Chapter 43
Re-establishing the Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus* Mitchill) in Poland

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Abstract The objective of this chapter is to present the aquaculture-based restitution program for Atlantic sturgeon *Acipenser oxyrinchus* Mitchill in Poland. Broodstock development using *A. oxyrinchus* population from St. John River (Canada) is currently under way. The juvenile sturgeon obtained from eggs imported from Canada was reared in recirculating aquaculture system (RAS). Currently, there are two rearing facilities in Poland where selected fish from 1998 and 2001–2010 are held. To examine the feasibility of the reestablishing program, 63,660 hatchery-produced juveniles were released to the historical sturgeon rivers in the Vistula and Oder drainages. Radio-telemetry studies of 0+ and 1+ sturgeon were conducted in the Drwęca River between 2007 and 2009. Sturgeon moved downstream during the night, and no schooling behavior was noted. The mean swimming speed was 1.18 km h^{-1} (0.73 BL s^{-1}), while the maximum was 8.73 km h^{-1} (9.51 BL s^{-1}). Sturgeon preferred deep holes in the river bed for prolongated stationary phases during the daytime.

43.1 Introduction

The Atlantic sturgeon, *Acipenser oxyrinchus* Mitchill was only one diadromous representative of the genus *Acipenser* inhabiting the Baltic Sea basin. *A. oxyrinchus* was historically widely distributed in the rivers flows into this sea. Mature individuals undertook spawning migrations in the rivers of the eastern and southern Baltic such as the Neva, Volkhov, Daugava, Nemunas, Pregola, Vistula, and Oder, where they would migrate to spawning grounds located in the upper reaches of

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these rivers or in tributaries (Wałecki 1864; Kulmatycki 1932; Berg 1948; Kuderskii 1983). The Atlantic sturgeon was a commercially important species in the Baltic Sea basin (Kolman et al. 2011). Continuously decreasing abundance of all European *A. oxyrinchus* populations was noted at the end of the nineteenth century (Kirschbaum and Gessner 2000; Mamcarz 2000; Kolman et al. 2008). The decline of the sturgeon has been considered for a long time to have occurred as a result of anthropogenic impact (Gessner et al. 2006). The last Atlantic sturgeon was caught in the Vistula River in 1965 (Mamcarz 2000) and in 1996 in the Baltic Sea (Paaver 1996).

The objective of this chapter is to present the aquaculture-based restitution program for Atlantic sturgeon in Poland. To examine the feasibility of this program, hatchery-produced juvenile *A. oxyrinchus* were released to the historical sturgeon rivers in the Vistula and Oder drainages. Radio telemetry was used to track juvenile Atlantic sturgeon and habitat use in the Drwęca River.

43.2 Restoring the Atlantic Sturgeon in Poland

Positive environmental changes occurred in the late twentieth and early twenty-first centuries in Polish rivers, and consequently in the southern Baltic Sea basin. Furthermore, the clarification of the species classification of the Atlantic sturgeon prompted the Inland Fisheries Institute in Olsztyn to undertake introductory steps to restore the *A. oxyrinchus*, based upon the restoration plan by Sych et al. (1996). This reintroduction strategy included the following steps:

– To use aquaculture systems to rear juveniles that will, in the future, form a broodstock to provide stocking material for the reestablishment project in the future
– Pilot stocking, with the aim of testing the adaptive abilities and behavior of sturgeon juveniles reared under controlled conditions

43.3 Broodstock Development

Beginning in 2004, various materials were imported from Canada to Poland annually, including fertilized eggs, hatchlings, and fingerlings. In the past 4 years, only fertilized eggs have been imported. This material was obtained from wild-caught spawners of the St. John River population (Photo 43.1). Artificial reproduction and the incubation of eggs to the advanced gastrula stage was performed at the hatchery of Acadian Sturgeon and Caviar, Inc., which is located on the St. John River about 30 km upstream from the river mouth to the Atlantic Ocean.

Tissue samples from the spawners as well as from the offspring were subjected to genetic testing. The results will be used after the broodstock has been

Photo 43.1 Catches of Atlantic sturgeon spawners in the St. John River

Photo 43.2 Closed aquaculture systems used for rearing sturgeon stocking material

established to maintain a high degree of genetic diversity in the progeny produced (see Chap. 42).

