A Report of Investigations and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake Bay (1996-2000)

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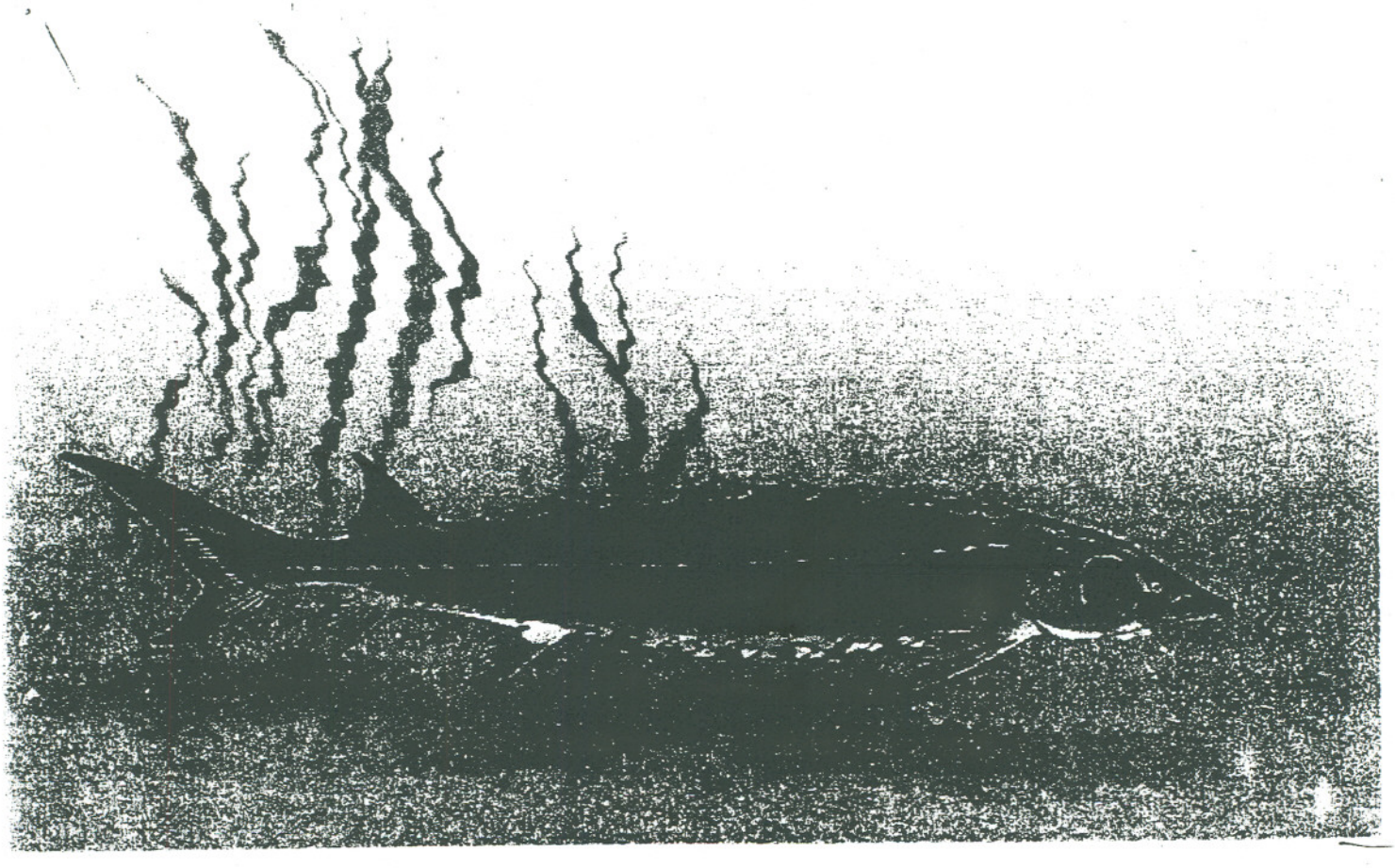

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ABSTRACT

A two-year gillnet study was conducted in Maryland waters of the upper Chesapeake Bay to determine the occurrence of the endangered shortnose sturgeon occurrence within areas of proposed dredge-fill operations. The U.S. Fish and Wildlife Service (USFWS), Maryland Fisheries Resource Office (MFRO) conducted the study in 19 sites determined by the National Marine Fisheries Service (NMFS). During the study, MFRO captured 14 Atlantic sturgeon within the proposed sites, but no shortnose sturgeon. In July 1996, USFWS in cooperation with Maryland Department of Natural Resources (MDNR) released 3,275 hatchery-reared Atlantic sturgeon into the Nanticoke River, a tributary of the Chesapeake Bay. A sturgeon reward program designed to pay commercial fishermen for holding live sturgeon to be processed by MFRO was another method used to determine distributions and movement of sturgeon within Maryland waters of the Chesapeake Bay. Through the reward program, 39 shortnose sturgeon, 451 wild Atlantic sturgeon, and 461 hatchery-reared Atlantic sturgeon were tagged and released by MFRO. Total length, fork length, weight, capture site and genetic samples were taken from each sturgeon before being tagged and released. Sonic tags were attached to 15 shortnose sturgeon to track movement in the Chesapeake Bay. We confirmed 3 shortnose sturgeon used the C&D canal, from the Chesapeake Bay to the Delaware River. We tagged wild Atlantic sturgeon and hatchery-reared Atlantic sturgeon with external tags, and recapture information suggests similar movements between hatchery-reared and wild sturgeon within the Chesapeake Bay and along the Atlantic Coast.

INTRODUCTION

Atlantic sturgeon (Acipenser oxyrinchus) and shortnose sturgeon (Acipenser brevirostrum) are anadromous fishes that occur along the Atlantic coast from Canada to Florida (Gruchy and Parker 1980a, 1980b). Historically, native Americans harvested sturgeon for meat and caviar (Hildebrand and Schroeder 1928). During colonial times (17th century) sturgeon were preserved by salting and smoking, and large numbers were exported to European Markets (Hildebrand and Schroeder 1928). A second period of heavy exploitation began just after the Civil War, with a harvest on the Atlantic coast reaching a high of 7 million pounds in 1890 (Atlantic and shortnose were not differentiated in these historical fishing records), but by the early part of the 20th Century the stocks had collapsed indicated by the low 1920 harvest of 22,000 pounds (Smith 1985). In addition to over exploitation, habitat losses, dams, decreased water quality, and siltation, have likely contributed to sturgeon declines in the Chesapeake Bay (Musick et al. 1993).

Few shortnose and Atlantic sturgeon were reported as bycatch in Chesapeake Bay fisheries during the mid to late 1900's. During the early 1990's, anecdotal information from commercial fishermen (watermen), however, indicated that sturgeon were not as rare in the Chesapeake Bay as indicated from bycatch. In 1992, at the request of the Atlantic States Marine Fisheries Commission (ASMFC), the Maryland Fisheries Resources Office (MFRO) of the U.S. Fish and Wildlife Service started a coast wide cooperative tagging program for Atlantic and shortnose sturgeon, patterned after the striped bass tagging program. The sturgeon program received financial assistance by the Hudson River Foundation and the National Fish and Wildlife Foundation, and now has federal, state, and university cooperators.

In addition to the cooperative tagging program, the MFRO has conducted or cooperated with other agencies on several studies of Atlantic and shortnose sturgeon in the Chesapeake Bay, many of which are ongoing. This report provides background information, methodologies, results, and conclusions for these studies. Study objectives are provided below.

1. To determine movement patterns of sturgeon using data from a cooperative tagging program in the Chesapeake Bay.

2. To determine if a resident shortnose sturgeon population exists within the Chesapeake Bay.

3. To determine if shortnose sturgeon move from the Delaware River to the Upper Chesapeake Bay via the Chesapeake and Delaware Canal (C&D Canal).

4. To assess genetic composition of shortnose sturgeon from the Chesapeake Bay and Delaware River.

5. To assess genetic composition of Atlantic sturgeon in the Chesapeake Bay.

6. To determine if sturgeon use areas of proposed dredge and fill operations in the Chesapeake Bay.

7. To evaluate the success of hatchery-reared Atlantic sturgeon released into the Nanticoke River in 1996.

8. To determine growth rates in Atlantic and shortnose sturgeon based on tagging data.

9. To estimate ages of Atlantic sturgeon from analysis of pectoral spines.

MATERIALS AND METHODS

Study area

The Chesapeake Bay is the nation's largest estuary, and one of its most valuable resources. The Bay is located in the mid-Atlantic region and is 314 km long, and between 5.5 and 56 km wide. The Chesapeake Bay watershed encompasses six states and drains an area of 165,760 km^2. The bay averages 30 ft in depth, and the tidal influence ranges from about 2.5 ft at the mouth to less than one foot at the head. The Bay's watershed is highly populated (about 13 million people) and both point and nonpoint pollution caused a decline of water quality and living resources in past years. However, programs initiated by participants of the 1987 Chesapeake Bay Agreement

(including the Federal Government, states within the Chesapeake Bay watershed, and Washington D.C.) have improved water quality.

Sturgeon tagging program in the Chesapeake Bay

Sturgeon (both Atlantic and shortnose) are a bycatch of commercial fisheries in the Chesapeake Bay. Because commercial watermen fish throughout the Chesapeake Bay, information on bycatch is useful in understanding sturgeon distributions. Beginning in 1994, we cooperated with commercial watermen in a tagging program to determine the distribution and movement patterns of sturgeon within the Chesapeake Bay. Initially, we asked watermen to retain the sturgeon until a MFRO biologist could tag the fish, but apparently the time and effort involved with keeping fish alive resulted in a low reporting rate (only two fish in two years). As an incentive, we offered a $100 reward for live sturgeon from Maryland Chesapeake Bay waters beginning January 1996 (cooperators were the Maryland Department of Natural Resources (MDNR) and the Chesapeake Bay Foundation (CBF)). In 1997, the reward program was modified to include a $25 reward for hatchery-reared sturgeon, and a $100 reward for wild sturgeon, and announced by postcard to all licensed watermen. The sturgeon reward program was expanded in February 1997 to include the James, York, and Rappahannock rivers in Virginia (Spells 1998, unpublished report, Appendix 1).

When a waterman reported a captured sturgeon, we recorded the location of capture, type of gear, and holding site. Watermen typically held fish at dockside in pens, cages, crab pots, or tied fish to the dock by string around the caudal peduncle. Fish captured in pound nets were sometimes held at the capture site, and staff would accompany the waterman to the net to tag the fish. Tagging procedures for the hatchery reared Atlantic sturgeon and shortnose sturgeon are described later. The wild Atlantic sturgeon were tagged with yellow T-Bar tags manufactured by Hallprint LTD[3], Holden Circle, South Australia. Typically, two T-Bar tags were placed on each fish, one at the base of the dorsal fin, and the other through the left pectoral fin. Later, in addition, a Floy FIM 96[3] double barb tag was placed in the musculature of the

anterodorsolateral region (below the 3rd, 4th, or 5th scute) of large fish over 700 mm. An applicator supplied by Floy was used to insert the double barb tag into the musculature through a small incision in the skin. Sturgeon were weighed on an O'haus[3] model CT6000 electronic scale to the nearest gram, or a DETECTO[3] model T50 mechanical scale to the nearest 1/4 pound. Fish over 50 lbs exceeded scale capacity, and therefore were generally not weighed. Lengths (total and fork) were recorded to the nearest millimeter.

Sturgeon use of areas of proposed dredge and fill operations in the Chesapeake Bay.

In addition to the sturgeon reward program, the MFRO initiated a gill net study (funded by the U.S. Army Corps of Engineers) to determine if sturgeon use areas of proposed dredge and fill operations in the Chesapeake Bay. Experimental monofilament gillnets (400 ft X 8 ft or 300 ft X 8 ft comprised of 100 ft panels of 4, 5, or 6 inch stretched mesh) were fished by MFRO biological technicians. The nets were set during daytime (3-4 hours) and overnight (24 hours). Overnight sets were not used in water temperatures above 18° C, because mortality of sturgeon and bycatch will likely increase as temperature exceeds 18° C. The nets were set on a rotating schedule at 19 stations (see Table 1, Figure 1), and in other areas where watermen had captured sturgeon. The 19 sample locations were determined by the National Marine Fisheries Service (NMFS) based on areas for proposed dredge and fill operations. Location of all net sets were recorded using a Geographic Positioning System (GPS), and both set and pull time were recorded. Depth and water quality parameters such as temperature, conductivity, salinity, and dissolved oxygen were recorded. Bycatch species were enumerated and recorded.

Success of hatchery-reared Atlantic sturgeon released into the Nanticoke River in 1996.

Of 3,275 hatchery-reared Atlantic sturgeon released into the Nanticoke River on 8 July 1996, 1,657 were released at Sharptown and 1,618 were released at Vienna. Because of heater malfunction, some hatchery sturgeon were kept in cold water over the winter and ranged from 80 - 210 mm total length at the time of release. Others were held in heated water and ranged from 190 - 420 mm total length at release. Before initial release, all hatchery-reared Atlantic sturgeon were tagged under the third dorsal scute with a binary coded wire tag (CWT) manufactured by Northwest Marine Technologies[3], Seattle, WA. The CWT were used to differentiate hatchery-reared sturgeon from wild sturgeon. Atlantic sturgeon examined after the release of hatchery fish were scanned for the presence of a CWT using a Northwest Marine Technology detector wand to determine their origin. In addition to the CWT, 910 hatchery-reared Atlantic sturgeon in the 190 - 420 mm group were tagged (T-Bar) at the base of the dorsal fin before release following procedures described above for wild Atlantic sturgeon. In addition, recaptured hatchery-reared Atlantic sturgeon were tagged, weighed, and measured using procedures described above for wild fish; however, tags on recaptured fish were left in place.

