NOAA Species Recovery Grants to States (Section 6 Program)
Grant number: NA19NMF4720101

Project Title:
Spawning movement behaviors, habitat dependencies and run size of Nanticoke River Atlantic Sturgeon

Grantee:
Maryland Department of Natural Resources

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Award Period:
07/01/2019 – 06/30/2022

Progress Report Period:
07/01/2019 – 12/31/2019

Goal

Recovery planning for Atlantic Sturgeon requires estimates of population and distinct population segments (DPS) abundances against which to evaluate takes, protect critical habitats, and develop feasible restoration targets. There are five key questions about status and recovery reference points for Atlantic Sturgeon:

(1) What is the likely size of spawning runs and the spawning population?

(2) How is the Nanticoke-Marshyhope Creek spawning run genetically related to other Chesapeake Bay DPS spawning units?

(3) How are active acoustics (Adaptive Resolution Imaging Sonar. ARIS) best deployed to estimate spawning run size in the Marshyhope Creek and similar spawning tributaries?

(4) Does current spawning result in juvenile recruits?

(5) How consistent are spawning run behaviors across years and individuals with respect to environmental cues and key habitat utilization areas?

The objectives for this project will aid researchers in answering these questions.

Project Objectives

1. **Capture and release acoustically tagged adult Atlantic Sturgeon** in the Marshyhope Creek and upper Nanticoke River to augment the current sample of tagged fish to test ARIS detection efficiency, spawning run duration, and in-river movements. Aug.-Oct. 2019-2021.
2. **Maintain a fixed acoustic receiver array** in the Marshyhope Creek and the upper Nanticoke River. Mar.-Dec. 2019-2021
3. **Deploy a fixed-station ARIS system** in the lower Marshyhope Creek to intercept fall spawning run Atlantic Sturgeon. From telemetry data of tagged fish detected crossing the station, estimate (1) detection probability of the ARIS system; and (2) frequency of multiple counts of the same individual by the ARIS system. Aug.-Sept. 2019-2021
4. **Conduct mobile ARIS surveys**. Simultaneous to the fixed site ARIS deployment, in two surveys each year, deploy a second ARIS system in a survey of the entire Marshyhope Creek spawning reach (15 km). From telemetry data of tagged fish in the

fixed array, estimate the probability of transition by Sturgeons across survey strata during each survey. Sept. 2019-2021

5. **Develop spawning run estimates** and variances adjusted for capture efficiency, multiple detections, and movement among strata. Compare estimates between the intercept and mobile ARIS survey approaches. Conduct sensitivity runs to evaluate the robustness of either approach to key assumptions. 2020-2021
6. **Evaluate spawning run behaviors**, spawning cues, and habitat utilization areas on the basis of both ARIS surveys and telemetered fish. 2019-2021
7. **Conduct surveys for juvenile Atlantic Sturgeon** to confirm successful reproduction in the upper Nanticoke River/Marshyhope Creek. Characterize nursery habitat. Feb.-Apr. and Oct.-Nov. 2019-2021
8. **Continue acoustic habitat mapping** in the Delaware portion of the Nanticoke River to further identify suitable spawning habitat. 2019-2021 NOAA Chesapeake Bay Office (NOAA-CBO)
9. **Continue and augment outreach and advisory work** conducted by study partners.

1. Capture and release acoustically tagged adult Atlantic Sturgeon

Methods

Sinking gillnets 25.40 - 35.56 cm stretch mesh, 3.1 m in height, 45.7 - 91.4 m in length were set perpendicular to the water current. Nets were anchored at both ends with a 6.4 kg Danforth anchor. Water depth (m), temperature (°C), salinity (ppt), and dissolved oxygen (mg/l) were recorded each day in the middle of the sampling reach. All parameters were measured at the river bottom. Gill nets were placed in locations where sturgeon were captured in the past or a sturgeon with an acoustic tag was detected. Nets were checked hourly for the presence of a captured Atlantic Sturgeon.

