzovBas 2002; Russian State Duma 1995; Lagutov 1995, 1996, 1997).

Artificial propagation and release might only be an auxiliary short-term tool for stock replenishment which should be used with due care and reservations (Birstein et al. 1997). Millions of juveniles released from the hatcheries might prolongate commercial fishing for a short period but they cannot sustain a population. Hatchery production is only one, not the primary, of many strategies required to protect and increase the levels of natural reproduction. The primary strategy towards sturgeon stock consumption should be to restore, maintain and secure its natural restoration mechanisms, created over hundreds of millions years of evolutionary development. Only in this case the sturgeon population, and its consumption upon full rehabilitation, if any, can be sustainable.

From this perspective the Ural river provides a unique opportunity to preserve the sturgeon gene pool and to restore the sturgeons through the entire Caspian basin. As indicated above, the Ural river contained the natural spawning habitats for every sturgeon species historically inhabiting the Caspian Sea. Though slowly decreasing in size due to habitat degradation, climate change and anthropogenic activities (i.e. dredging for navigation and sand-gravel extraction), the habitats supporting all sturgeon life cycles are still available throughout the entire historical species areal in the Ural river (Dmitriev and Vasilenko 2007; KamUralRybVod 2007). Currently they are underutilized, if utilized at all, for reproduction due to lack of producers. All possible measures should be employed to secure spawners' arrival to spawning grounds and their successful spawning. The priority of natural sturgeon reproduction in the region leads to the necessity to prioritize sturgeon conservation needs over other participants of the integrated water management process.

To promote the idea of preservation of the Ural sturgeon habitats and to facilitate international transboundary activities to secure natural sturgeon reproduction the Ural Basin Sturgeon Project, aiming at the Ural sturgeon's conservation and rehabilitation, was initiated by Central European University, the environmental NGO "DonEco", and a number of federal environmental agencies. The First International Ural Basin Workshop was conducted in Orenburg, Russia, in June 2007. The participants, including international and national experts, decision-makers and local community representatives, developed a set of recommendations[24] on Ural sturgeon restoration. The main recommendation was the establishment of a protected area along the Ural River stream (a so-called International Transboundary Ural Sturgeon Park) with a high level of local population and international community involvement.

Conclusions and recommendations

The sturgeon species in the Caspian basin nowadays have not only lost their former economic value, but also literally are on the brink of extinction.

Despite the high level of attention by international and national communities to the Caspian region, basin-wide regular biodiversity assessments in general and sturgeon-related aspects in particular have not been undertaken. Generally the sparse data on sturgeon abundance, catch and life characteristics are contradictory, flawed or biased. There are some attempts to create Caspian wide databases on Caspian biodiversity (CEP 2002b), but their usability is undermined by the lack of reliable information on a river-basin scale as well as biased and contradictory sources of information. Most of the available data is a compilation of the outdated results of field research or observations conducted in the 1930s–1970s. In addition, the Ural river basin was excluded from the few contemporary study projects. The results of the modern sturgeon population stock estimates by national fishery-affiliated agencies and institutions are significantly undermined by deliberate or unintended distortions and are doubted by international expert communities.

Though conservation and restoration of sturgeon stock is proclaimed as a priority target in national strategic action plans in Caspian littoral countries, the specific activities and policies in the region aim rather at short-term consumption of the resource until its total extinction.

Fishery management strategies and existing sturgeon stock restoration schemes have proved to be ineffective to say the least. Fishery-centric approaches to optimizing sustainable maximum yield are not adequate for the conservation and restoration of the sturgeon populations. The attempts to squeeze as much as possible from diminishing sturgeon stock (i.e. the current approach to CITES quotas) would result in its total degradation and extinction.

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[24] The recommendations and resolution of the First Ural River Basin Workshop can be found in this volume.

At the moment, Ural sturgeon stocks are following the Caspian-wide trend. Fish population analysis, which is exposed to high level of uncertainty by default, is complicated by the above mentioned factors. However, it is obvious that the Ural sturgeon populations have been brought to the verge of extinction during the last few decades solely due to state (USSR and later Kazakhstan) regulated and organized overfishing, including commercial, illegal, scientific and productive catches. Unlike in other regions, poaching played a minor role in the stock decrease in comparison to other factors. All additional factors crucial for other regions, such as river regulation, or spawning grounds' loss did not a play significant role in the Ural sturgeon stock's depletion.

The sturgeon population in the Caspian Sea basin can be sustainable only in the case of preservation and restoration of natural sturgeon. The only remaining sturgeon spawning grounds for all Caspian sturgeon species are in the Ural River. Thus, the Ural River should become the center for Caspian-wide sturgeon conservation and rehabilitation programs.

The role of hatchery-reared restocking in wild sturgeon population restoration is dubious. With regards to the Ural basin with natural habitats available and unobstructed migration routes, the only place for hatcheries, if any, should be close to the historical spawning grounds. This requirement implies relocation of existing sturgeon hatcheries upstream the Ural river.

Since the historic Ural sturgeon areal spread runs through the territory of Russia and Kazakhstan only joint transboundary measures to preserve this unique ecosystem and its sturgeon population will be productive and meaningful.

Considering the Ural spawning grounds' underexploitation the very first and urgent step towards sturgeon population rescue should be to secure breeders' access upstream by imposing a ban on any kind of river sturgeon fishing (including scientific) and enforcing its implementation with a high degree of international involvement.

The cross-disciplinary multi-sectoral basin-wide approach should be utilized. The issue of sturgeon preservation goes far beyond fisheries management plans. Instead, the sturgeon populations should be considered as an indicator of sustainability in a basin-wide regional development strategy. All involved stakeholders and aspects of anthropogenic influence on the sturgeon population and riverine ecosystem should be taken into account. Being a perfect environmental bioindicator of the basin ecosystem conditions, sturgeon also allows environmental, social and economic aspects of regional sustainable development to be brought together.

In particular, water usage and land use patterns in the Ural watershed, especially in floodplain areas, should be closely monitored and regulated.

Though requiring some improvements, the national and international legislative basis for these activities already exists. However, closer attention to the enforcement of the existing national laws is required.

Considering the high economic and environmental importance of the sturgeon species and traditional biased estimates and study results by national sturgeon authorities this process should be closely monitored by the international community.

At the same time a high level of cooperation from local communities is required. In the case of the Ural river basin this can be easily achieved through the involvement of the reviving Cossack communities.

Faced with a lack of reliable information on sturgeon migrations and life cycle characteristics, regular independent monitoring utilizing modern equipment (i.e. using satellite tagging, satellite images analysis, GIS, modeling, etc.) is urgently required.

If the Ural sturgeon stock restoration is successful fishing efforts should be focused only on repeatedly spawning sturgeons, but the ban on catching first time spawners should remain.

The long-term economic benefits of restocking sturgeons can significantly outweigh the initial costs. Upon stock rehabilitation the Ural sturgeon can also serve as a gene pool for sturgeon restocking programs and aquaculture production in other regions.

To secure natural sturgeon reproduction it is recommended that an International Transboundary Ural Sturgeon Park should be established along the sturgeon migratory routes throughout the historic range of sturgeon areal in the Ural basin.

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