To determine if a resident shortnose sturgeon population exists within the Chesapeake Bay.

Movement and genetic analyses (see below) were done to determine if shortnose sturgeon captured in the Chesapeake Bay were migrants from the Delaware River. To assess movement between the Chesapeake Bay and Delaware River, shortnose sturgeon were tagged in the upper Chesapeake Bay and in the Delaware River. Shortnose sturgeon from the upper Chesapeake Bay were obtained during the sturgeon reward program and those from the Delaware River (below Scutter's Falls) were captured using 30 m X 2 m and 60 m X 2 m monofilament gill nets (5-6 inch stretched mesh) set by the MFRO and Environmental Research and Consulting, Inc.

(ERC). Shortnose sturgeon from the Chesapeake Bay and Delaware River were tagged with Hallprint T-Bar tags, Carlin tags manufactured by Floy Inc.[3], passive integrated transponder (PIT) tags, 400 KHz, manufactured by Destron[3], and sonic tags (CT82-2E manufactured by Sonotronics[3], Tucson, AZ). T-Bar tags were placed through the pectoral fin using the same method as described above for Atlantic sturgeon. To attach a Carlin tag, two hypodermic needles were punched through the base of the dorsal fin (Smith et al. 1990), wire (attached to the Carlin tag) was then threaded through the needles from the left side and tied off on the right side after removal of the hypodermic needles. The PIT tags (2.1 X 11 mm glass coated tags that emit a signal corresponding to a unique number when scanned) were injected 1 cm into the musculature of the upper anterodorsolateral region between the 3rd and 4th dorsal scutes using a syringe (12 gauge needle). A sonic tag was mounted on two scutes using 60 lb test nylon-coated stranded stainless steel trolling/leader wire. The wire was first threaded through holes in the sonic tag, then through holes drilled through the point of the scutes, and then through holes of a backing plate. The wire was then fashioned into a harness using leader sleeves (size 4) and crimped with a crimping tool.

A permit from the National Marine Fisheries Service was issued to the Maryland Fisheries Resource Office (MFRO) in March 2000 allowing sonic tags to be internally implanted in shortnose sturgeon. The sonic tags were placed in the ventral portion of the body cavity. Using a sterile scalpel, a MFRO biological technician made a one to two inch incision in the ventral body wall approximately three to four inches anterior to the anal opening. The tag was inserted into the body cavity of the sturgeon and pushed forward as far as possible to prevent it from irritating the surgical area. The incision was sewn together using Ethicon©[3] 3-0 chromic gut surgical sutures placed approximately 1/4" apart along the length of the incision. The wound was then treated with Betadine[3] solution to prevent infection. Following surgery, the fish was contained until it showed signs of recovery and then released into the water. Fish under 700 mm were generally not fitted with sonic tags due to the size of the tag.

Fish with sonic tags were tracked by boat with a Directional Hydrophone DH-2 and a Sonotronics Digital Receiver USR-5W. Researchers deployed the hydrophone every ½ to 3/4 mile, and would travel toward a sonic signal until it was equal strength in every direction. The fish was then assumed to be directly under the boat, and depth and geographic coordinates (determined with a GPS) were recorded. To monitor possible movement through the C& D Canal a Data logger DL-95, Scan Receiver USR-90, and a Directional Hydrophone were placed at the U.S. Army Corps of Engineers Compound at Chesapeake City, MD. The hydrophone was mounted on the seawall pointing diagonally across the canal. The system was powered by a 12 volt marine battery hooked to a battery charger that was powered by night security lights. Data from the palmtop logger were downloaded to a laptop computer every 4 to 6 weeks. A second logger was later placed at the National Oceanic and Atmospheric Administration (NOAA) monitoring station on the Canal's south shore near Delaware City, Delaware.

Genetics

Tissue samples for genetic analyses were taken from Atlantic and shortnose sturgeon provided by watermen or from those captured by researchers. A ½ square inch tissue sample was cut from the ray section of the caudal fin using sterilized scissors. Tissue samples were placed into a labeled vial containing 95% Ethyl alcohol, and refrigerated for 24 hours to allow time for tissue fixation. Tissue samples from Atlantic sturgeon were sent to Dr. Tim King at USGS-BRD Kerneysville, WV, for genetic analysis. Tissue samples from shortnose sturgeon were collected from 73 individuals from the Delaware River and 28 individuals from the upper Chesapeake Bay. These tissue samples and existing tissue samples from the Hudson and Savannah River fish were analyzed using mitochondrial and genomic DNA analysis. The mitochondrial DNA analysis (PCR and direct sequencing) was conducted by Dr. Isaac Wirgin, NYU Medical Center, Tuxedo, NY. The cellular DNA analysis

(microsatellites) is currently being done by Dr. Tim King, but at this time is not complete.

Ageing of Atlantic sturgeon.

A 5 -10 mm section of the right pectoral spine of wild Atlantic sturgeon was removed with a mini hacksaw (Sandvik[3] 268 Junior Hacksaw) and placed into a labeled plastic bag. After removal of the spine section, we applied an antiseptic (Betadine solution) to the pectoral fin. Atlantic sturgeon were aged by Dr. David Secor and students at the Chesapeake Biological Laboratory, Solomons, MD, using the following methods summarized from Stevenson and Secor (2000). Sections of pectoral spines were embedded in a block of Spurr epoxy and sectioned using an Isomet saw, or not embedded and sectioned using a jeweler's saw. Next, thermoplastic glue was used to mount all sections onto glass slides. Sections were then polished using an automatic polishing wheel with fine grit carborundum paper and a 0.3 um alumina slurry on a polishing cloth. Due to a good representation of spines taken from all size classes of wild Atlantic sturgeon, samples were not collected during the last year of the project.

RESULTS AND DISCUSSION

Atlantic sturgeon distribution

From 1996 through 2000, 451 wild and 461 hatchery-reared Atlantic sturgeon (these numbers do not include multiple captures) were tagged and released in the Chesapeake Bay, MD (Figures 2 and 3). Distributions determined from captures reported to the reward program are biased because of fishery dependence. Bycatch of sturgeon during the summer was primarily from a poundnet fishery near the shoreline, whereas most sturgeon captured in the winter were bycatch from a gill net fishery (Figures 4 and 5). Nevertheless, distributions based on fishery dependent samples can provide useful information, particularly when little distribution information is available. Our fishery dependent data suggest that distributions of wild and hatchery-reared sturgeon are similar.

Three hatchery-reared Atlantic sturgeon (76 - 127mm TL) stocked in the Hudson River in October 1994 were recaptured several years later in the Chesapeake Bay (30 Oct. 1997, 965 TL; 9 Nov 1997, 965 TL; and 5 Jan. 1998, 912 TL) and the individual captured on 9 Nov 1997 was caught two months earlier (9 Sept 1997) in the lower Delaware River.

Growth, age, and genetics of Atlantic sturgeon

Length-weight relationships for sturgeon between 445 and 1100 mm were similar between wild and hatchery-reared fish (Figure 6); however, all sturgeon longer than 1100mm were wild fish (Figure 7). Genetic and age studies of Atlantic sturgeon are still in progress, and will be reported at a later date.

Sturgeon use of areas of proposed dredge and fill operations in the Chesapeake Bay

From 1998 to 2000, 14 Atlantic sturgeon were captured in MFRO gillnets in the 19 proposed dredge sites and fill areas in the Chesapeake Bay (Table 2, Figure 8). The gillnets were sampled seasonally, a total of 10,661 hours (Table 3). During the study, there were no shortnose sturgeon caught in MFRO gillnets. Although the data shows that few sturgeon were captured in these sites, Atlantic and shortnose sturgeon were captured in commercial gear within the proposed dredged dumping sites during the time of the study (Table 4). Therefore, our results may be a function of sampling and can only suggest that Atlantic and shortnose sturgeon were not frequenting these sites while MFRO gillnets were fishing.

The bycatch recorded during each gillnet set consisted of species common to the Chesapeake Bay (Murdy et al., 1997) and varied seasonally in species composition and number (Table 5-8). Average temperature, salinity, dissolved oxygen, percent dissolved oxygen, and conductivity varied seasonally (Table 9-13).

Shortnose distribution, growth, and genetics

Since the beginning of the Atlantic sturgeon reward program in 1996, 39 shortnose sturgeon have been captured in the Chesapeake Bay, MD (Figure 9). Three shortnose sturgeon were captured in the lower Susquehanna River, two were caught in the Bohemia River, two south of the Bay Bridge near Kent Island, three in the Potomac River, and one just north of Hoopers Island. In addition, one was captured in the Elk River and two in Fishing Bay. The remaining sturgeon were caught in the upper Chesapeake Bay north of Hart-Miller Island. The length-weight relationship for shortnose sturgeon from the upper Chesapeake Bay was Log W = 3.17(Log FL) - 5.60 or Log W = 3.25 (Log TL) - 6.00 (Figure 10) and was similar to those reported and summarized by Dadswell et al. (1984).

Before the reward program, there were only 15 published historic records of shortnose sturgeon in the Chesapeake Bay (Dadswell et al. 1984). Most of these are based on personal observations from the upper Chesapeake Bay during the 1970's and 1980's (Dadswell et al. 1984), but one verified record from the Potomac River dates back to 1876 (Musick et al. 1993). An additional record is from the Rappahannock River in Virginia (Spells 1998, unpublished report). Shortnose sturgeon are rarely caught as bycatch in commercial fisheries, even in the Hudson and Delaware Rivers where large populations exist (pers. comm. O'Herron 1997, pers. comm. Brundage 1997). This suggests that these fish may be widely distributed in Maryland waters of the Chesapeake Bay and possibly constitute a resident population.

The 1876 record indicates that shortnose sturgeon were present in the Chesapeake Bay before the Chesapeake and Delaware Canal (C&D canal) was a sea-level canal which allowed fish to move freely between the Chesapeake Bay and Delaware River in 1927. Before the C&D canal, shortnose sturgeon in the Chesapeake Bay were geographically separated and potentially genetically isolated from those in the Delaware River. From 1996 through 2000, tissue samples from 28 shortnose sturgeon were collected through the reward program in the Chesapeake Bay. PCR and direct sequencing showed no significant differences between shortnose

sturgeon from the Delaware River and Chesapeake Bay(Dr. I. Wirgin, Nelson Institute of Environmental Medicine, pers. comm., 2000).

Movement of shortnose sturgeon

Sonic tags were attached to 35 shortnose sturgeon (26 external and 9 internal) from the Delaware River and 15 snortnose sturgeon (14 external and 1 internal) from the Chesapeake Bay. These were used to monitor the movement of shortnose sturgeon through the Chesapeake and Delaware (C&D) Canal. Monitoring equipment located in the canal at the NOAA station, Delaware City, gave a false signal and performance did not improve after a low pass filter (LPF-94) was added to reduce noise. Due to excessive noise, the monitoring equipment was removed. A shortnose sturgeon tagged in the Chesapeake Bay on 5 April 1998 (Figure 11) was recorded in the canal by monitoring equipment located at Chesapeake City, and later relocated in the Delaware River by C. Shirey (DE Division of Fish and Wildlife). It is likely that this shortnose sturgeon swam through the canal, because it was tagged in the Chesapeake Bay, later relocated in the canal, and later relocated in the Delaware River. Another shortnose sturgeon tagged in the middle Chesapeake Bay (Figure 12) and relocated 101 days later in the Delaware River was not detected in the canal; however, the monitoring equipment at Chesapeake City had malfunctioned for approximately three weeks after this sturgeon had been sonic tagged. From May to August 2000 the monitoring equipment at the Chesapeake City location did not record information due to a malfunction in the computer. The monitoring equipment was removed from the Chesapeake City location in September 2000, due to seawall reconstruction and will be placed elsewhere.

Telemetry from boats yielded 22 of the 50 sonic tagged sturgeon, and several tags were relocated more than once (Table 13). Delaware River fish were tagged and released on or near the spawning grounds (near Scutter's Falls or Bordentown); consequently, most of these fish were later relocated downstream of their release site.

Movements of shortnose sturgeon in the Chesapeake Bay did not appear to follow a specific pattern (Figures 14 - 17).

Locations provided by telemetry can be used to estimate distances of sturgeon movements. A straight path between two locations is "hypothetical" because a sturgeon likely does not follow a straight line between two points determined by telemetry. However, the hypothetical path provides an estimate of the minimum distance traveled during a given period of time. Distances moved by shortnose sturgeon in this study ranged from 0 to 5.7 km per day (Table 10). Sturgeon captured by watermen in the Chesapeake Bay were typically tagged and released at dockside (Figures 15-17), and estimates of movement include distances fish swam from the tag and release location. Our findings of movement by shortnose sturgeon are similar to those reported and summarized by Dadswell et al. (1984).

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FOOTNOTES

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[3]The USFWS MFRO does not promote or endorse the equipment used

Table 1. Sites where gill nets were deployed in the upper Chesapeake Bay, Maryland (see Figure 1).