The hatch obtained from the sturgeon eggs imported from Canada was reared in recirculating aquaculture system (RAS) tanks to a mean weight of 5–7 g (Photo 43.2). These fry were used for stocking, since current studies indicated they were sufficiently resistant and had the ability to adapt to natural conditions (Kapusta et al. 2008; Kolman et al. 2008). About 200 individuals from each batch of these fry were retained for further rearing. Some of the fish that are reared to a mean body weight exceeding 30 g are used in experimental stocking and migration studies, while the rest are reared to the select stage for use as the subsequent year of the broodstock. Currently, there are two rearing facilities in Poland where selected fish from 1998 and 2001–2010 are held. These fish are tagged with PIT tags to allow individual identification after genetic characterization.

43.4 Habitat Use and Behavior

Since 2006, pilot stocking has been performed in the Drwęca River in the Vistula drainage and in the Oder River drainage of the Drawa, Warta, and Gwda rivers, all of which were previously inhabited by sturgeon. The results of these studies indicate that currently all of these rivers meet the requirements for normal fry growth and, in the future, for sturgeon spawning. Both stocking and experimental work is being conducted in the Oder River basin jointly with German scientists under the auspices of a co-operative agreement between the Inland Fisheries Institute in Olsztyn and the Leibniz Institute of Freshwater Ecology and Inland Fisheries in Berlin. Within the framework of this co-operation, more than 63,000 individuals of various sizes of American Atlantic sturgeon stocking material have been released in the Vistula (51,650 individuals) and Oder (12,010 individuals) catchment areas (Table 43.1). Stocking has been performed at various times of the year and with material of varying sizes. Some of these fish had been reared under natural conditions in flow-through ponds that provided access to natural food, while others had been reared in tanks on commercial diets. Some of the juvenile released into the rivers were fitted not only with external Carlin tags, but also with internal telemetry tags (micro radio transmitters) (Table 43.1). This made it possible to follow the movements of the fish. With species threatened with extinction, discovering what kinds of habitats they prefer can be decisive when implementing conservation measures.

Radio-telemetry studies of sturgeon were conducted in the Drwęca River between 2007 and 2009. Sturgeon were tagged with ATS F1805, F1810 and F1815 transmitters (respectively, weight: 3, 6, 7 g and operational life: 19, 34, 114 days), and Holohill BD-2 transmitters (weight of 0.62 g, operational life 21 days). A total of 101 juvenile sturgeon fitted with telemetry transmitters were released, and information was collected for 86 of these fish (Table 43.1). No natural mortality was confirmed among the fish fitted with the transmitters. The juvenile sturgeon released in spring remained at the release site from 1 to 21 days, and then moved downstream (Kapusta et al. 2008). In the fall, all of the fish released left the site within 2 days. The rate at which they descended the river was highly variable. Periods of slow movement altered with periods of rapid movement. The mean swimming speed was 1.18 km h^{-1} (0.73 BL s^{-1}), while the maximum was

Table 43.1 Characteristics of the Atlantic sturgeon stocking material released into Polish rivers

River basin	River stocked	Date	Type of material age/weight (g)	Quantity (ind)	Tag type
	Drwęca	9.10.2006	0+/7–9	1,500	–
	Drwęca	12.06.2007	1+/400–500	12	Carlin + T-M
	Drwęca	15.06.2007	1+/400–500	200	Carlin
	Drwęca	29.10.2007	0+/7–9	700	–
	Drwęca	30.10.2007	0+/20–40	250	Carlin
	Drwęca	30.10.2007	0+/30–50	20	Carlin + T-M
	Drwęca	30.10.2007	1+/500–650	10	Carlin + T-M
	Drwęca	3.06.2008	1+/300–400	370	Carlin
	Drwęca	3.06.2008	1+/300–400	30	Carlin + T-M
	Drwęca	15.10.2008	1+/400–500	30	Carlin + T-M
	Drwęca	19.06.2009	1+/26	1,900	Carlin
	Drwęca	3.07.2009	1+/350–500	430	Carlin + T-M
	Drwęca	20.10.2009	0+/7–9	10,500	–
	Drwęca	21.10.2009	0+/3–5	22,000	–
	Drwęca	26.10.2009	0+/5	1,630	–
	Drwęca	10.11.2009	0+/7–9	10,000	–
	Drwęca	30.04.2010	1+/80–150	1,900 (120)	Carlin
	Wisłoka	06.10.2009	1+/450–600	26	Carlin + T-M
Vistula	Wisłoka	06.10.2009	0+/5–7	150	–
	Drawa	10.05.2007	0+/150–250	10	Carlin + T-M
	Drawa	28.10.2007	2+/1,600–1,800	200	Carlin
	Gwda	29.10.2007	2+/1,600–1,800	238	Carlin
	Warta	29.10.2007	2+/1,600–1,800	200	Carlin
	Warta	29.10.2007	0+/5–7	4,000	–
	Gwda	19.03.2008	1+/200–400	550	Floy Tag + T-M
	Wisłoka	05.05.2008	0+/100–200	103	Carlin
	Barycz	21.10.2008	0+/7–12	2,000	–
	Warta	05.11.2008	0+/7–12	500	–
	Warta	05.11.2008	0+/30–50	100	–
	Warta	05.11.2008	0+/300–500	100	–
	Barycz	04.05.2009	1+/40–70	2,100(600)	Carlin + Floy Tag
	Warta	22.10.2009	0+/3–6	3,175	–
Oder	Warta	14.04.2010	0+/100	835	Carlin