Four gill nets were deployed during each sampling trip. This was considered to be a single sampling trip. If an additional boat was used, eight nets were set and it was considered to be a second trip for that day. The use of two boats allowed for additional net to be set in the

water. Furthermore, the second boat could continue to tend nets while the first boat processed any captured Atlantic Sturgeon.

Measures were taken to notify boaters of net in the water, which included signs posted at all local boat ramps informing them how to navigate safely around the nets (Figure 1) and Jim-Buoys® placed at either end of the sampling reach stating "DANGER GILL NETS AHEAD" (Figure 2). Additionally, the top of each net was marked with 5-7 orange bullet floats and a single green bullet float. The orange floats were intended to increase net visibility to boaters while the green float was intended to notify boaters where it was safe to travel around the net.

Catching and tagging Atlantic Sturgeon was performed under protocols established in National Marine Fisheries Service (NMFS) permit number 20134. Captured fish were held on board the boat in a tank 2.40 m in length, 0.46 m wide and 0.40 m deep. The tank was filled by a one horse power water pump with river water and was supplemented with compressed oxygen. River water was exchanged for each fish captured. All fish were measured for total length (cm), fork length (cm), and weight (kg) and examined for any existing tags. Recaptured fish were immediately released. Morphometrics on recaptures were measured only once per season. All first-time captures were given an external dart tag and an internal passive integrated transponder (PIT) tag. A DNA sample was taken from a 1 cm^2 piece of caudal fin and stored in EtOH for analysis. Untagged fish were also internally implanted with acoustic transmitters (VEMCO© model V16-6H, battery life 10 years; Bedford, Nova Scotia, Canada) to track migration patterns and movements. To gain access to the abdominal cavity, a 2-4 cm incision was made between the 3rd and 4th ventral scute between the anal and pelvic fin and slightly left or right of the mid-ventral line (Kahn and Mohead 2010). Transmitter magnets were removed, tags were verified as operational, and were then inserted into the body cavity. After insertion of the transmitter, Ethicon® 2-0 coated Vicryl undyed braided suture material was used with a CP-2 reverse cutting needle to make two butterfly stiches for wound closure. Betadine was swabbed over the sutures prior to release.

Results

Gill netting by the Maryland Department of Natural Resources in Marshyhope Creek began 28 August and concluded 25 September 2019. Sampling was initiated when river water temperatures fell below 27°C. Temperatures remained below this threshold for the duration of

the sampling season. Seven sampling trips were conducted with a single boat and three trips were conducted with two boats, bringing the total number of sampling trips to 13.

Eight adult Atlantic Sturgeon were captured in Marshyhope Creek in 2019, with one fish (VEMCO ID A69-9001-23901) being captured twice (Table 1). Of these captured fish, four males and one female were sturgeon the department caught and tagged in a previous year. The three new Atlantic Sturgeon consisted of one male and two females. All fish captured were mature adults. The males expressed milt upon capture. The two newly tagged females had black eggs visible through the incision made for the acoustic transmitter implantation (Figure 3). The recaptured female was full-bodied and did not appear to be spawned out. The presence of male and female Atlantic Sturgeon, 71 km upstream in the Nanticoke River system in spawning condition, lead researchers to believe that sturgeon may be spawning in Marshyhope Creek and Nanticoke River. Fertilized eggs and juveniles have yet to be captured in this system.

2. Maintain a fixed acoustic receiver array

In 2013, an angler reported on the Maryland Department of Natural Resources Angler's Log that an Atlantic Sturgeon jumped into their boat on Marshyhope Creek. In response, the first two acoustic receivers (VEMCO© model VR2) were placed in Marshyhope Creek in areas where anglers report sightings of sturgeon jumping. Additional receivers (VEMCO© model VR2W) were added to the array each year.

Project biologists deployed receivers in the spring and removed the receivers in the fall once all tagged Atlantic Sturgeon left the river system. Receivers were removed to prevent loss of assets due to icing conditions, theft and vandalism during winter months. Receivers were deployed on private piers and United States Coast Guard (USCG) fixed piling aids to navigation (Figure 4). Permission was granted by all private pier owners and the USCG (License HSCG83-14-6-0026) to place acoustic receivers on their property.