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1. Aberdeen around Poole's Island
2. G-east
3. Site 92
4. Site 1
5. Site 2
6. Site 3
7. Site 104
8. Mouth of Susquehanna River
9. Worton Point
10. Worton Deep
12. Swan Point Channel
13. Craighill Channnel Upper Range
14. Craighill Channel
15. Brewerton Channel Extension
16. Tolchester Channel South
17. Tolchester Channel North
20. C&D Approach of Still Pond Creek
21. C&D Approach of Bohemia River
22. Shad Battery Shoal

Table 2. Sturgeon captured in Maryland Fisheries Resource Office gillnet sites during 1998-2000.

Species	Capture Date	Site #	Total Length (mm)	Fork Length (mm)	Weight (g)
Atlantic Sturgeon	10/25/99	2	970	871	4763
Atlantic Sturgeon	7/6/99	2	890	790	3856
Atlantic Sturgeon	8/19/99	2	980	860	4536
Atlantic Sturgeon	8/19/99	2	915	790	4536
Atlantic Sturgeon	6/18/98	4	885	796	3515
Atlantic Sturgeon	8/4/98	4	700	630	1588
Atlantic Sturgeon	8/4/98	4	770	675	2268
Atlantic Sturgeon	6/10/98	6	880	760	1814
Atlantic Sturgeon	3/7/00	7	864	760	3289
Atlantic Sturgeon	7/21/99	12	840	735	2835
Atlantic Sturgeon	7/27/98	13	700	590	1588
Atlantic Sturgeon	7/27/98	13	700	620	1588
Atlantic Sturgeon	7/27/98	13	720	640	2041
Atlantic Sturgeon	6/10/98	22	1285	1110	9526

Table 3. Total hours of sampling conducted in Maryland Fisheries Resource Office gillnet sites during each season. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6),summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site #	Season				Total Hours
	Winter*	Spring	Summer	Fall	
1	68	158	70	277	574
2	88	226	71	109	493
3	175	120	55	0	350
4	99	112	61	0	272
5	101	15	70	0	186
6	191	167	47	15	420
7	689	201	149	151	1190
8	234	144	200	411	990
9	206	57	42	188	494
10	792	43	43	7	886
12	84	125	50	101	360
13	148	48	45	0	240
14	92	72	109	133	406
15	93	34	52	0	178
16	99	148	72	0	318
17	91	108	66	194	459
20	288	171	182	760	1400
21	586	174	153	139	1052
22	0	332	60	0	392
Total	4124	2454	1598	2485	10661

**Total hours during winter months are greater due to overnight sets.

Table 4. Atlantic and shortnose sturgeon caught in commercial gear during Maryland Fisheries Resource Office study.

Species	Capture Date	Site #	Capture Gear	Origin	Total Length (mm)	Fork Length (mm)	Weight (g)
Atlantic Sturgeon	02/16/98	1	Drift Gillnet	Hatchery	762	-	2381
Atlantic Sturgeon	02/28/00	3	Drift Gillnet	Wild	643	582	1361
Atlantic Sturgeon	12/18/96	6	Drift Gillnet	Hatchery	530	440	680
Atlantic Sturgeon	11/16/98	6	Drift Gillnet	Wild	860	740	2721
Atlantic Sturgeon	01/30/97	7	Drift Gillnet	Hatchery	-	-	-
Atlantic Sturgeon	05/19/97	7	Pound Net	Wild	851	740	2535
Atlantic Sturgeon	06/15/97	7	Pound Net	Wild	820	720	2280
Atlantic Sturgeon	06/15/97	7	Pound Net	Hatchery	690	600	1437
Atlantic Sturgeon	04/22/98	10	Gillnet	Wild	950	820	3175
Shortnose Sturgeon	04/22/98	10	Drift Gillnet	Wild	410	355	340
Shortnose Sturgeon	04/23/98	10	Eel Pot	Wild	432	390	453
Atlantic Sturgeon	02/11/99	13	Drift Gillnet	Wild	1380	1210	14742
Atlantic Sturgeon	02/23/99	16	Drift Gillnet	Hatchery	985	850	3855
Atlantic Sturgeon	02/19/98	20	Drift Gillnet	Hatchery	857	750	3175
Atlantic Sturgeon	02/19/98	20	Drift Gillnet	Hatchery	927	780	3515
Atlantic Sturgeon	01/25/99	20	Drift Gillnet	Wild	1475	1290	16897
Shortnose Sturgeon	12/05/97	20	Drift Gillnet	Wild	840	740	2496

Table 5. Bycatch caught in Maryland Fisheries Resource Office gillnets during winter months (January, February, and March).

	Site #																	
Species	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	20	21
American Eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
American Shad	0	0	0	2	0	0	0	0	7	0	0	0	0	0	0	0	0	0
Atlantic Menhaden	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0
Blue Crab	0	1	0	0	0	0	0	0	1	1	0	0	1	0	4	0	6	8
Catfish Species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2
Channel Catfish	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	1
Duck (Scaup)	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Duck species	0	0	0	0	1	0	2	0	0	0	0	0	0	0	2	0	0	0
Flounder species	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Gizzard Shad	1	5	1	10	1	1	62	7	17	0	0	9	0	2	4	2	2	25
Hogchoker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Horseshoe Crab	0	0	0	0	0	0	11	0	0	0	1	0	0	0	0	0	0	0
Red Throated Loon	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skilletfish	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Striped Bass	0	1	31	90	1	1	49	52	62	0	2	4	0	2	1	7	51	40
White Perch	0	4	3	0	0	0	3	0	1	0	2	0	1	0	3	0	1	3
Yellow Perch	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Total	1	11	35	106	3	2	166	66	90	1	5	13	2	4	14	9	68	81

Table 6. Bycatch caught in Maryland Fisheries Resource Office gillnets during spring months (April, May, and June).

	Site #																		
Species	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	20	21	22
American Shad	2	0	1	1	2	1	1	49	2	1	0	0	0	0	0	0	0	0	0
Atlantic Croaker	0	0	1	1	0	34	26	0	0	0	16	11	65	12	8	1	0	0	0
Atlantic Menhaden	2	12	76	73	0	702	357	41	5	3	396	234	1090	177	320	104	322	3	3
Blue Crab	12	7	20	23	0	5	18	0	3	4	9	10	11	12	0	3	3	21	20
Catfish species	40	1	1	1	2	1	0	2	0	1	0	0	0	0	1	0	12	35	11
Channel Catfish	7	8	14	8	0	0	5	50	5	0	0	5	16	10	8	4	10	39	7
Common Carp	0	0	0	0	0	0	0	23	2	0	0	0	0	0	0	0	3	5	0
Cownose Ray	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Crayfish species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Flounder species	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0
Gizzard Shad	62	4	14	2	31	46	10	204	64	9	10	5	14	14	19	2	186	221	41
Hickory Shad	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Hogchoker	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Horseshoe Crab	0	0	0	0	0	24	5	0	0	0	2	2	11	0	5	0	0	0	0
Largemouth Bass	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Spot	0	0	0	2	0	1	9	0	0	0	1	0	0	0	0	0	0	0	3
Spotted Seatrout	0	0	0	0	0	0	4	0	0	0	0	0	1	1	1	0	0	0	0
Striped Bass	27	22	7	26	6	23	26	40	6	2	18	14	43	4	106	5	30	58	131
White Perch	0	0	2	0	2	5	10	6	0	0	1	1	10	0	5	3	8	6	0
Total	152	54	136	139	44	843	474	417	87	20	453	283	1261	230	473	122	574	389	216

Table 7. Bycatch caught in Maryland Fisheries Resource Office gillnets during summer months (July, August, and September).

	Site #																		
Species	1	2	3	4	5	6	7	8	9	10	12	13	14	15	16	17	20	21	22
Alewife	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Atlantic Croaker	0	1	15	2	33	28	145	0	6	3	1	27	22	12	53	14	14	0	2
Atlantic Menhaden	7	60	25	0	232	19	123	288	15	7	138	66	314	13	209	73	50	45	15
Blue Crab	23	47	40	29	40	0	47	3	26	12	19	11	29	12	30	48	110	190	52
Bluefish	0	0	1	0	5	0	2	0	1	0	2	3	5	2	5	0	3	1	0
Catfish species	0	0	0	0	1	0	0	23	2	0	0	0	0	0	0	0	22	8	0
Channel Catfish	22	4	5	43	2	6	0	52	1	2	0	20	2	3	2	5	72	39	2
Common Carp	0	0	0	0	0	0	0	44	0	0	0	0	0	0	0	0	1	1	0
Cownose Ray	1	0	1	0	4	2	0	0	1	0	0	3	1	1	0	0	0	0	0
Flounder species	0	5	1	2	2	0	9	0	0	0	0	1	1	0	0	0	0	0	0
Gizzard Shad	37	14	6	3	22	49	11	170	33	22	25	49	34	11	26	8	30	15	14
Harvestfish	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Hogchoker	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Horseshoe Crab	0	0	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0
Largemouth Bass	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Smallmouth Bass	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Spanish Mackerel	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Spot	0	1	5	4	15	46	74	0	0	1	5	4	34	10	34	2	6	1	0
Spotted Seatrout	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Striped Bass	4	5	2	1	10	79	6	6	0	0	16	36	44	7	10	13	2	0	3
Weakfish	0	1	0	0	0	0	3	0	0	0	1	1	2	0	6	0	3	0	0
White Catfish	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
White Perch	1	0	0	1	2	9	1	2	1	0	1	1	5	2	8	0	7	0	0
Total	95	138	101	85	370	241	423	592	86	48	209	223	494	74	383	163	320	300	88

Table 8. Bycatch caught in Maryland Fisheries Resource Office gillnets during fall months (October, November, and December).

	Site #											
Species	1	2	6	7	8	9	10	12	14	17	20	21
Atlantic Croaker	0	0	0	20	0	0	0	41	2	0	0	0
Atlantic Menhaden	5	3	14	133	0	81	0	1	13	20	84	0
Black Drum	0	0	0	2	0	0	0	0	0	0	0	0
Blue Crab	2	4	7	30	0	5	1	0	7	7	62	2
Bluefish	0	0	3	0	0	0	0	0	0	0	0	0
Brown Bullhead	0	0	0	0	0	0	0	0	0	1	0	0
Catfish species	0	0	0	0	0	0	0	0	0	0	7	0
Channel Catfish	3	3	0	0	135	4	1	0	0	7	33	23
Common Carp	0	0	0	0	39	0	0	0	0	0	0	0
Flounder species	0	0	0	2	0	1	0	0	1	2	2	0
Gizzard Shad	220	1	10	209	71	136	0	72	14	2	30	8
Harvestfish	0	0	9	0	0	0	0	0	2	0	0	0
Hogchoker	0	0	0	0	65	0	0	0	0	0	0	0
Horseshoe Crab	0	0	0	21	0	0	0	0	0	0	0	0
Largemouth Bass	0	0	0	0	4	0	0	0	0	0	0	0
Lizardfish	0	0	0	1	0	0	0	0	1	0	0	0
Northern Hogsucker	0	0	0	0	1	0	0	0	0	0	0	0
Quillback	0	0	0	0	1	0	0	0	0	0	0	0
Smallmouth Bass	0	0	0	0	1	0	0	0	0	0	0	0
Spot	0	0	1	2	0	0	0	0	1	7	0	0
Spotted Seatrout	0	0	0	0	0	0	0	0	1	0	1	0
Striped Bass	19	3	4	11	15	2	0	6	5	14	45	20
Walleye	0	0	0	0	2	0	0	0	0	0	0	0
Weakfish	0	1	0	2	0	0	0	1	4	6	5	0
White Catfish	0	0	0	0	0	0	0	0	0	0	1	0
White Perch	0	0	0	0	0	0	0	0	0	0	2	0
White Sucker	0	0	0	0	3	0	0	0	0	0	0	0
Total	249	15	48	433	337	229	2	121	51	66	272	53

Table 9. Seasonal average temperature (°C) at Maryland Fisheries Resource Office gillnet sites. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6), summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site	Season			
#	Winter	Spring	Summer	Fall
1	6.0	19.2	24.9	11.0
2	4.0	15.9	27.2	20.0
3	5.0	24.5	-	-
4	6.5	20.0	26.0	-
5	3.2	15.0	24.1	-
6	4.0	15.8	25.6	18.0
7	7.2	17.7	26.2	14.1
8	7.2	22.5	24.1	10.6
9	7.1	18.8	27.3	19.0
10	3.1	22.6	26.7	19.0
12	4.3	16.4	26.0	11.0
13	1.0	20.0	25.0	-
14	7.2	17.9	24.9	14.3
15	1.0	17.0	27.0	-
16	7.0	23.0	25.9	-
17	2.5	22.0	24.0	17.0
20	6.3	21.3	26.2	13.6
21	6.7	22.2	27.5	20.0
22	-	15.6	26.8	-

Table 11. Seasonal average dissolved oxygen (ppm.) at Maryland Fisheries Resource Office gillnet sites. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6), summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site	Season			
#	Winter	Spring	Summer	Fall
1	16.40	11.02	8.30	-
2	-	7.96	7.32	-

Table 10. Seasonal average salinity (ppt.) at Maryland Fisheries Resource Office gillnet sites. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6), summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site	Season			
#	Winter	Spring	Summer	Fall
1	3.0	1.7	7.0	8.0
2	3.5	1.2	7.3	3.0
3	4.0	1.8	-	-
4	4.0	1.0	6.3	-
5	7.0	1.0	7.7	-
6	5.0	4.5	8.8	8.0
7	6.2	5.5	8.5	11.2
8	1.0	0.0	0.2	0.5
9	2.1	0.5	8.7	3.5
10	0.2	2.1	7.8	3.5
12	8.8	4.0	9.1	10.0
13	11.0	4.5	11.0	-
14	4.0	3.4	8.0	9.4
15	10.5	2.3	6.2	-
16	6.5	3.5	8.3	-
17	3.0	1.5	5.2	4.5
20	0.0	2.3	3.4	4.3
21	1.5	0.8	2.8	2.0
22	-	0.5	4.0	-

Table 12. Seasonal average percent dissolved oxygen at Maryland Fisheries Resource Office gillnet sites. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6), summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site	Season			
#	Winter	Spring	Summer	Fall
1	-	85.0	105.7	-
2	-	88.3	94.9	-
3	114.8	95.5	-	-
4	-	-	90.2	-
5	115.0	-	98.7	-
6	60.0	110.4	148.5	79.2
7	99.7	89.9	82.2	98.2
8	60.5	88.2	90.4	94.7
9	-	94.9	90.1	-
10	-	93.2	82.4	-
12	91.2	-	87.8	97.1
13	-	108.7	108.3	-
14	103.8	124.6	95.8	100.0
15	93.3	-	67.6	-
16	124.3	-	94.1	-
17	93.1	-	105.3	-
20	98.8	94.3	112.4	90.4
21	94.8	83.5	79.2	-
22	-	76.2	75.2	-

Table 13. Seasonal average conductivity ($\mu mhos$) at Maryland Fisheries Resource Office gillnet sites. Seasons categorized by winter (months 1, 2, and 3), spring (months 4, 5, and 6), summer (months 7, 8, and 9), and fall (months 10, 11, and 12).

