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Final Report

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Project Title: **Abundance of Sub-adult Atlantic Sturgeon and Areas of Concentration Within the Lower Delaware River**

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Introduction

The Delaware Division of Fish and Wildlife initiated this study to address questions that were raised by the Atlantic sturgeon tagging program in the lower Delaware River from 1991 through 1995 (Shirey 1996). The tagging program was successful in documenting sturgeon migrations outside the Delaware River and in revealing trends of abundance of sub-adult Atlantic sturgeon in the lower Delaware River. However, other information such as daily, intertidal, and seasonal movement within the estuary remained unknown. This study was initiated to attempt to locate other important Atlantic sturgeon habitats within the lower Delaware River and hopefully gain insight into inter-tidal movements. The abundance monitoring and tagging were also continued to maintain the database and time series on sturgeon abundance

established in 1991.

The data collected in this program will be useful in determining long-term trends in abundance while at the same time providing additional information on critical habitat usage within the Delaware Estuary. Sampling programs which can monitor the abundance of young sturgeon are important to document recent spawning success and future recruitment potential into the adult spawning stock. Critical habitats can be protected from possible impact and degradation.

Methods

The abundance of sub-adult Atlantic sturgeon was determined through the use of gill nets set in the lower river near Artificial Island, NJ and Reedy Island, DE. The net, consisting of six 61-meter panels of multi-filament nylon gill net with various mesh sizes ranging from 10.2 to 25.4-cm stretched mesh, was set at the end of ebb tide and fished through slack tide. The duration of the set was usually about one hour. All sturgeon collected were tagged, measured, weighed and released. Tissue samples, consisting of either a barbel or fin clip, were collected and preserved in alcohol for future DNA analysis. Spine samples were taken from most sturgeon (except those tagged with sonic transmitters) to determine age structure of the catch.

Ultrasonic transmitters were used to monitor movement of selected Atlantic sturgeon within the Delaware River. Three sturgeon were fitted with transmitters in August of 1996. We used individually coded tags manufactured by Sonotronics (Tucson, AZ) with external mounts and magnetic on / off switches. Two different locations on the sturgeon were used to attach the transmitter during the program.

During 1996, the transmitter was attached just beneath the dorsal fin via two small gauge stainless steel wires that were passed through the body using a pointed hollow metal tube (approximately 3 mm in diameter). The wires were then twisted together on the opposite side of the body and the excess trimmed off.

During July of 1997, seven additional sturgeon were fitted with transmitters, but the method of attachment was greatly modified. The transmitter was moved anteriorly from just below the dorsal fin to the 4th and 5th pre-dorsal scute. Four holes (two on each adjacent scute) were drilled with a portable drill and 1/8 th inch bit. Each set of holes was then flushed with an antiseptic (betadine). A brass grommet was inserted into each hole to act as a bushing to prevent the wire from slowly cutting through the scute. The ends of a 25-cm piece of Berkley© nylon-coated wire (120 lb test ; .042 dia) were passed through each end of the tag and through the paired holes of the scutes. Each end of the wire was then passed through a large plastic washer on the side of the scute opposite the tag. A pair of metal sleeves were crimped on the wire to secure it in place and the excess wire trimmed. Throughout the procedure of attaching the transmitter, the sturgeon was held in river water in a small on-board plastic pool kept in the shade to minimize handling stress. The entire procedure took between 3 and 5 minutes to complete. The sturgeon were immediately released after the transmitter was attached and the initial direction of movement was determined.

Tracking

A USR-5W ultrasonic tracking receiver with a DH-2 directional hydrophone was used to locate tagged sturgeon. The hydrophone was mounted on one end of a 183-cm x 3.175-cm diameter PVC pipe; an elbow fitting and a 20-cm section of pipe was

attached to the opposite end which pointed in the same direction as the hydrophone. The river was scanned for a transmitter signal by holding the boat stationary (relative to the water) and lowering the hydrophone to a depth well beneath (1 meter) the hull of the boat. The hydrophone was slowly rotated 360°, at least twice, in an attempt to receive any nearby transmitter signals. If no signal was heard, we moved approximately 0.5-nm and repeated the scanning procedure. If a signal was detected, its bearing was determined by the direction of the strongest signal. The closer to the transmitter, the wider the angle the signal could be heard. This process was repeated until the transmitter signal could be heard the entire 360° of the hydrophone scan. At that point we assumed we were almost directly over the transmitter.