Methods

Stainless steel cable, 6.4 mm in diameter, was looped through two holes drilled into square tube steel (to be used as an anchor), and crimped into place with two zinc-plated copper crimps. The length of cable needed was determined by lowering the anchor to the bottom of the river. A length of hydraulic tubing was placed over the cable inside the loop to prevent the cable

from wearing on the wooden beams of a pier or lower step of the USCG fixed piling. The cable was looped around a lower beam on the pier, cut and crimped into place with two crimps. The acoustic receiver was attached to the cable with two stainless steel hose clamps and two heavy duty cable ties a few feet from the riverbed (Figure 5).

If no private piers or USCG fixed pilings could be utilized, a Maryland Department of Natural Resources Jim-Buoy® was deployed (Figure 6). In this instance, researchers shackled a 2.0 m length of stainless steel cable that held the receiver to the eye bolt on the bottom of the buoy. It was weighted with square tube steel at the opposite end for ballast. The receiver was attached in the same manner as with the private piers and USCG fixed pilings.

Results

In early 2019, nine acoustic receivers were placed throughout the Nanticoke River (Figure 7) and 18 acoustic receivers were placed throughout Marshyhope Creek (Figure 8). Receivers were placed at locations established by the Maryland Department of Natural Resources under previous Section 6 grants (NA13NMF4720042, NA15NMF4720017). Two additional receivers, "North Federalsburg" and "Deep Hole" were added in 2019 to determine the farthest point upstream that Atlantic Sturgeon travel in Marshyhope Creek. Receivers are still deployed at the time of this report and are not scheduled to be removed until December. These 2019 data will be assessed and reported on in the next reporting cycle (01/01/2020-06/30/2020).

3. Deploy a fixed-station ARIS system

Information provided by University of Maryland Center for Environmental Science (UMCES) in the Appendix.

4. Conduct mobile ARIS surveys

Information provided by UMCES in the Appendix.

5. Develop spawning run estimates

No activities were conducted during this reporting period.

6. Evaluate spawning run behaviors

No activities were conducted during this reporting period.

7. Conduct surveys for juvenile Atlantic Sturgeon

On the basis of criteria developed by the Atlantic States Marine Fisheries Commission (ASMFC), spawning in the Nanticoke-Marshyhope Creek is "Highly Likely". The classification of "Confirmation" by ASMFC requires direct observation of embryos, larvae or age-0 juveniles. The "Highly Likely" classification is based on the capture of 25 ripe adult male Atlantic Sturgeon and four female Atlantic Sturgeon with mature eggs. In order to upgrade the Nanticoke River from "Highly Likely" to "Confirmation" the Maryland Department of Natural Resources trawled in areas suspected to be used by juvenile Atlantic Sturgeon.

Methods

A 7.6 m semi-balloon trawl with 3.8 cm mesh and knotless netting in the body was towed at 12 fixed locations in the Nanticoke River from Bivalve near the mouth of the Nanticoke River to the MD/DE state line, and 10 locations in Marshyhope Creek from the mouth of the creek to Williamsburg, MD (Figure 9). The trawl was deployed off the port side of the boat and the trawl doors were walked back to either side of the stern. The 60.9 m lead ropes were fed out slowly, by hand, to prevent the trawl doors from flipping. The lead ropes were attached at the boat to a 6.3 mm stainless-steel harness cable that was attached to the tie-down anchor points on the transom. A pulley was installed on the harness to allow the lead ropes to move freely while the boat turned.

The trawl was towed with the tide for 6 min at 6.4 km/h. Once the trawl ended, the lead ropes, trawl doors and trawl were retrieved in the opposite order of deployment. Once the trawl was on board the boat, the contents were emptied in to a stock tank. Notations of all species captured were made, but bycatch was not counted. Captured juvenile Atlantic Sturgeon were placed in an onboard tank filled with fresh river water supplemented with compressed oxygen.