Site	Season			
#	Winter	Spring	Summer	Fall
1	3100	2600	12100	5280
2	3700	1560	13200	6000
3	3950	3280	-	-
4	4200	1000	11900	-
5	6200	1200	14100	-
6	4300	6030	16400	7500
7	6550	8070	13600	11900
8	430	202	323	250
9	2810	615	13000	4000
10	309	3340	9480	4000
12	9200	4320	13600	12500
13	10000	8900	18000	-
14	4200	5830	13200	11500
15	10000	2800	11900	-
16	518	4600	14400	-
17	3200	2150	6830	3240
20	147	2550	5190	5260
21	819	1290	4560	3950
22	-	1250	8040	-

Table 14. Movement data (minimum distances) from sonic tagged shortnose sturgeon.

Sonic Tag Number	Release/ Located*	Date	Distance (km)	Days	Estimated distance (km)/day	Location: C = Chesapeake Bay D = Delaware River
2-2-9	release	1/23/98				C
2-2-9	located	4/3/98	11.23	70	0.160	C
2-2-9	located	4/6/98	0.85	3	0.283	C
2-2-9	located	4/7/98	0.67	1	0.670	C
2-2-9	located	4/8/98	0.62	1	0.620	C
2-2-9	located	4/21/98	0.81	13	0.062	C
2-2-9	located	5/6/98	0.64	15	0.043	C
2-2-9	located	6/2/98	0.41	27	0.015	C
2-3-2-7	release	12/8/97				C
2-3-2-7	located	2/10/98	10.25	69	0.149	C
2-3-3-6	release	1/6/98				C
2-3-3-6	located	3/6/98	30.8	59	0.522	C
2-3-3-6	located	4/7/98	14.9	32	0.466	C
2-3-3-6	located	4/8/98	5.74	1	5.740	C
2-3-3-6	located	4/13/98	12.86	5	2.572	C
2-3-3-6	located	5/6/98	10.38	23	0.451	C
2-3-3-6	located	5/28/98	12.2	22	0.555	C
2-3-4-5	release	12/10/97				C
2-3-4-5	located	2/10/98	16.84	62	0.272	C
2-3-4-5	located	4/2/98	18.82	51	0.369	C
2-3-4-5	located	4/3/98	5.28	1	5.280	C
2-3-9	release	4/4/00				D
2-3-9	located	7/25/00				D
2-4-2-6	release	12/10/97				C
2-4-2-6	located	3/20/98	22.83	100	0.228	C
2-4-3-5	release	12/10/97				C
2-4-3-5	located	4/21/98	13.74	132	0.104	C
2-4-3-5	located	5/6/98	4.82	15	0.321	C
2-4-3-5	located	5/28/98	11.24	22	0.511	C
2-4-3-5	located	11/19/98	6.66	175	0.038	C

Table 14. Continued.

Sonic Tag Number	Release/ Located*	Date	Distance (km)	Days	Estimated distance (km)/day	Location: C = Chesapeake Bay D = Delaware River
2-4-7	release	1/24/98				C
2-4-7	located	6/16/98	54.3	142	0.382	
2-4-7**	located	7/15/98	24.6	30	0.820	D
2-4-8	release					
2-4-8**	located	5/4/98				C
2-6-6	release	4/4/00	203.9	101	2.019	D
2-6-6	located	7/25/00				D
3-7-5	release	3/19/98				D
3-7-5	located	8/31/98	0.42	165	0.003	D
3-8-4	release	3/19/98				D
3-8-4	located	8/31/98	2.57	165	0.016	D
3-9-5	release	4/2/98				D
3-9-5	located	9/3/98	106.55	154	0.692	D
3-9-5	located	9/24/98	0.6	21	0.029	D
4-4-6	release	3/26/98				D
4-4-6	located	7/30/98	88.68	126	0.704	D
4-4-6	located	8/5/98	0.34	6	0.057	D
4-4-6	located	8/13/98	0.25	8	0.031	D
4-4-6	located	9/3/98	0.13	21	0.006	D
4-4-6	located	9/11/98	1.28	8	0.160	D
4-4-7	release	3/6/98				D
4-4-7	located	8/31/98	17.9	178	0.101	D
4-5-5	release	4/2/98				D
4-5-5	located	8/31/98	53.2	151	0.352	D
4-5-8	release	4/1/98				D
4-5-8	located	8/31/98	51.8	152	0.341	D

Table 14. Continued.

Sonic Tag Number	Release/ Located*	Date	Distance (km)	Days	Estimated distance (km)/day	Location: C = Chesapeake Bay D = Delaware River
4-6-5	release	3/6/98				D
4-6-5	located	7/15/98	112.4	131	0.858	D
4-6-5	located	7/30/98	0	15	0.000	D
4-6-7	release	4/1/98				D
4-6-7	located	8/31/98	31.87	152	0.210	D
5-8-9	release	6/9/00				D
5-8-9	located	7/25/00				D
8-8	release	6/30/00				D
8-8	located	7/25/00				D
9-10	release	4/1/98				D
9-10	located	8/31/98	31.27	152	0.206	D

*located by telemetry
**movements of 2-4-7 and 2-4-8 were assumed to be through the C & D canal

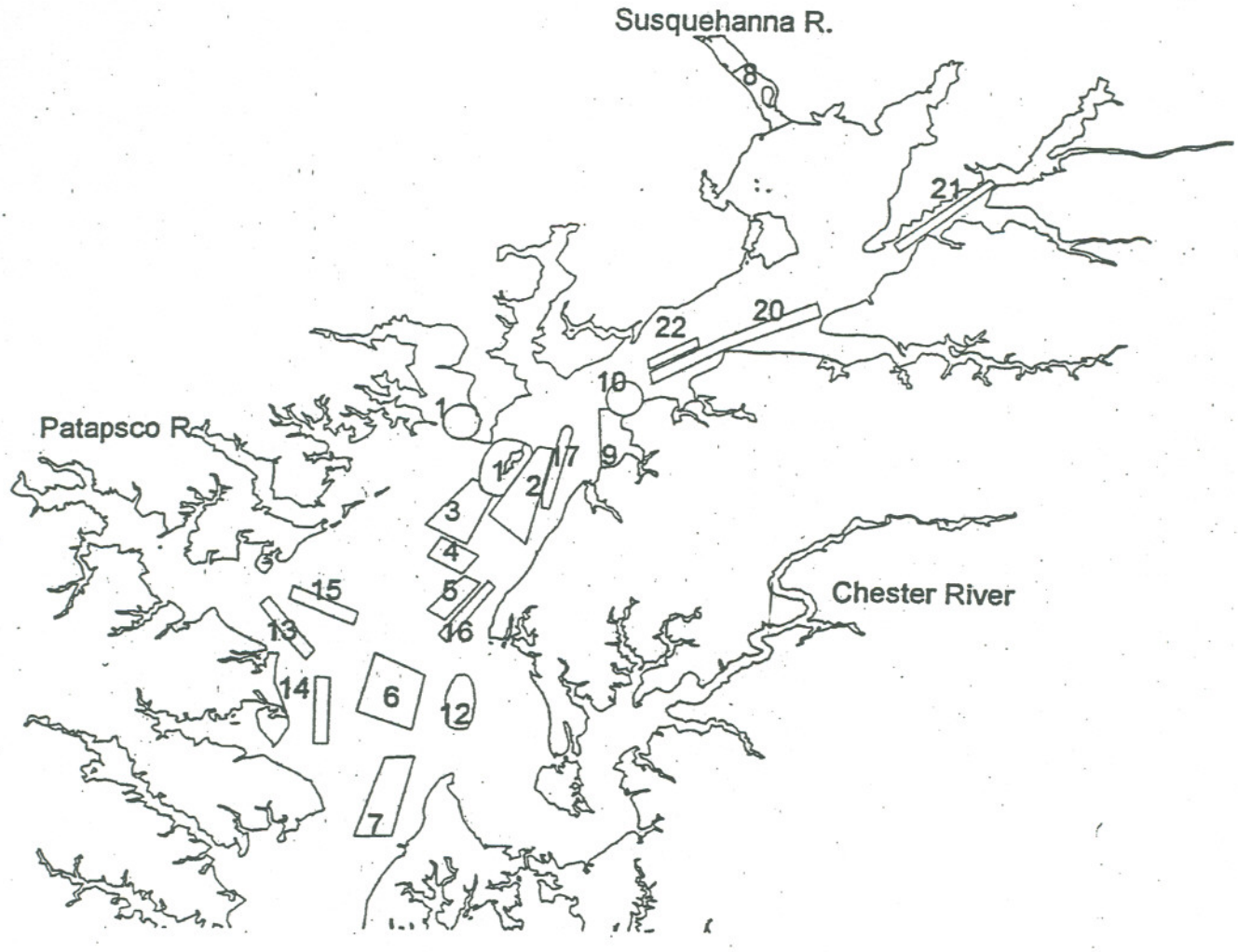

Figure 1. Site locations where gillnets were deployed in the Upper Chesapeake Bay, Maryland (see Table 1).

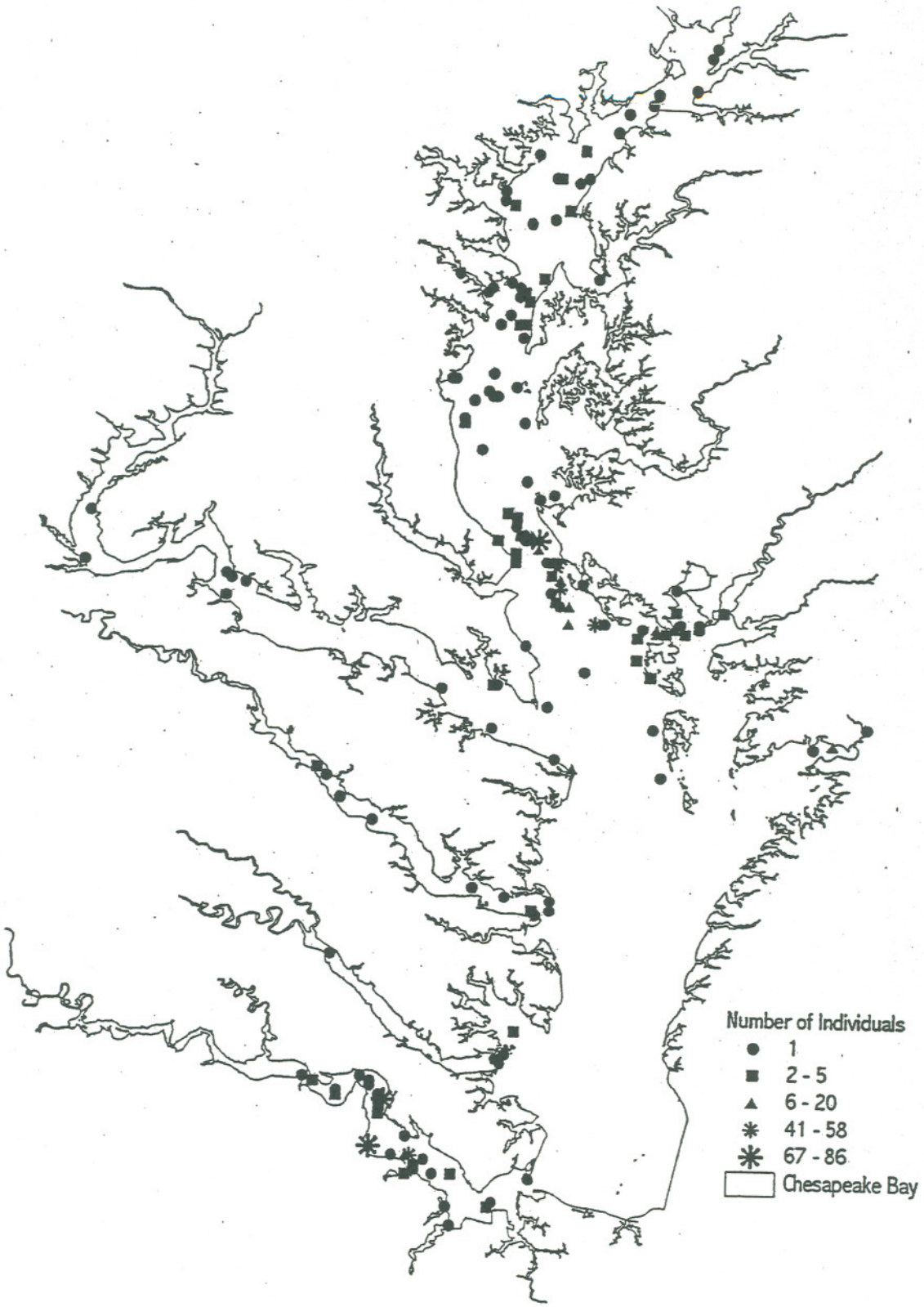

Figure 2. Capture locations of wild Atlantic sturgeon in the Chesapeake Bay, Maryland and Virginia during 1996-2000. Virginia data provided by A. Spells (USFWS).