The fish's latitude and longitude was marked at that position using a hand-held GPS (global positioning system). Water chemistry was taken at the surface and bottom using a YSI Model 610-D; parameters measured included water temperature, salinity, conductivity, dissolved oxygen, pH and depth.

Atlantic sturgeon were relocated throughout the summer and into the fall on a weekly basis when weather and other field sampling allowed. We initially relocated the sturgeon by beginning either well above or below where we anticipated finding the fish based on their time at large.

Results

Abundance

During 1997, gill-net sampling commenced on June 19 and continued through October 21. A total of 17 gill net sets were made which captured 57 Atlantic sturgeon in 17.2 hours of soak-time. The overall CPUE was 3.31 fish per net hour. A population

estimate could not be made due to the lack of any recaptures of fish tagged during the 1997 sampling season.

Daily catches and hourly catch rates are presented in Table 1. The number of sturgeon taken generally increased from late June at 1.2 fish per hour to a peak of 12 fish and a 10.3 fish/h rate on July 25. The highest catch rate occurred on August 22. However, this was a short set made at the up-river site described in the tracking portion of this report.

The length frequency distribution of Atlantic sturgeon taken during 1996 and 1997 is presented in Figure 1. The average size of sturgeon taken was larger in 1997 than in 1996. In 1997, sturgeon ranged from 72-cm to 162-cm (TL) with a mean total length of 109-cm (SD 17.5-cm). Fish from 100 to 120-cm were the most abundant size group and accounted for over 50% of the catch with a combined catch rate of 1.8 fish/h. Small sturgeon less than 80-cm were poorly represented, with only one fish taken for a catch rate of 0.06. Large sturgeon over 120-cm increased in number, proportion of the catch, and catch rate compared to the 1996 collections.

Recaptures:

A total of five sturgeon tagged in previous years were recaptured during 1997. Tag and recapture information for 1996 and 1997 are presented in Table 2 and Table 3 respectively. In 1997, the time at large for these recaptures ranged from 62 to 1,845 days. The recapture of a fish tagged on September 1, 1992, was the longest time at large of any previous recapture from this program. All sturgeon recaptured in 1997 were reported alive at the time of capture and were released.

Three Atlantic sturgeon that were collected during 1997 were missing their left

pelvic fin. These sturgeon may have been from a hatchery release made in the Hudson River during 1994 by the U.S. Fish and Wildlife Service (J. Skjeveland - USFWS, per. comm). The hatchery reared fish were all marked with a left pelvic fin clip and a coded wire tag. Unfortunately we did not scan them for the presence of a wire tag. One of these fin-clipped fish was subsequently recaptured in the mid-Chesapeake Bay on November 10, only 62 days after being tagged in the Delaware River. This much distance traveled in such a short time period during the fall may suggest movement through the Chesapeake and Delaware Canal.

Sonic Tracking (1996)

Sonic tracking of sub-adult Atlantic sturgeon commenced in mid-August, 1996. Given the late start-up date of the project in 1996, we concentrated our efforts on gaining experience in attaching the transmitters and use of the sonic telemetry equipment. One sturgeon was taken in a gill net set on August 16 near Reedy Island, the other two on August 19 in the same location. During the late summer and early fall of 1996 we attempted to follow the movements of these three sturgeon. Biological information on all those tagged with sonic transmitters is presented in Table 4.

The initial movement of the first fish tagged (#15-15) was followed the day of its release to a position near the eastern end of the Chesapeake and Delaware Canal (Table 5 and Figure 2), an upstream movement of approximately 3.0 nautical miles. Tracking was then terminated for the day. This fish was not relocated again throughout the remainder of the season.

Sturgeon 3-3-4-4 was tagged on August 19, 1996 and released. It was relocated

16 times from August 22 (day 3) through September 5 (day 17) (Table 6). This sturgeon remained in the same general area near the Phoenix wreck ("WR10R") and the northern end of Artificial Island. During this period it was usually in or relatively close to the shipping channel in much deeper water than it was collected.