Catching and tagging Atlantic Sturgeon was performed under protocols established in National Marine Fisheries Service (NMFS) permit number 20134. Captured juvenile sturgeon were measured to total length (TL; mm) and fork length (mm) and weighed (g). Juvenile sturgeon 250-350 mm TL received an 8.4 mm PIT tag. Juvenile sturgeon >350 mm TL and 100 g received an 11.5 mm PIT tag and an acoustic transmitter (VEMCO© model V9-6H, battery life 3

months). Transmitters were implanted in the same manner as adults (Kahn and Mohead 2010). Juvenile sturgeon exceeding 300 mm TL received an external dart tag. All captured juvenile Atlantic Sturgeon had a 1 cm^2 piece of tissue removed from the caudal fin for genetic analysis.

Results

No activities were conducted during this reporting period. This objective will be performed in March 2020 and results will be reported in the next cycle (01/01/2020-06/30/2020).

8. Continue acoustic habitat mapping

No activities were conducted during this reporting period. This objective will be conducted by the National Oceanic Atmospheric Administration Chesapeake Bay Office (NOAA-CBO).

9. Continue and augment outreach and advisory work

Maryland Department of Natural Resources biologists conducted two outreach presentations during the reporting period. In August 2019, staff participated in an outreach event through ShoreRivers to educate third grade teachers about the Atlantic Sturgeon life cycle and current research by the department. This outreach consisted of a classroom presentation and a hands on learning experience where they met live, captive bred Atlantic Sturgeon which originated from Canada (not subject to Endangered Species Act regulations and NMFS permit protocols). The teachers added information they learned about sturgeon to their classroom unit on life cycles. The department also provided Atlantic Sturgeon tracking data through the Students Collaborating to Undertake Tracking Efforts for Sturgeon (SCUTES) program. Teachers and students were able to see how sturgeon travel through the Chesapeake Bay and the Atlantic Ocean. This outreach helps to support ShoreRivers and Maryland's portion of the Chesapeake Bay Watershed Agreement with an elementary aged meaningful watershed educational experience (MWEE) and will benefit 1,200 children in Talbot and Dorchester counties in Maryland.

Researchers also presented on the current state of Atlantic Sturgeon in the Chesapeake Bay in October 2019 to the Free State Fly Fishers, a local fly fishing club in Maryland. A group of 25 individuals received an in-depth look at the current work being conducted on Atlantic Sturgeon in Maryland waters of the Chesapeake Bay and a hands on look at the types of

equipment used to capture, tag and track Atlantic Sturgeon. Through this presentation, the department has been invited to speak about Atlantic Sturgeon to the Potomac Valley Fly Fishers early in 2020.

Tables

Table 1. *Capture and morphometric information for all Atlantic Sturgeon captured by the Maryland Department of Natural Resources in 2019. *Atlantic Sturgeon 23901 was captured twice in 2019. Only the first capture was included in the table.*

VEMCO ID	Date Caught	New/ Recapture	Mesh Size (cm)	Sex	Total Length (cm)	Fork Length (cm)	Weight (kg)
23901*	8/28/2019	Recapture	31.75	Male	1730	1600	33.4
18978	9/5/2019	New	31.75	Female	2120	1779	49.9
26353	9/10/2019	Recapture	25.40	Male	1714	1526	32.7
18977	9/18/2019	New	31.75	Female	1950	1761	51.3
18979	9/19/2019	New	31.75	Male	1750	1522	37.6
21069	9/19/2019	Recapture	30.48	Male	1826	1615	-
21066	9/25/2019	Recapture	31.75	Female	2380	2092	75.5