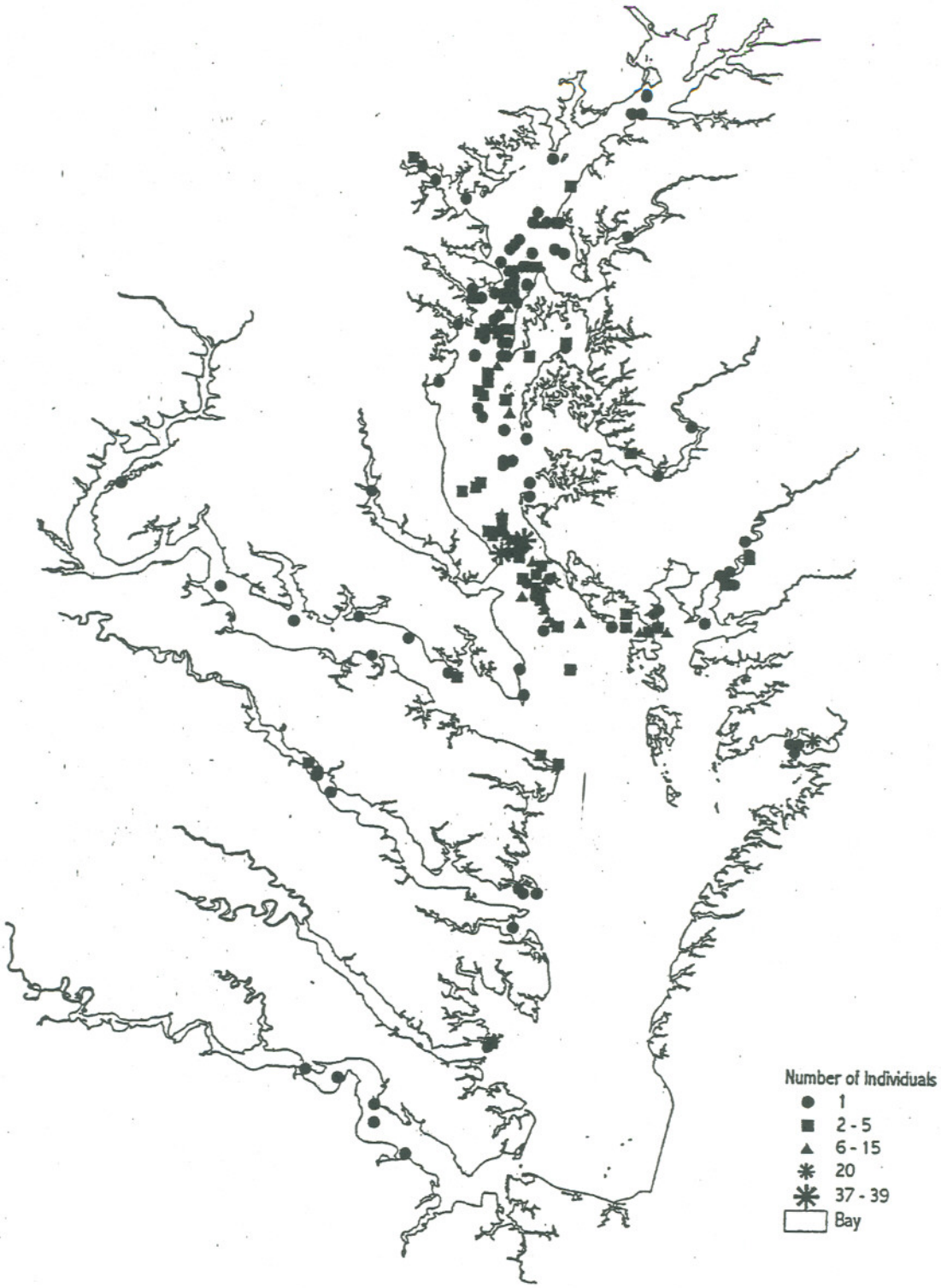

Figure 3. Capture locations of hatchery-reared Atlantic sturgeon in the Chesapeake Bay, Maryland and Virginia during 1996-2000. Virginia data provided by A. Spells (USFWS).

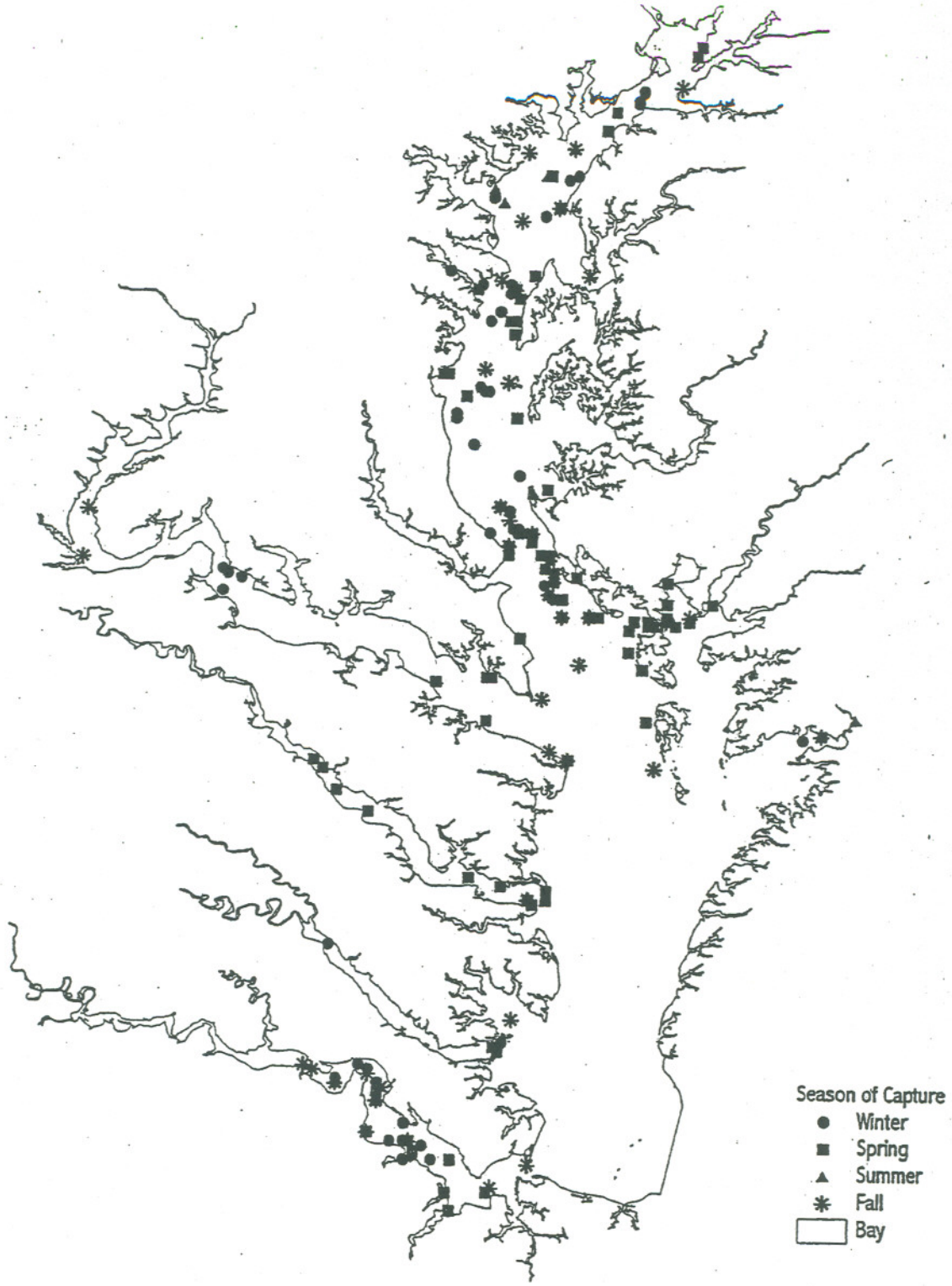

Figure 4. Capture locations of wild Atlantic sturgeon in the Chesapeake Bay, Maryland and Virginia during 1996-2000. Locations are categorized by winter (months 1,2 and 3), spring (months 4,5 and 6), summer (months 7,8 and 9), and fall (months 10, 11 and 12).

Figure 5. Capture locations of hatchery-reared Atlantic sturgeon in the Chesapeake Bay, Maryland and Virginia during 1996-2000. Locations are categorized by winter (months 1,2 and 3), spring (months 4,5 and 6), summer (months 7,8 and 9), and fall (months 10, 11 and 12).

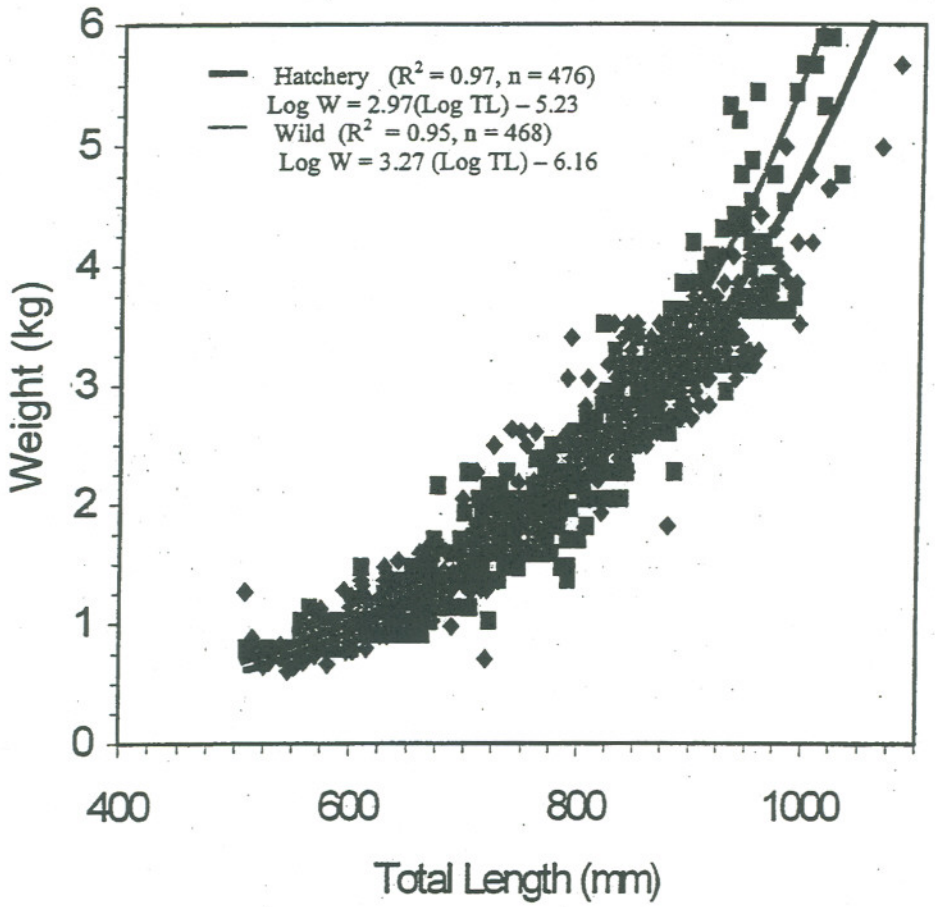

Figure 6. Weight-length relationship from wild (range 445-1100 mm TL) and hatchery-reared (range 465-1100mm TL) Atlantic sturgeon from Chesapeake Bay.