On September 4, we monitored this sturgeon's movements around the change of the tide to determine if there was any noticeable inshore movement compared to the relatively deep water habitat where it was normally found. The predicted low water was at 11:37 hours. The sturgeon was located at 11:25 hours on the western side of the shipping channel in 14-m of water (Figure 3, position 16), mid-way between the yellow marker N "B" and the Phoenix wreck ("WR10R"). A slack tide occurred at 12:10 hours. During the slack tide the sturgeon crossed the channel from the west to the east side, but no inshore movement occurred. A significant upriver movement occurred between 13:30 hours on Sept. 4 and the morning of Sept. 5. This sturgeon was re-located approximately 14 nautical miles up river in the vicinity of the Cherry Island Flats across from the mouth of Shell Pot Creek, DE in deep water adjacent to the shipping channel. This was the last position that this fish was found.

The sturgeon with tag #10-6 was tagged and released on August 19, 1996 at the same time as fish 3-3-4-4. It was relocated on six occasions from day 4 through day 22 (Table 7); always downstream of its release site (Figure 4). This sturgeon probably lost its tag shortly after day 8. No significant movement from this co-ordinate was detected on any subsequent date after August 26. Assuming the transmitter was still attached, we attempted to capture this fish, or any others that might be in the area by gill net on September 10 but no sturgeon were taken.

Sonic Tracking (1997)

Two sturgeon were tagged and released on July 9, 1997. Tag number 3-7-5 was attached to a 122-cm (TL) sturgeon. The sturgeon with tag number 4-6-5 was 101-cm. Both of these fish were released in the same general location at approximately 12:15 hrs at the beginning of the flood tide. Their initial movements were monitored throughout the remainder of day until sunset. Both fish moved up-river with the current remaining in relatively deep water close to the shipping channel. Fish 4-6-5 moved up close to the southern end of Pea Patch Island by 17:30 h. Fish 3-7-5 traveled upstream at a faster rate but it also halted its upstream movement above Pea Patch Island at the change of the flood tide. Tracking was terminated for the day at 19:00 h.

Fish #3-7-5, was not relocated again until July 18, nine days after release. It was found well upriver near the DE state line across the river from Marcus Hook, PA near Oldman's Creek, NJ (Figure 5). Tag #4-6-5 was relocated the day after release below Artificial Island approximately 4.7 nautical miles below the original capture site (Figure 6). On July 11 (day 2) it was relocated still further downstream just north of Collins Beach, DE approximately 8.4 nautical miles below the release location. At some point over the next two days the sturgeon returned upstream to the vicinity of its original capture, being found on day 5 off Artificial Island in the lower end of the designated anchorage area.

Overall, fish #4-6-5 was located on 35 occasions from July 9 through October 9. Except for the downstream movement observed on day 1 and day 2, it spent the rest of the summer in the vicinity of Artificial Island (Figure 6). On most occasions it was located in the deep flats of the anchorage area near the island. However, it was also

found moving into the adjacent portion of the shipping channel. This fish also formed an association with another sonic-tagged fish (# 3-8-4) and remained close to it from July 31 through the month of August and into September (Figure 10). The tag was probably shed sometime shortly after September 15 as almost no change in location was noted after this date.

On July 22, 1997 five additional sturgeon were captured by gill net, tagged with sonic transmitters, and released in the same general area as the first two. Tag #3-4-3-4 was attached to a relatively large sturgeon (122-cm TL) which was a recapture from tagging efforts in the Delaware River during 1994. It was originally tagged on Oct. 24, 1994 when it was 81-cm (TL). The next year it was recaptured in Delaware Bay off the mouth of the Leipsic River in a commercial gill net and released. Unfortunately, the transmitter failed to function upon release and was not detected in any of the surveys during the remainder of the program.

The movements of the other four sturgeon were monitored into October. Two fish from this release, #2-8-5 and #2-9-4, moved upstream above the Delaware Memorial Bridge and remained there throughout the rest of the summer(Tables 10 and 12 and Figures 7 and 9). The other two sturgeon, #2-7-6 and #3-8-4, maintained their position in the vicinity of Artificial Island for the remainder of the program (Tables 11 and 13 and Figures 8 and 10).