Figures

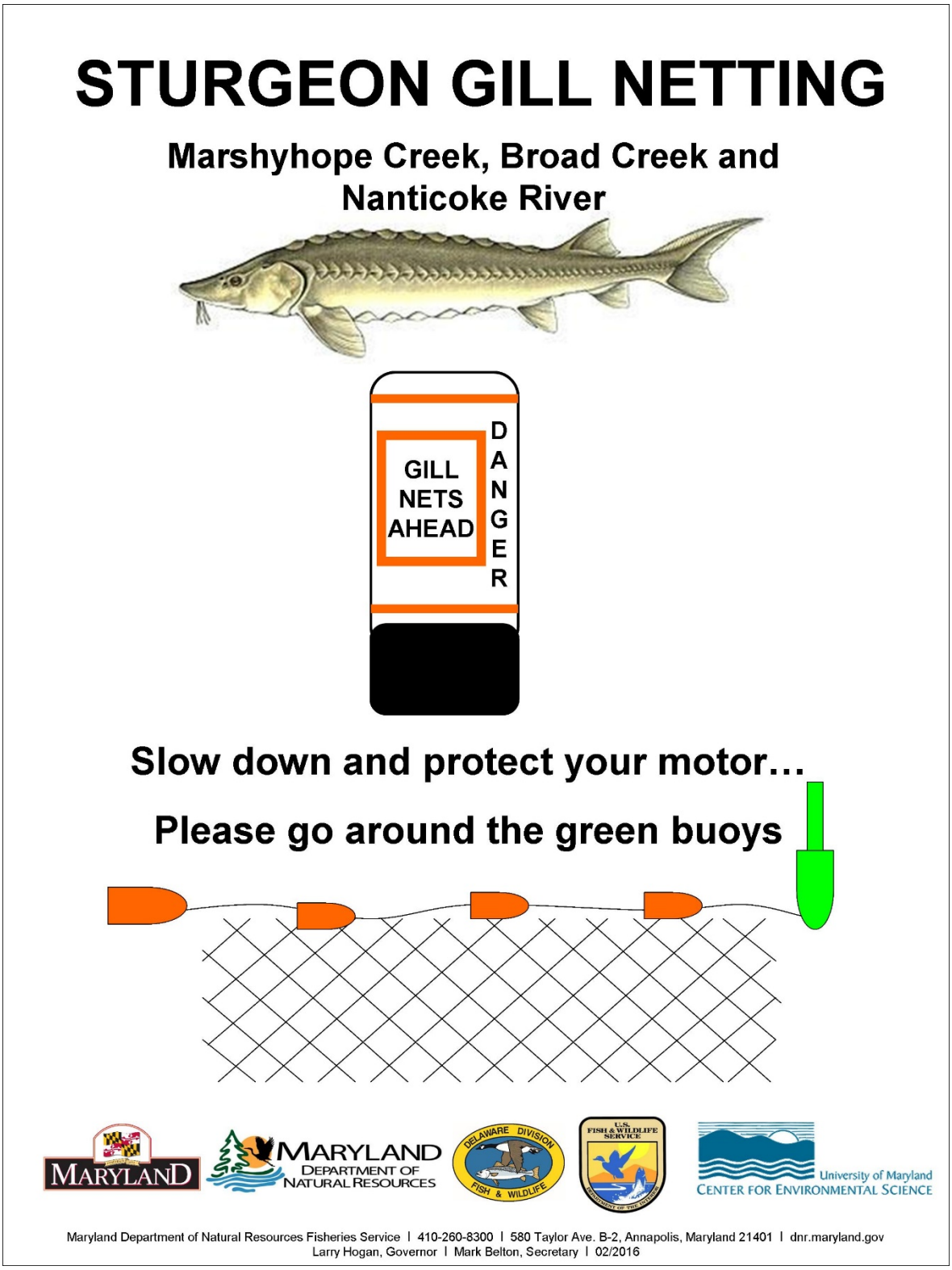

Figure 1. A *Maryland Department of Natural Resources sign placed at boat ramps on the Nanticoke River and Marshyhope Creek to alert and inform boaters how to navigate safely around gill nets.*

Figure 2. *Jim Buoy® used by the Maryland Department of Natural Resources to notify boaters there are gill nets actively fishing in the water.*

Figure 3. *Mature black eggs visible in a female Atlantic Sturgeon during acoustic transmitter implant surgery.*