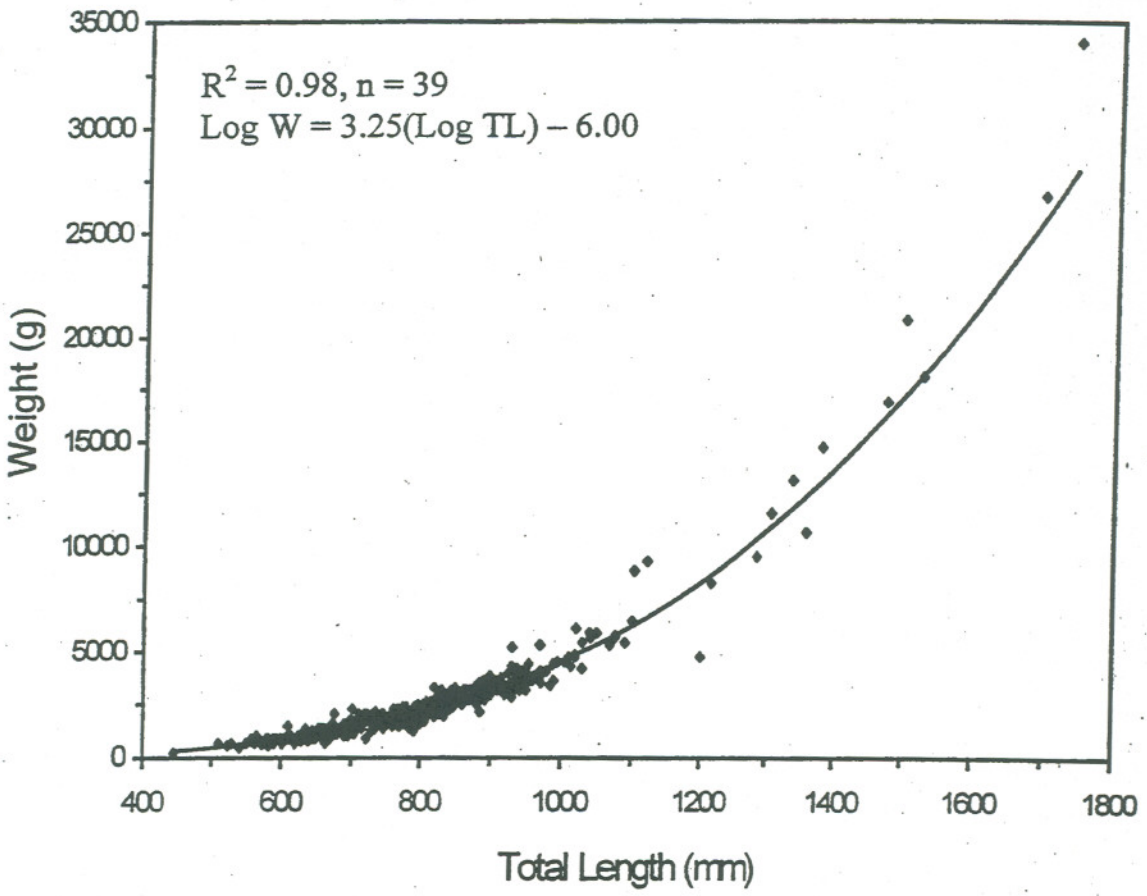

Figure 7. Weight-length relationship for wild Atlantic sturgeon (range 445-1740 mm TL) from Chesapeake Bay.

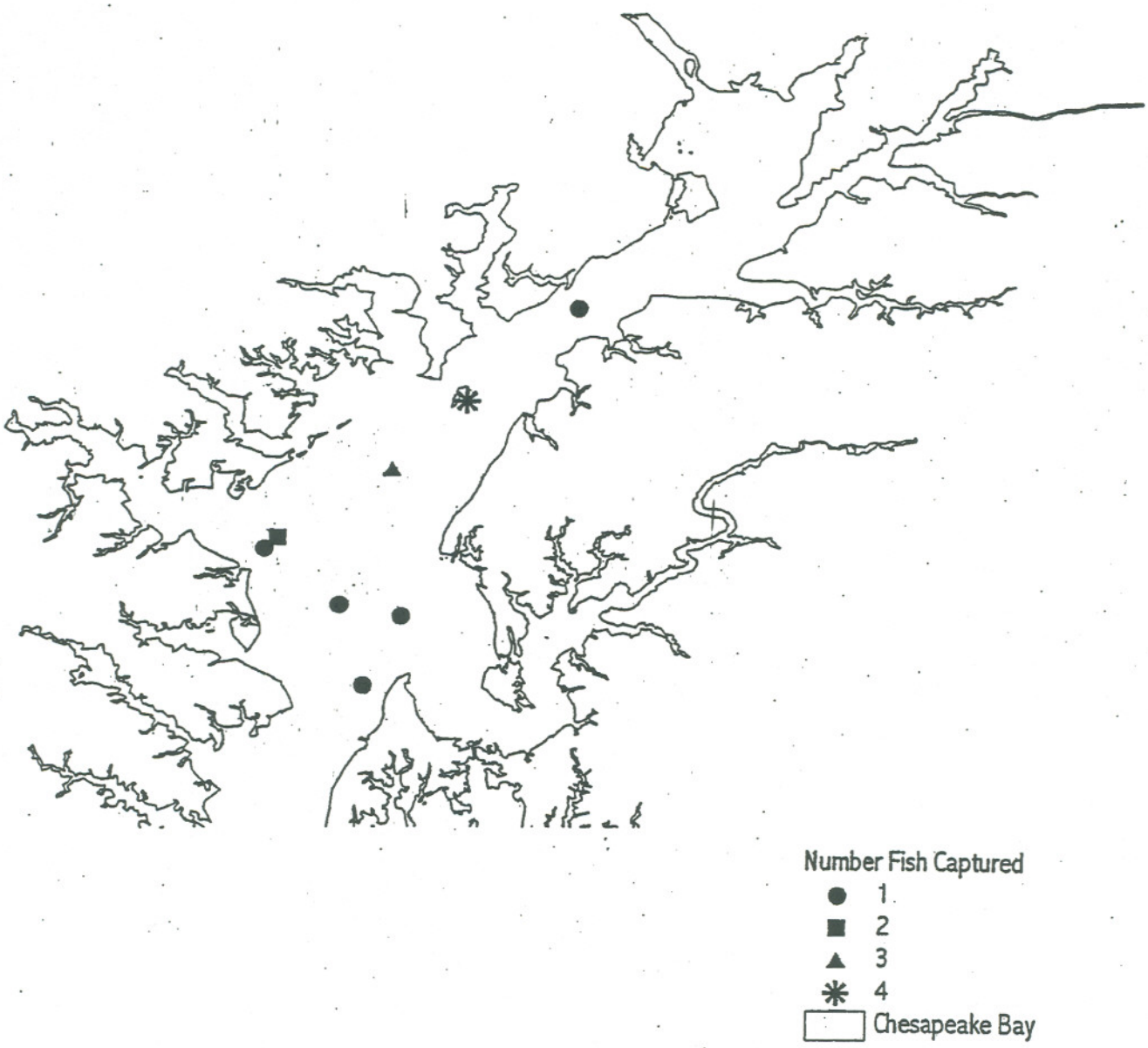

Figure 8. Locations of Atlantic sturgeon captured in Maryland Fisheries Resource Office gillnets in the Upper Chesapeake Bay, Maryland during (1998-2000)

Figure 9. Capture locations of shortnose sturgeon in the Chesapeake Bay, Maryland and Virginia during 1996-2000. Virginia data provided by A. Spells (USFWS).

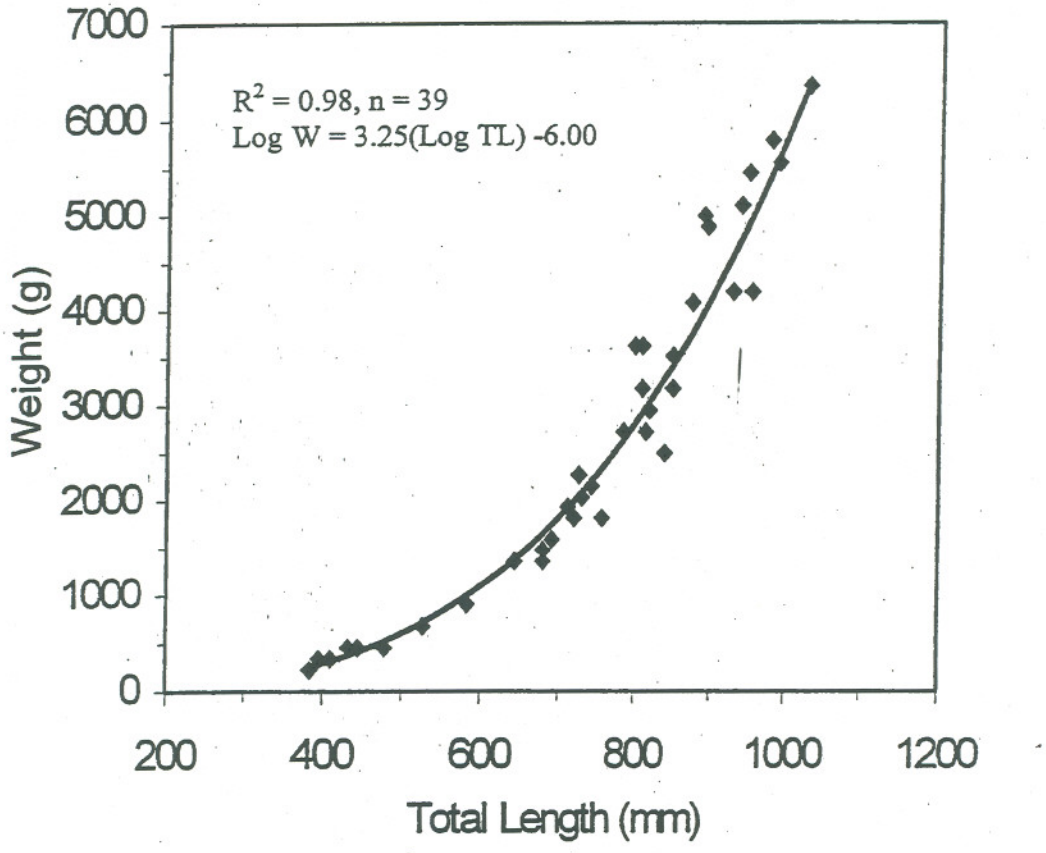

Figure 10. Weight-length relationship for shortnose sturgeon (range 384 - 1030 mm TL) from Chesapeake Bay.

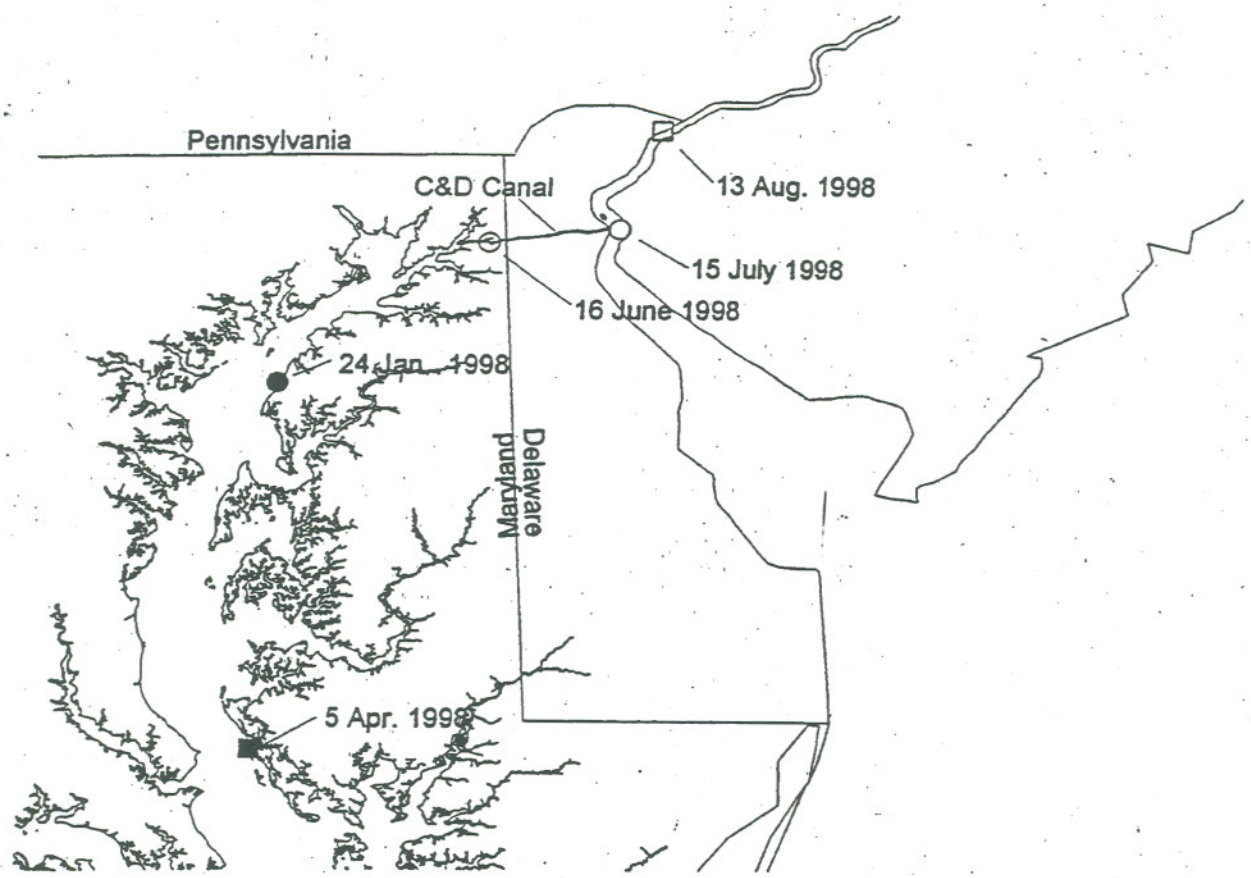

Figure 11. Tag and release locations (closed symbols) of two shortnose sturgeon in the Chesapeake Bay that were located by telemetry (open symbols) in the Delaware River.