Discussion

The abundance of sub-adult Atlantic sturgeon increased slightly during 1997 based on CPUE from 2.5 to 3.49. This ended a dramatic decline in catch and catch rates that had been observed since the program was initiated in 1991. The increase in

the catch of large sub-adults, greater than 120-cm, was an encouraging feature of the 1997 length frequency distribution and may reflect improvements in the stock. Given the lack of any directed commercial fisheries throughout the region, the stock size and age structure should continue to improve. In 1994 an increase in the abundance of large sub-adults was also noted in the Delaware River tagging program with an overall CPUE of 3 per hour (Shirey 1995). The catch of this size class declined sharply in the following years however. This decline, in the absence of any significant in-river fishery, may represent emigration to coastal areas utilizing different habitat types until the sturgeon reach maturity.

Only one sturgeon under 80-cm (TL) was collected during 1997. Spine samples aged in 1995 indicated sturgeon 80-cm and less were represented by ages two through four (Shirey 1996). The continued low abundance of these small sturgeon are indicative of continued poor reproduction and recruitment in the Delaware River. Future monitoring efforts should focus on determining relative abundance and age structure of these small sturgeon to predict year class strength and spawning success as stock restoration occurs.

The origin of the sturgeon occurring in the lower Delaware River has been in question since this program was initiated. In 1995 we recaptured a sturgeon that was tagged in the Hudson River during 1993 as a small (68.5-cm) sub-adult. Movement from the Hudson River into the Delaware has been documented previously. Dovel and Breggren (1983) reported a portion of those tagged in the Hudson were recaptured in the Delaware Estuary. More evidence was gathered this year that suggest that a portion of the sub-adult sturgeon observed in the Delaware River are of Hudson River

origin. The three fish that were missing their left pelvic fins were all of the appropriate size to be part of the hatchery release in the Hudson River that occurred in 1994. Spine samples were taken, but as yet have not been aged.

The sharp decline in catches in this program observed since 1992 may be more indicative of poor reproduction in the Hudson rather than large fluctuations in spawning success and recruitment of Delaware River sturgeon. The tissue samples that were obtained from this program and provided to two researchers should give some indication as to the genetic make-up of these fish. However, the continued absence of a reference sample of either young of the year or mature adult sturgeon from the Delaware River makes stock identification more difficult.

Intertidal movement

One of the objectives of the telemetry program was to gain some insight into possible intertidal movement of sub-adult Atlantic sturgeon which have historically utilized this portion of the Delaware River. Some form of inter-tidal movement was suggested by differences in catch rates observed during high versus low tide. Since 1991, we have tagged and released over 1,700 sturgeon in the lower Delaware River with nearly all of them taken during the end of the ebb tide. Attempts to capture fish at this same location on a high tide have been unsuccessful. We assumed that some distinct pattern of movement related to tidal stage was the cause of the great disparity in catches. By following the sturgeon's movement during different portions of the tidal cycle, we hoped to distinguish a pattern which would indicate the cause of these differences in catch rates. One inherent problem with this technique was assuming that the movement of one individual fish is reflective of the habits of a larger group. In

addition we had no idea as to how the tag and tagging process may have influenced the tagged fishes natural migratory habits or daily patterns of movement.

We attempted to monitor these inter-tidal movements in three ways: 1) by determining the sturgeon's positions on a random basis and noting the tidal stage; 2) specifically relocating and following tagged sturgeon at the change of the tide; and 3) monitoring their movements continuously throughout a complete tidal cycle.

There was no apparent trend in the tagged sturgeons' daily activity that yielded any insight into intertidal movement within the gillnet sampling area. In actuality, the sonic-tagged sturgeon that remained in the general vicinity of Artificial Island were seldom relocated within the area where we typically set our nets regardless of the stage of the tide. Not only did we fail to discern why catch rates during high tide were poor, but it left the question as to why the low tide sets were as good as they were.