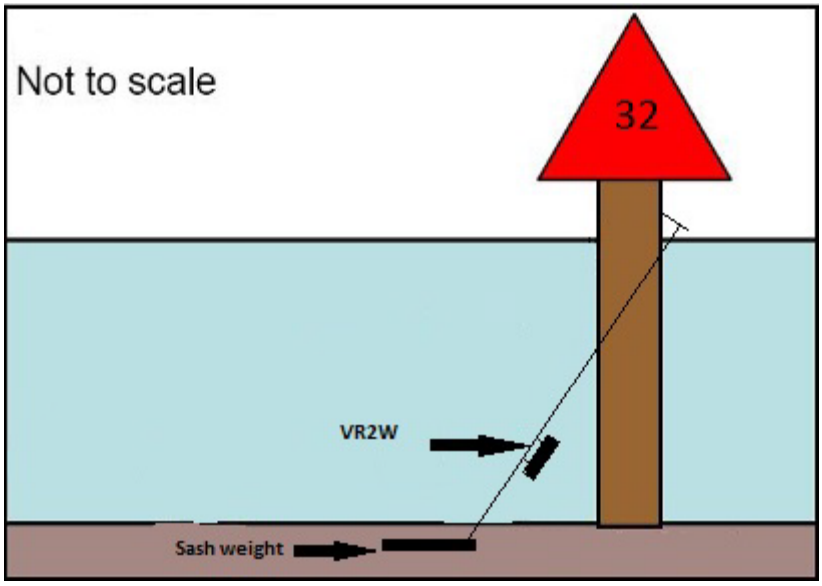

Figure 4. *Maryland Department of Natural Resources methodology for attaching receivers to United States Coast Guard fixed piling aids to navigation.*

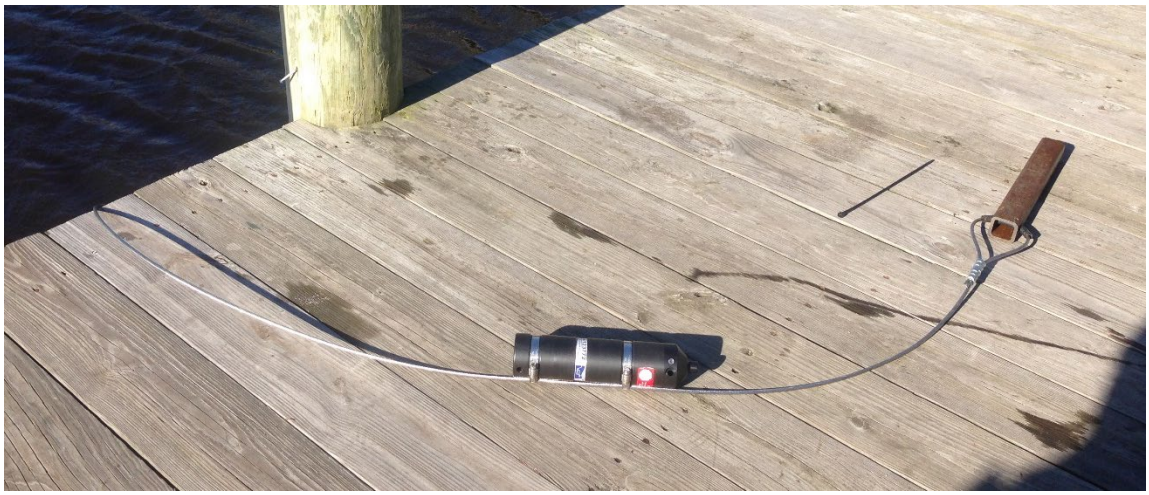

Figure 5. *Maryland Department of Natural Resources methodology for attaching acoustic receivers to stainless steel cable on the Nanticoke River and Marshyhope Creek.*

Figure 6. *Maryland Department of Natural Resources Jim-Buoy®. These buoys are used to place acoustic receivers in specific locations when no USCG fixed pilings or private piers could be located.*