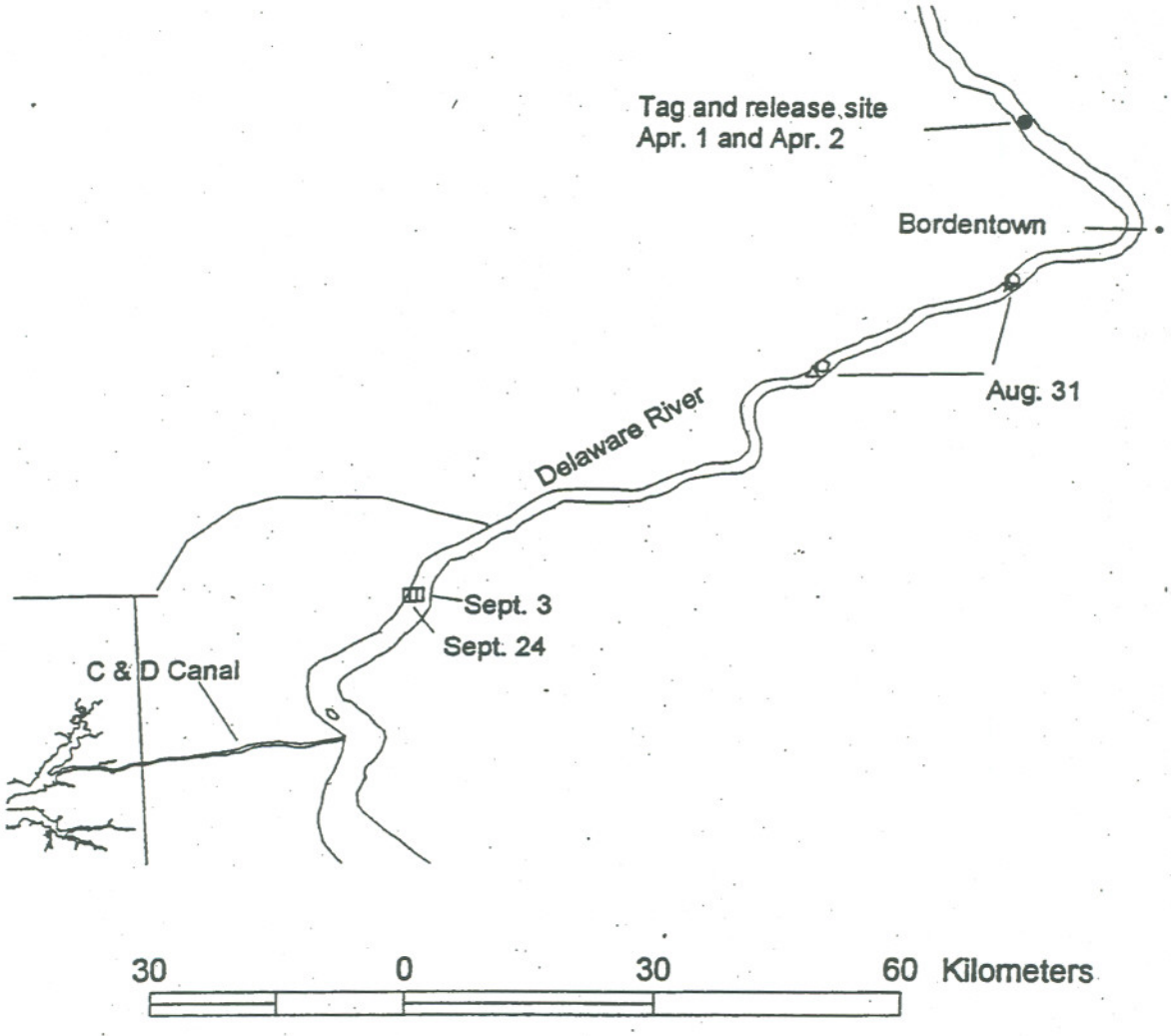

Figure 12. Movements of five shortnose sturgeon in 1998 released on 1 April or 2 April. Fish locations (open symbols) were determined by telemetry.

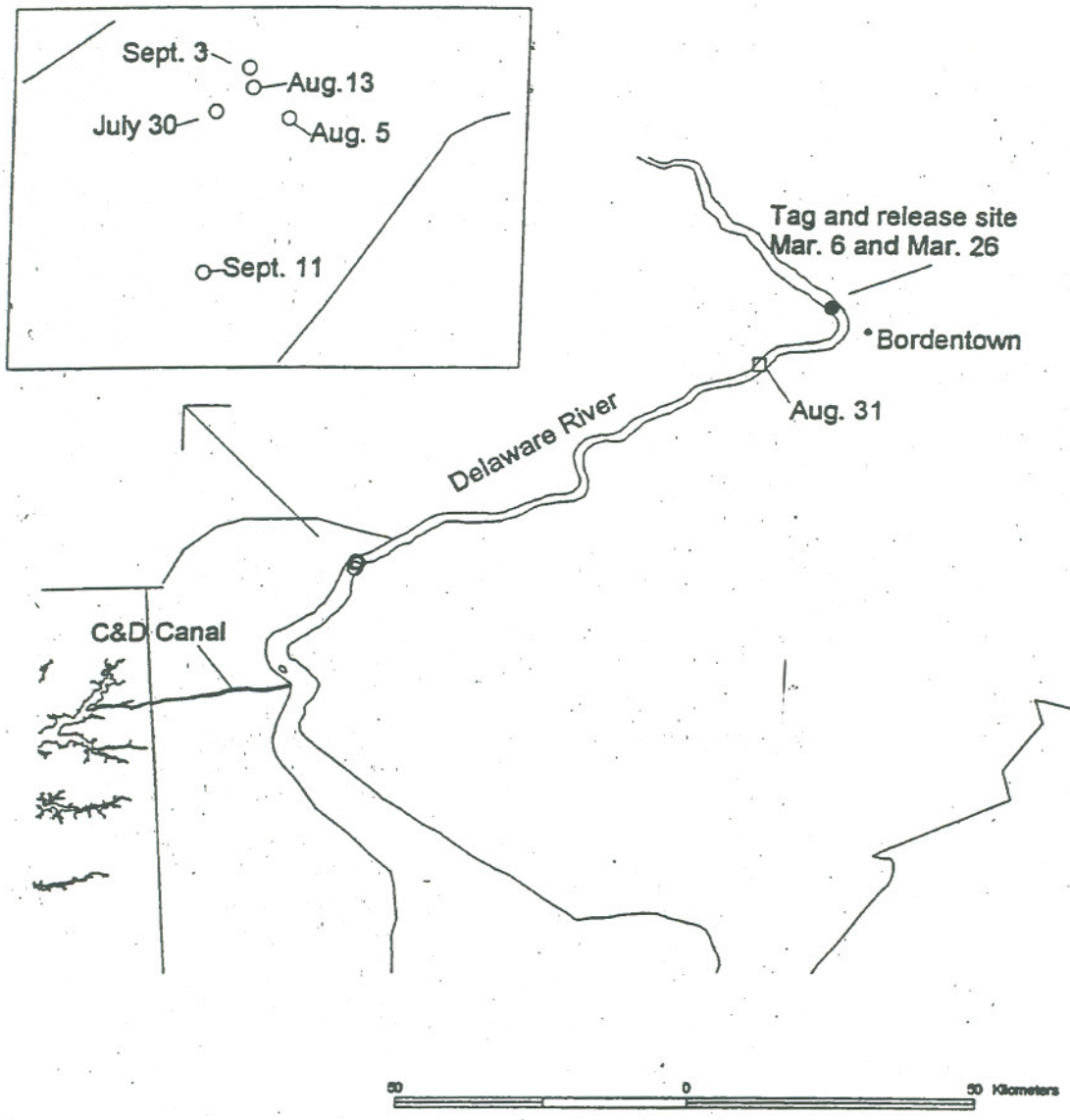

Figure 13. Movements of two shortnose sturgeon released at the same location in March 1998. Fish locations (open symbols) were determined by telemetry for individuals released on 6 March (square) and 26 March (circle).

APPENDIX A

Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay

Atlantic sturgeon population evaluation utilizing a fishery dependent reward program in Virginia's major western shore tributaries to the Chesapeake Bay

An Atlantic Coastal Fisheries Cooperative Management Act Report

For
National Marine Fisheries Service

By
Albert J. Spells
U.S. Fish And Wildlife Service
Virginia Fisheries Coordinator
Charles City, Virginia

Fiscal Year 1998

Atlantic sturgeon population evaluation... a fishery dependent reward program in Virginia: FY98

The National Marine Fisheries Service provided Atlantic Coastal Fisheries Cooperative Management Act funds to the U.S. Fish and Wildlife Service to assess the absence or presence of Atlantic sturgeon in the major western shore tributaries (James, York and Rappahannock River Systems) of the Chesapeake Bay in Virginia in FY98. Funds were used to pay rewards for sturgeon captured by watermen and held alive for FWS during commercial fishing operations. Other funding agencies for this program included FWS, the Fish and Wildlife Service's Chesapeake Bay/Susquehanna River Ecosystem Team, Virginia Marine Resources Commission, Chesapeake Bay Foundation, and Maryland Department of Natural Resources. Other cooperators included the United States Geological Survey- Biological Resources Division, Leetown Laboratory; the University of Maryland-Chesapeake Bay Laboratory; and the Virginia Institute of Marine Science.

The purpose of the program was to obtain data on the presence of sturgeon in Virginia's major tributaries to the Chesapeake Bay. Objectives included ascertaining age and growth of captured fish, determining genetic diversity among fish captured from the Bay and fish from other Atlantic coast systems. The program consisted of working closely with commercial watermen fishing on the James, York, and Rappahannock Rivers. The partnership offered a $100 reward for each live sturgeon that watermen would retain for the program through November 1997. In February 1998 the reward was reduced to $50 per live sturgeon. Rewards were pad only if captured fish were alive and could be released. Watermen were given several telephone numbers through which they could reach the Fish and Wildlife Service. These numbers were to office phones, cellular phones, and a pager. A Service staff member from the Virginia Fisheries Coordinator Office was on call seven days a week from February through November 1997, and in February 1998.

When we received a call, a staffer was dispatched to the location where the fisherman was holding the fish. Information obtained from fishermen included the location of the capture site, the type of gear, size of gear, depth of water, and quantity of gear. Total and fork lengths were measured, and the fish was weighed. Because Maryland Department of Natural Resources released approximately 3,000 Atlantic sturgeon into the upper Chesapeake Bay during the summer of 1996, a wand type coded wire tag (cwt) detector was used to scan each fish for the presence of a cwt.. Small portions of the caudal fin, and a barbel were collected from each specimen and preserved in pure ethyl alcohol for genetic analysis. A small section of the pectoral spine was taken to ascertain age and growth of a sturgeon captured during the program. Anchor tags were inserted into the right pectoral fin (looking from the rear), and into the left base of the dorsal fin. Sample for genetic analysis were immediately put on ice until the sample could be refrigerated later on.

A total of 303 sturgeon were reported during the program. One sturgeon captured from the Rappahannock River in May has been confirmed as a shortnose sturgeon. This may be the first confirmed living shortnose ever recorded in Virginia. Most fish were captured in anchor gill nets with mesh ranging from three-inch stretch mesh, up to 7-inch stretch mesh. Ninety percent (90%) of all sturgeon captured came from the James River, and 95.7% of all sturgeon captured

appear to be wild fish, i.e., no external tag or cwt were observed (Table 1). Hatchery released fish accounted for 1.1%, 33.3 % (of nine fish captured) and 33.3% (21 fish sample), of sturgeon from the James, York and Rappahannock Rivers, respectively. A month-by-month summary of sturgeon captured during the program is attached (Table 2). The month-by-month data do not include several specimen captured by the Virginia Institute of Marine Science juvenile trawl survey program.

Preliminary results of this program suggest that a successful spawn of Atlantic sturgeons in the lower Bay in the very recent past may have occurred Many small (<500 mm TL) fish were collected during October and November. VIMS captured a 260 mm TL individual in April. A reliable source also reported the capture and release of two sturgeon in the 250-mm size class in the upper James River during the winter of 1997. These specimens were captured with cast nets that were being used to catch bait fish. Preliminary age results from spines indicated that 34% of 85 spines examined from sturgeon examined during this study were age 1. Thirty-nine percent (39%) were age 2 (Dr. David Secor, Chesapeake Bay Laboratory, personal communications).

Sizes of fish captured appear to have been dictated by the target species that watermen were after. During the period that watermen targeted striped bass (February through May), sturgeon averaged 945 mm TL. 805 mm. 811 mm. and 817 mm, In February, March, April and May, respectively. The typical mesh size during the period was 5 inches or more. During October, November and February 1998 when fishermen targeted croaker, weakfish, and perch using three to 3.25 inch mesh, the average size of fish dropped to 510 mm, 504 mm and 543 mm. Due to the nature of the commercial fisheries in Virginia, few watermen fish upriver, and we therefore do not have any fish captured above Jamestown Island in the James River, for example. The U.S. Geological Survey's Biological Resources Division (Leetown Laboratory, WV) has conducted preliminary genetic analysis on tissue samples for DNA markers. Those results are reported in King and Lubinski (1998).