Based solely on the areas most frequented by these tagged fish, catches could be improved by setting the net out in deeper water and down-river closer to the tip of Artificial Island. Our normal sampling area is centered around the yellow marker N "B". This marker delineates the northern end of the ship anchorage area that continues downstream adjacent to Artificial Island. Most gill net sets were made a short distance downstream of this marker. The net was always set perpendicular to the tidal flow with the amount of net deployed towards the channel varying from 25% to 75% of the net's 366-m length. The eastern end of the net typically extended into relatively shallow water where tagged sturgeon were seldom relocated.

Three of the six sturgeon that we tracked during 1997 remained near Artificial Island throughout most of the summer and into the fall. Their positions in the river were

pin-pointed a total of 54 times, not including the day that they were released. Sturgeon #2-7-6 was never encountered within the relatively shallow water of the sampling area on any of the 13 times that it was relocated. Sturgeon #4-6-5 only entered what was considered the gill netting area on three of the 16 low tide observations. Sturgeon #3-8-4 was found in the sampling zone on only two occasions, both of which were during high tide. Overall, these three fish remained in the deeper portions of the anchorage zone, rarely being observed in water depths less than 7.6-m deep. On only one occasion was one found at a depth less than 6.1-m. This does not rule out the possibility that these sub-adult Atlantic sturgeon may utilize shallower water during darkness since all of these observations were made during daylight hours. However, Moser and Ross (1995) found no diurnal patterns to sturgeon movement in the Cape Fear River, NC.

On August 7, 1997 we monitored the sturgeon's movements hourly throughout a 12-hour period from 0600 hrs through 1800 hrs. A modest amount of travel up and down river was noted for some of the fish (Figure 5.). However, no substantial inshore or offshore movement was determined throughout this tidal cycle on this date which would have accounted for observed differences in catch rates at low and high tide. The three sturgeon which had relocated in the vicinity of Cherry Island Flats were also monitored on that day for 12 hours. As in the case of the down-river group, no noticable inshore movement or movement into shallow water was noted throughout the tidal cycle. If movement occurred, it almost always was in the direction of tidal flow rather than against the tide.

Other Areas of Concentration

The second objective of the sonic tagging portion of the program was to gain information on other locations within the Delaware River where Atlantic sturgeon may concentrate during the summer months. We were fairly confident that the sturgeon that utilized the lower portion of the river near Artificial Island moved upstream to some alternate locations for part of the summer before emigrating downstream in the fall. This was based on previous trends in the recapture of tagged sturgeon in the gill net program, but we had no evidence to confirm this theory. All previous attempts to capture sturgeon elsewhere in the lower river had been unsuccessful. This was primarily due to the absence of any anecdotal information on good or likely locations where sturgeon may concentrate and be susceptible to capture by gill net. In addition, much of the river outside the shipping channel is heavily fished with crab pots which makes setting gill nets not feasible. By attaching transmitters to a small number of fish in the summer we hoped they would relocate to some of these alternate locations. If these fish remained in one location for a prolonged period or were frequently found in one general location we assumed that would represent a preferred important habitat.

Three of the sturgeon that were tagged during July of 1997 relocated over 12 nautical miles upriver and remained above the Delaware Memorial Bridge throughout the summer. Sonic tag number # 3-7-5, tagged on July 9, was found above the bridge on July 18, nine days after tagging. It remained above the bridge from day nine through at least day 58. It primarily stayed on the east side of the shipping channel below the Cherry Island Flats (Figure 5). However, it did initially move upstream at least as far as the Marcus Hook Bar, 20 nautical miles upstream of the release site. Sturgeon

numbers # 2-8-5 and # 2-9-4, both tagged on July 22, also relocated up-river nine days after tagging (Figures 7 & 9). These two fish were frequently found in close proximity upstream of Cherry Island Flats immediately above Oldmans Point, NJ. They were always located on the broad relatively deep flats adjacent to the shipping channel.

On August 22, we set an 800-ft gill net in the area where sturgeon # 3-7-5 was frequently found below Cherry Island Flats. Six untagged sturgeon from 103 to 139-cm (TL) were taken in this 24 minute set, verifying that other sturgeon also were utilizing this same section of river. No gill net sets were made at the other up-river location where two sturgeon were frequently located due to the presence of submerged pipe lines and other obstructions.