Carlin, Floy Tag – external identification tags; T-M – radio telemetry tags

8.73 km h^{-1} (9.51 BL s^{-1}). In fall 2007, the migration speed of two groups of juvenile sturgeon was compared. The migration rates of fish aged 1+ was statistically significantly slower ($P < 0.05$) than that of the fish aged 0+ (0.83 and 2.94 BL s^{-1} respectively). The overall migration rate in the Drwęca was similar to that noted in 0+ sturgeon in the Drawa River (Fredrich et al. 2008), while it differed substantially from that of 0+ sturgeon in the Nanticoke River, which descended to the estuary at rates ranging from 0.04 to 0.4 km day^{-1} (Secor et al. 2000).

Fig. 43.1 Historic occurrence of Atlantic sturgeon *Acipenser oxyrinchus* in the second half of the twentieth century (according to Rolik 1959; Jaskowski 1962; Anon. 1965; Rudnicki 1966; Grabda 1968) and reported recapture of sturgeon released into the Drwęca River in the 2006–2009

After being released into rivers, sturgeons descend the rivers into the estuaries (Fig. 43.1). All of the tagged sturgeon exhibited a tendency to migrate downstream to the mouths of the rivers where they remained for about 2 weeks feeding intensively, as is evidenced by their increased body lengths and weights (Table 43.2).

Fredrich and Gessner (2007) reported that it is possible for the fish to migrate upstream; one specimen migrated a distance of 7 km in the Peene River, Germany. No such cases were noted in the Polish studies. During migration, some individuals remained in a given area for lengths of time ranging from a few days to over 2 weeks (10% of fish localizations), while sometimes they moved upstream by 50–200 m (5% of fish localizations); nevertheless, these movements were within areas characterized by a single, distinct type of bottom structure (Kapusta et al. 2008).

Table 43.2 Characteristics of sturgeon individuals caught in the Gdańsk Bay in the Vistula catchment

	Total length (cm)		Body length (cm)		Body weight (g)		
Tag number	Stocked	Caught	Stocked	Caught	Stocked	Caught	Site caught
P620AC	66.5	67.5	52.0	54.5	925	931	Vistula mouth
P891AC	58.0	59.0	45.5	48.5	465	502	Vistula mouth
P934AC	53.0	53.5	42.0	42.5	400	396	Vistula mouth
P862AC	66.0	–	51.5	–	589	–	Vistula–Grudziądz
P808AC	59.0	81.0	46.5	–	536	2,450	Gdańsk Bay near Mikoszewo
–	–	71.0	–	57.0	About 520	1,700	Gdańsk Bay near Junoszyno
P675AD	59.0	65.0	40.5	–	312	870	Vistula mouth