The reward program was suspended in Virginia beginning on November 6 due to a lack of funds. Additional funding was receive to re-start the program in February 1998, but they were expended in four (4) days after the reward was reduced to $50 per live fish. Watermen continued to cooperate regarding keeping incidentally caught fish alive, and waiting with the fish until someone could process the data. A reward amount lower than $50 per live fish may not encourage participation by many watermen. This project should be established as a multi year program to determine any trends in the numbers and sizes of fish in Virginia tributaries.

Table 1. Atlantic sturgeon* reported during the sturgeon reward program in Virginia's tributaries of the Chesapeake Bay, February-November 5, 1997, and February 10 - 13, 1998 (USFWS).

River	Total Fish Captured	Wild Fish Captured	% of Total	Hatchery Fish Captured	% of Total
TOTAL	303	290	95.7	13	4.2
James	273	270	98.9	3	1.1
York	9	6	66.7	3	33.3
Rappahannock	21	14	66.7	7	33.3

*One sturgeon from the Rappahannock River was confirmed as a shortnose sturgeon.

Table 2. Month by month summary of sturgeon data collected during the reward program in Virginia's tributaries to the Chesapeake Bay, February - November 3, 1997, and February 10-13, 1998 (USFWS)

		MONTH				
River		**Feb**	**Mar**	**Apr**	**May**	**Jun**
James	# Cap/# Hat.	2/0	10/2	14/1	18/0	2/0
	Avg. TL/Hat.	945/-	805/575	811/815	817/-	648
	Size Range/(Hat.)	835-1055(-)	440-1030(510-640)	260-1390(815)	510-1700(-)	420-931
York	# Cap/# Hat.	1/0	2/1	3/2	1/1	0/0
	Avg. TL/Hat.	625/-	1150(630)	675/683	759/-	-
	Size Range/Hat	-	-	675(680-687)	-	-
Rapp	# Cap/# Hat.	0/0	1/1	14/5	4/0	1/1
	Avg. TL/Hat.	-	-/595	716/647	630/-	-/630
	Size Range/Hat	-	-	506-993(508-744)	506-708(-)	-

		MONTH					
River		**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Feb**
James	# Cap/# Hat.	1/0	2/0	4/0	90/0	30/0	69/0
	Avg. TL/Hat.	875/-	-	470/-	510/-	504/-	543/-
	Size Range/Hat.	-	-	445-495(-)	402-2600(-)	442-940(-)	438-953
York	# Cap/# Hat.	0/0	0/0	1/0	0/0	0/0	0/0
	Avg. TL/Hat.	-	-	615/-	-	-	-
	Size Range/Hat	-	-	-	-	-	-
Rapp	# Cap/# Hat.	0/0	0/0	0/0	1/0	0/0	0/0
	Avg. TL/Hat.	-	-	-	1004/-	-	-
	Size Range/Hat	-	-	-	-	-	-

Cap./# Hat = Number of fish captured/# hatchery fish recaptured

Avg. TL/Hat. = Average Total Length (mm) of all wild fish captured*/Average Total Length (mm) of hatchery fish recaptured

Size Range/Hat. = Size range (Total Length, mm) of wild fish/size range (Total Length, mm) of recaptured hatchery fish

*All fish not possessing an external tag or cwt indicating that they were hatchery fish are considered wild until proven otherwise, e.g. DNA analysis

References

King, T.L., and Lubinski, B.A. 1998. Conservation genetics of Atlantic sturgeon (*Acipenser oxyrinchus*): marker development and identification of genetic diversity (Status Report). USGS- BRD, Aquatic Ecol. Lab., Leetown, WV.

Appendix C

Transmittal Letter to USFWS for Interim Biological Assessment on the Potential Impacts of Dredged Material Placement Operations in the Upper Chesapeake Bay on Shortnose Sturgeon November 2000

November 13, 2000

Operations Division

Mr. John Wolflin
Field Supervisor
U.S. Fish & Wildlife Service
177 Admiral Cochrane Drive
Annapolis, Maryland 21401

Dear Mr. Wolflin:

I am enclosing a copy of the *Interim Biological Assessment on the Potential Impacts of Dredged Material Placement Operations in the Upper Chesapeake Bay on Shortnose Sturgeon, June 2000,* for your information, review, and comment.

The Interim Biological Assessment (BA) reflects most of the results of the two and one-half-year sturgeon study conducted by your office. Copies of the Interim BA and *A Report of Investigation and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake Bay, October 2000* were sent to the National Marine Fisheries Service (NMFS) for review and comment. Upon receipt of comments from the NMFS and your office, and receipt of the genetic analyses reports, we will incorporate this information together with the findings of your report in the final BA and forward a copy to your office for information.

I received Mr. Skjeveland's October 17, 2000 proposal to continue tagging and tracking sturgeon for an additional year. We will continue to cooperate with the NMFS and the FWS in this endeavor. Details of the study will be worked out upon Mr. Skjeveland's return to the office.

Please provide any comments on the Interim BA before December 15, 2000. Please call me at 410-962-5657 if you have any questions regarding this matter.

Sincerely,

Jeffrey A. McKee
Operations Manager
Operations Division

Enclosure

McKEE/CENAB-OP/nls/25657
FILE: WORD\BALTIMORE\FWS-STUR-BA

Appendix D

Transmittal Letter to NMFS for Interim Biological Assessment on the Potential Impacts of Dredged Material Placement Operations in the Upper Chesapeake Bay on Shortnose Sturgeon November 2000

November 13, 2000

Operations Division

Dr. Chris Mantzaris
United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
One Blackburn Drive
Gloucester, Massachusetts 01930-2298

Dear Dr. Mantzaris:

I am enclosing a copy of the draft *Interim Biological Assessment on the Potential Impacts of Dredged Material Placement Operations in the Upper Chesapeake Bay on Shortnose Sturgeon, June 2000,* and the U.S. Fish & Wildlife Service's (FWS) *A report of investigation and Research on Atlantic and Shortnose Sturgeon in Maryland Waters of the Chesapeake Bay, October 2000*, for your information, review, and comment.

The Interim Biological Assessment (BA) and FWS report were prepared in response to the National Marine Fisheries Service's (NMFS) October 20, 1997, and December 18, 1999, letters requesting that the Baltimore District initiate consultation with the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act, conduct a two-year sampling and tracking program to collect information on the distribution and habitat requirements of the shortnose and Atlantic sturgeon in the upper Chesapeake Bay, study the ecology and genetics of the shortnose sturgeon in order to evaluate the potential impacts of dredging and dredged material placement on the shortnose sturgeon in the upper Chesapeake Bay, and prepare a biological assessment. The Interim BA and FWS report reflect the results of the two and one-half-year conducted by the FWS under contract to the Corps of Engineers. The final results of the genetic testing are expected within the next several weeks. Upon receipt of the genetics report and any comments on the Interim BA, we will finalize the BA and forward it to your office for use in preparing a biological opinion.

The FWS recently approached us about continuing to tag and track sturgeon for an additional year. The scope of work for this additional work has been coordinated with your staff. We will cooperate with the NMFS and the FWS in this endeavor.

Please provide any comments on the reports before December 15, 2000. Please call me at 410-962-5657 if you have any questions regarding this matter.

Sincerely,

Jeffrey A. McKee
Operations Manager
Operations Division

Enclosures

Copy Furnished:

Mr. Timothy E. Goodger
Habitat Protection Branch
Environmental Assessment Division
National Marine Fisheries Service
Oxford Laboratory
Oxford, Maryland 21654

McKEE/CENAB-OP/nls/25657

S:\General Correspondence\O P\Baltimore Harbor\NMFSSTURBA.rtf

Appendix E

Carrie McDaniel
NOAA email
dated August 29, 2002

-----Original Message-----
From: Carrie Mcdaniel [mailto:Carrie.Mcdaniel@noaa.gov]
Sent: Thursday, August 29, 2002 5:16 PM
To: Jeff McKee
Cc: Kim Damon-Randall; Pasquale Scida
Subject: Upper Bay dredging

Hi Jeff-
This is in regards to our earlier conversation on your upcoming dredging in the Upper Chesapeake Bay. I understand the ACOE Baltimore District plans to dredge 4 channels beginning in October of this year. I believe these 4 channels include the Craighill Entrance, Craighill Channel, Craighill Upper Range, and Cutoff Angle; please let me know if this isn't the case.

NOAA Fisheries previously has had limited information on the potential for sturgeon to be taken in mechanical dredges. As such, previous letters to you (dated October 1997; January 1998; December 2000) indicated that if a mechanical/clamshell dredge was used in ACOE Baltimore maintenance dredging, shortnose sturgeon were not likely to be adversely affected. As I mentioned on our call, new information has come up that indicates sturgeon may be taken in these types of dredges. For example, an Atlantic sturgeon was killed in the Cape Fear River in a bucket and barge operation, and within the last year, an Atlantic sturgeon was captured in a clamshell bucket, deposited in the dredge scow, and release apparently unharmed during dredging operations in the Kennebec River. While these documented takes have been Atlantic sturgeon, the similarity of the species, distribution, and behavior, indicates that shortnose sturgeon could be taken as well. Endangered species takes of these kind are not authorized without an Incidental Take Statement. While the impacts to shortnose sturgeon from mechanical bucket dredging are expected to be less than those from other types of dredges (e.g., hopper and hydraulic pipeline), the potential for taking shortnose sturgeon with this type of dredge exists. Furthermore, dredging in the Delaware River and Kennebec River have incorporated mechanical dredging time of year restrictions due to the presence of shortnose sturgeon.

This represents new information that was not available to NOAA Fisheries during the last consultation, and this information changes the basis for the previous conclusion. We recommend that measures be taken to minimize impacts to shortnose sturgeon during the upcoming dredging projects. Specifically, NOAA Fisheries recommends dredging take place this year from September to November. If this is not possible and mechanical dredging must occur from December to March this year (or a hydraulic dredge is used), we recommend the ACOE initiate formal consultation with NOAA Fisheries so that the impacts of dredging on shortnose sturgeon during this time frame can be assessed. Regardless, if the ACOE plans to use mechanical dredges in the Chesapeake Bay in the future and NOAA Fisheries determines that shortnose sturgeon may be taken during these operations, it will be necessary to engage in formal consultation for all of the Baltimore Harbor Channels to assess the impacts to shortnose sturgeon and provide an Incidental Take Statement.

Appendix F

Kimberly Damon-Randall
NOAA email
dated October 29, 2002

-----Original Message-----
From Kimberly.Damon-Randall [mailto:Kimberly.Damon-Randall@noaa.gov]
Sent Tuesday, October 29, 2002 7:25 AM
To Mckee, Jeffrey A
Cc Carrie Mcdaniel; Pasquale Scida; Mary A Colligan
Subject dredging and dredge placement in the upper Chesapeake Bay

Hi Jeff. I have been working with Carrie McDaniel regarding the proposed dredging in the upper Chesapeake Bay. We have reviewed the biological assessment (BA) that was prepared in 2000, and we believe the ACOE has done a thorough job with the BA. However, several sections need to be updated with new information collected since June 2000. Those sections include: the information related to dredging and shortnose sturgeon, all details related to the proposed project (i.e., what has happened with the ACOE's schedule for dredging, channels to be dredged, placement areas, etc. since 2000), and the dredging impacts to the species (e.g., include details on mechanical takes and any others in hoppers, how species may be impacted given NOAA Fisheries preferred time of year restriction that prohibits dredging from December through the month of July). Also, after having carefully reviewed the information contained in the BA, we recommend the following revisions:

Page 8: in the fourth paragraph, a reference is made to an interim BO being prepared. NOAA Fisheries does not issue interim BOs.

Page 9: information pertaining to the FWS Reward Program should be updated to reflect the shortnose sturgeon captures since June 2000. As of July 2002, 50 shortnose sturgeon have been documented in the Chesapeake Bay and its tributaries as a result of the Reward Program.

Page 27: last partial paragraph, states that post-spawning adults move to deep overwintering sites. This should be changed to pre-spawning adults as post-spawning adults migrate downstream after spawning to forage, typically in estuarine areas.

Page 29: first full sentence on the page states that after spawning, adults move to deep overwintering sites. After spawning, adults move downstream to forage. This, therefore, should be changed to prior to spawning, adults move to deep overwintering sites.

Page 31: update Reward Program information

The BA states that a bucket, hydraulic, or hopper dredge might be used for this project. As such, NOAA Fisheries must assess the effects of each type of dredge on shortnose sturgeon. As Carrie mentioned in her August 29, 2002 email, we have new information on the potential effects of bucket dredging on shortnose sturgeon. An Atlantic sturgeon was killed in the Cape Fear River in a bucket and barge operation (NMFS 1998) and in 2001, an Atlantic sturgeon was captured in a clamshell bucket, deposited in the dredge scow, and release apparently unharmed during dredging operations at Bath Iron Works in the Kennebec River (Maine DMR 2002). While these documented takes were Atlantic sturgeon, the similarity of the species, distribution, and behavior indicates that shortnose

sturgeon could be taken as well. While the impacts to shortnose sturgeon from mechanical bucket dredging are expected to be less than those from other types of dredges (e.g., hopper and hydraulic pipeline), the potential for taking shortnose sturgeon with this type of dredge exists. As such, if the dredging in the upper Chesapeake Bay cannot be accomplished during the preferred time period, formal consultation will be necessary.

I will be the contact person for the consultation. If you have any questions or require further clarification on any of the issues addressed in this email, please feel free to call me at the number provided below or respond to this email. Thanks.

Kim