The upriver site that we sampled also was a designated anchorage area for ship traffic (General Anchorage No. 6). It had a similar depth profile as the Artificial Island site (General Anchorage No. 2). The bottom substrate in both of these locations contained what has been identified as "slag" from steel mill operations. Several pieces were entangled in the gill net when it was retrieved. This material is frequently encountered in gill net sets in the lower river sampling area also. The water quality at the upriver site was usually well above State standards. On only one occasion did the dissolved oxygen fall to near 5 mg/l (53% saturation). The remainder of the time oxygen levels remained above 75% saturation. Water temperature was similar at both the Artificial Island site and the upriver area, ranging from 25° to 28.5° C. The two sites did have a completely different salinity regime as would be expected. Salinity at the upriver location ranged from 0.3 to 3.4 ppt while the sturgeon were in the area. Salinity at the lower river site was always much higher and ranged from 3.8 to 11.6 ppt over the

same time period.

Downstream movement was also verified for sturgeon #3-7-5 during the end of the summer. On September 5 it was above the Memorial Bridge where it had been throughout the summer. On September 18 it was not found at the upriver site, nor was it found in the lower river the following day. However, on September 19 there was very heavy static from just below Pea Patch Island all the way to the south end of Artificial Island that prevented detection of any transmitter signal. This sturgeon was next relocated on October 7 (day 90) off Artificial Island. On October 9 (day 92) sturgeon # 3-7-5 was not found anywhere in the river, suggesting that further downstream movement into Delaware Bay may have occurred.

Conclusions

Overall the sonic tracking program was successful. We definitely found one, and possibly two other additional areas in the Delaware River which were utilized extensively by Atlantic sturgeon for prolonged periods during the summer months. Sturgeon are seldom taken in the trawl surveys conducted by the Division of Fish and Wildlife (S. Michels, DE F&W, personal comm.) and their overall abundance and distribution in the Delaware River Estuary is not well known. Kieffer and Kynard (1993) found that during three years of tracking, Atlantic sturgeon used the same general area of the Merrimack River, MA, although a new group of fish was tracked each year. Similar behavior may occur for Atlantic sturgeon in the Delaware River. The Artificial Island site has proven productive each year from 1991 through present. These new areas could be sampled by gill net in the future to provide a more accurate estimate of

sturgeon abundance rather than relying on a single sampling site.

The tracking program also helped fill in some of the gaps in knowledge with regard to sturgeon movement while they are in the river. We had suspected sturgeon moved through and upstream of the Artificial Island sampling site early in the summer. We also believed they moved back downstream in the early fall, but we had no tag return information from upriver to corroborate this theory. Sonic tracking verified this portion of the sturgeon's in-river movement and suggested when downstream migration occurs.

Our previous analysis of tag recaptures indicated that Atlantic sturgeon may remain in groups for prolonged periods. Fish which were tagged with dart tags on the same day were often recaptured together, even after a considerable time at large. The sonic tracking verified that this does occur. Two separate pairs of sturgeon eventually relocated within the same area and were found in close proximity for a prolonged period of time (weeks). On some occasions they were so close together that their transmitter signals which were operating on the same frequency were difficult to separate and identify. These pairs would frequently separate by a considerable distance only to be found in close proximity on the next survey. Moser and Ross (1995) found that holding areas were often used by several different individuals, but they never found more than one sonic-tagged sturgeon in any site at the same time.

The results of the tracking also has implications on the estimates of the population size of sturgeon utilizing this portion of the Delaware Estuary. In the past we used the Schnabel multiple mark and recapture formula to estimate the population of sturgeon that utilized the Artificial Island site. Potak et al found that the precision of

both the Jolly-Seber and Schnabel capture-recapture models are sensitive to temporary emigration, therefore affecting the confidence limits around the estimate. The precision of the population estimate would be greatly reduced if a large portion of the marked population is not available or susceptible to recapture thus violating one of the assumptions of the model. In our program, although only a small number of sturgeon were tagged with sonic transmitters, at least half of those tagged left the immediate area for most of the summer. Potak et al found that temporary emigration did not bias the estimate of the Schnabel model, but the confidence limits would broaden as the probability of emigration increased.