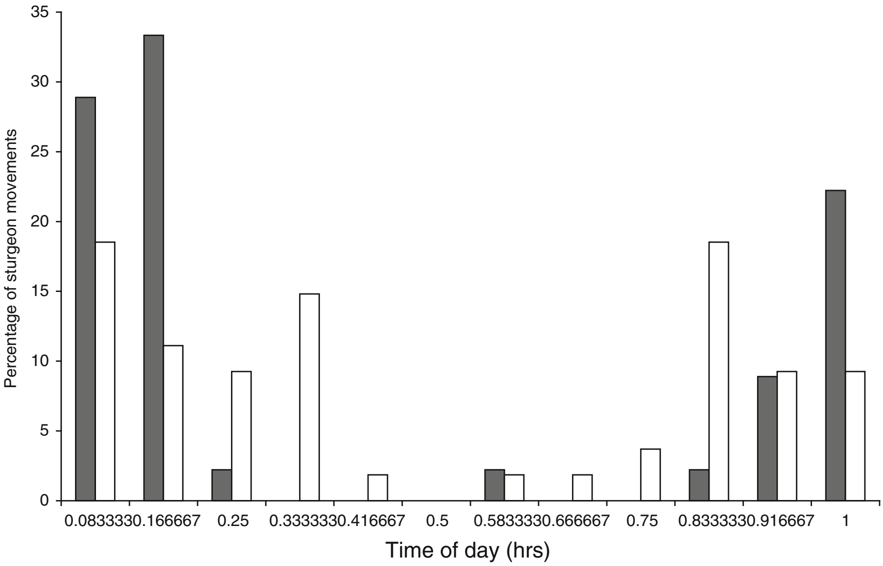

Fig. 43.2 Percentage of juvenile Atlantic sturgeon movements at different time of day in the Drwęca River registered by an automatic data-logging telemetry receiver. Spring and autumn movements are represented by solid and open bars respectively

The sturgeon released from rearing facilities moved in the Drwęca river at night (Kapusta et al. 2008). Substantial differences were noted in daily migration cycles depending on the seasons of the year (Fig. 43.2). The peak of migration occurred at night, and only single individuals were noted during the days. In fall, changes in the numbers of individuals registered throughout the day was less clear. Fish that moved at night dominated, but because this part of the day was longer, migration was also further and was more extended over time. Despite these differences, the general pattern of daily migration was similar. The first sturgeon migrations were registered about 1 h before sunset, and only single individuals continued to migrate during the day, usually during the morning hours.

There is little information available regarding the habitat preferences of young sturgeon during the river phase of their lives (Fredrich et al. 2008). In the Drwęca River, sturgeons were noted most frequently at deep holes, and no records were made of any fish in any shallower spots. The most fish were noted in smaller or larger channels that ran parallel to the river bed (Kapusta et al. 2008; Kolman et al. 2008). The share of sturgeon in the other habitats was similar (Fig. 43.2). The most common type of habitat in the segment of the Drwęca studied was lengths of even bottom, formed of sand and organic material. The habitat preferred in the Drawa River differed only slightly (Fredrich et al. 2008). Similarly to the Drwęca, most fish were registered in the channels. Nearly threefold more sturgeon occurred in the vicinity of partially submerged, dead trees in the Drawa River than were recorded at similar habitats in the Drwęca. Taking into consideration, however, the fact that depressions in river beds always form beneath submerged trees, the differences detected do not diverge from the overall pattern of habitat choice by juvenile sturgeon.

A particularly spectacular example of high growth rate is the individual with tag number P808AC, which was caught in mid November in the Gdańsk Bay near Mikoszewo at a depth of 30 m. Over a 6-month period, this individual's body weight increased by about 450%. Another sturgeon was caught in turbot nets in the Baltic Sea near Ustka on August 20, 2009. This specimen had been released into the Drwęca in the fall of 2008, and immediately prior to its release its total length was 55.5 cm and body weight was 528 g, and 10 months later 74 cm and 1.8 kg respectively. According to information obtained from fishermen working the Vistula Mouth and the Gdańsk Bay, by December 2008 a total of 27 sturgeon had been caught, most of which were released back into the water.

43.5 Conclusions

Our program will be regarded as a success when the released fish survive and return as adults. However, the results obtained to date make it possible to conclude that there are indications that future restoration programs will succeed. Atlantic sturgeon fry exhibit the ability to adapt to natural conditions, and they are finding good environmental conditions, including food supply, which not only permit them to remain in good health, but also to attain fast growth rates. Better fisheries monitoring is needed, along with enforcement to ban illegal catches. This study provides the first detailed information on the migratory behavior and habitat use by juvenile *A. oxyrinchus* in the Drwęca River. Our results establish that deep areas in river are important for juvenile sturgeon. Further studies designed to answer some of the questions are necessary for conservation and sustained management of this threatened species.

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