The sonic tracking program did not provide any insight into intertidal movement, nor did it suggest why our catch rates during the end of a high tide were significantly lower than those made at low tide. Sonic-tagged sturgeon rarely re-entered the gill net sampling area. Those tagged fish that were relocated within the zone did not show a definite preference or trend with respect to stage of the tide. Perhaps the movements of these tagged fish were not representative of the untagged population.

Future research on Atlantic sturgeon in Delaware should continue to monitor the abundance of sub-adult fish within the river on an annual or semi-annual basis. This and other similar surveys throughout the range of the species will help monitor changes to the stock in response to restoration efforts. Continued sonic tracking during the summer months could lead to the identification of additional areas within the estuary which provide important sturgeon habitat. Atlantic sturgeon abundance in these new areas could be determined by similar gill net surveys and a better population estimate could be achieved.

Sturgeon utilization of the lower estuary (Delaware Bay) remains unknown to a great extent. Tag returns suggest that most sturgeon that occur in the lower river during the summer tend to migrate out of the river and into the near-shore Ocean during the winter months. However, commercial gill netting, which is responsible for a large portion of Atlantic sturgeon tag returns, is at a relatively low level of effort in the Bay at this time and may not take place in small localized areas where sturgeon may typically congregate. Continued tracking of tagged sturgeon as they leave the river and enter Delaware Bay during the early fall could delineate these important over-wintering areas in the Bay.

Table 1. Daily catch rates of Atlantic sturgeon in gill net sets made in the lower Delaware River during 1997.

Date	No. Taken	Hrs Fished	CPUE	
06/19/97	0	0.85	0.0	12" Mesh
06/25/97	0	1.43	0.0	
06/26/97	1	0.85	1.2	
07/09/97	4	1.27	3.1	
07/10/97	3	0.83	3.6	
07/22/97	9	1.10	8.2	
07/25/97	12	1.17	10.3	
08/05/97	2	0.93	2.2	
08/11/97	6	1.55	3.9	
08/21/97	2	1.63	1.2	
08/22/97	6	0.40	15.0	
09/05/97	0	0.25	0.0	
09/09/97	8	0.90	8.9	
09/19/97	1	1.00	1.0	
10/07/97	1	1.37	0.7	
10/09/97	2	0.87	2.3	
10/21/97	0	0.80	0.0	
	57	16.35	3.49	

Table 2. Atlantic sturgeon previously tagged in the Delaware River and recaptured during 1996.

TAGGED			RECAPTURED						
Tag No.	Date	TL	Date	Days at Large	STATE	Location	GEAR	Target Species	Disposition
2228	06/28/94	1120	06/12/96	715	RI	Atl. Ocean	Unk	Unk.	Dead on beach
717	07/31/92	960	07/08/96	1438	MA	Atl. Ocean	H&L	Cod	Alive
2413	08/03/95	930	07/24/96	356	DE	DE RIVER	GN	Sturgeon	Alive
2218	06/22/94	1080	08/25/96	795	MA	Cape Cod Bay	GN	Dogfish	Alive
2022	06/07/93	1350	09/04/96	1185	DE	DE RIVER	GN	Sturgeon	Alive
2494	07/24/96	1195	11/01/96	100	DE	DE Bay	Trawl	Survey	Alive
759	08/04/92	1040	12/10/96	1589	RI	Atl.Ocean	GN	Cod	Alive

Table 3. Atlantic sturgeon previously tagged in the Delaware River and recaptured during 1997

TAGGED			RECAPTURED						
Tag No.	Date	TL (mm)	Date	Days at Large	STATE	Location	GEAR	Target Species	Disposition
2370	06/14/95	620	03/24/97	649	DE	DE Bay	GN	st. bass / wkfish	Alive
2239	07/01/94	995	06/10/97	1075	NY	Atl. Ocean	Trawl	bluefish	Alive
2358	10/24/94	810	07/22/97	1002	DE	DE River	GN	sturgeon	Alive
840	09/01/92	980	09/20/97	1845	NC	Pamlico Ri	GN	Unk	Alive
2563	09/09/97	965	11/10/97	62	MD	Ches Bay	Pound Net	st. bass / menhaden	Alive