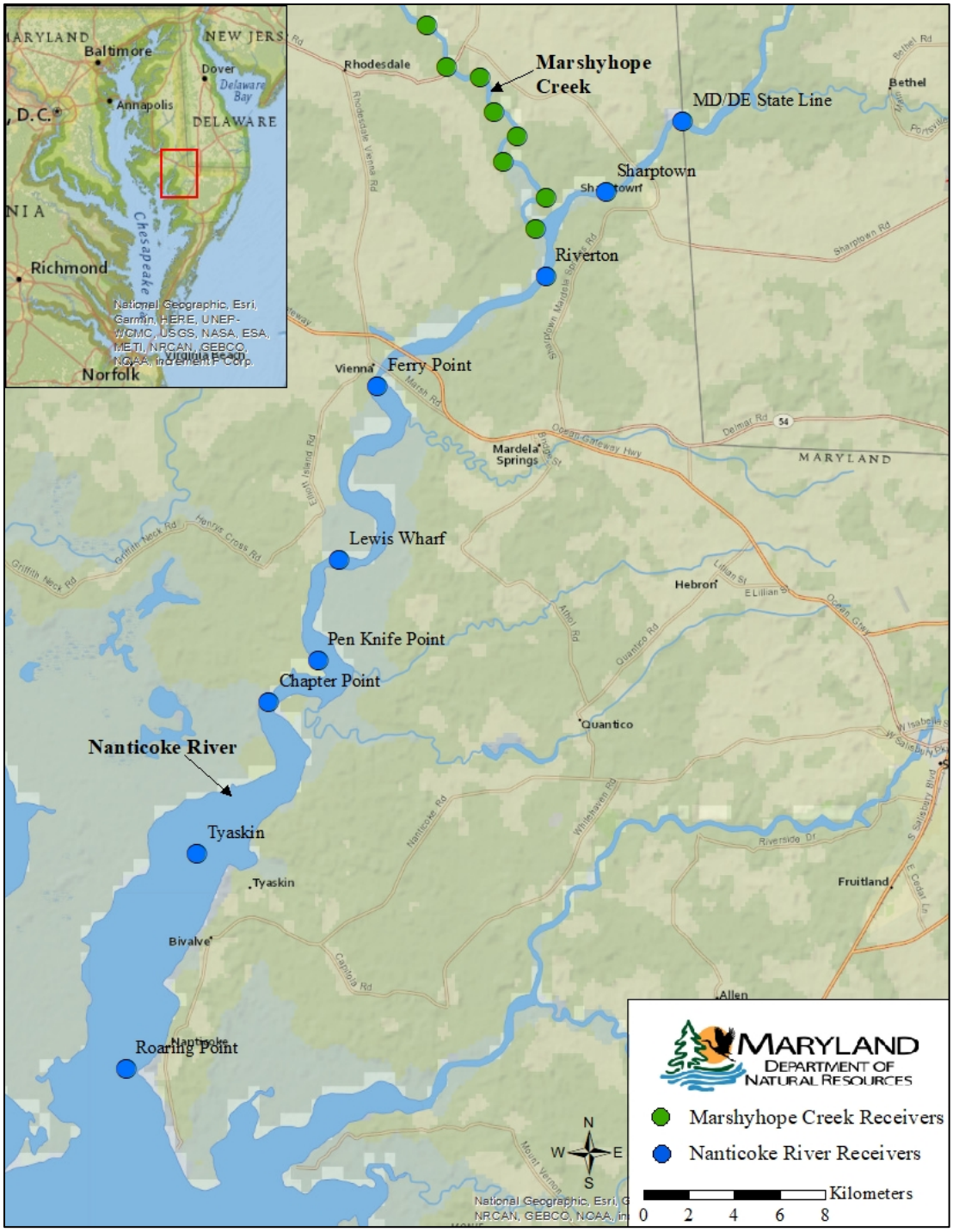

Figure 7. *2019 Maryland Department of Natural Resources acoustic receiver locations in the Nanticoke River.*

Figure 8. *2019 Maryland Department of Natural Resources acoustic receiver locations in the Marshyhope Creek.*

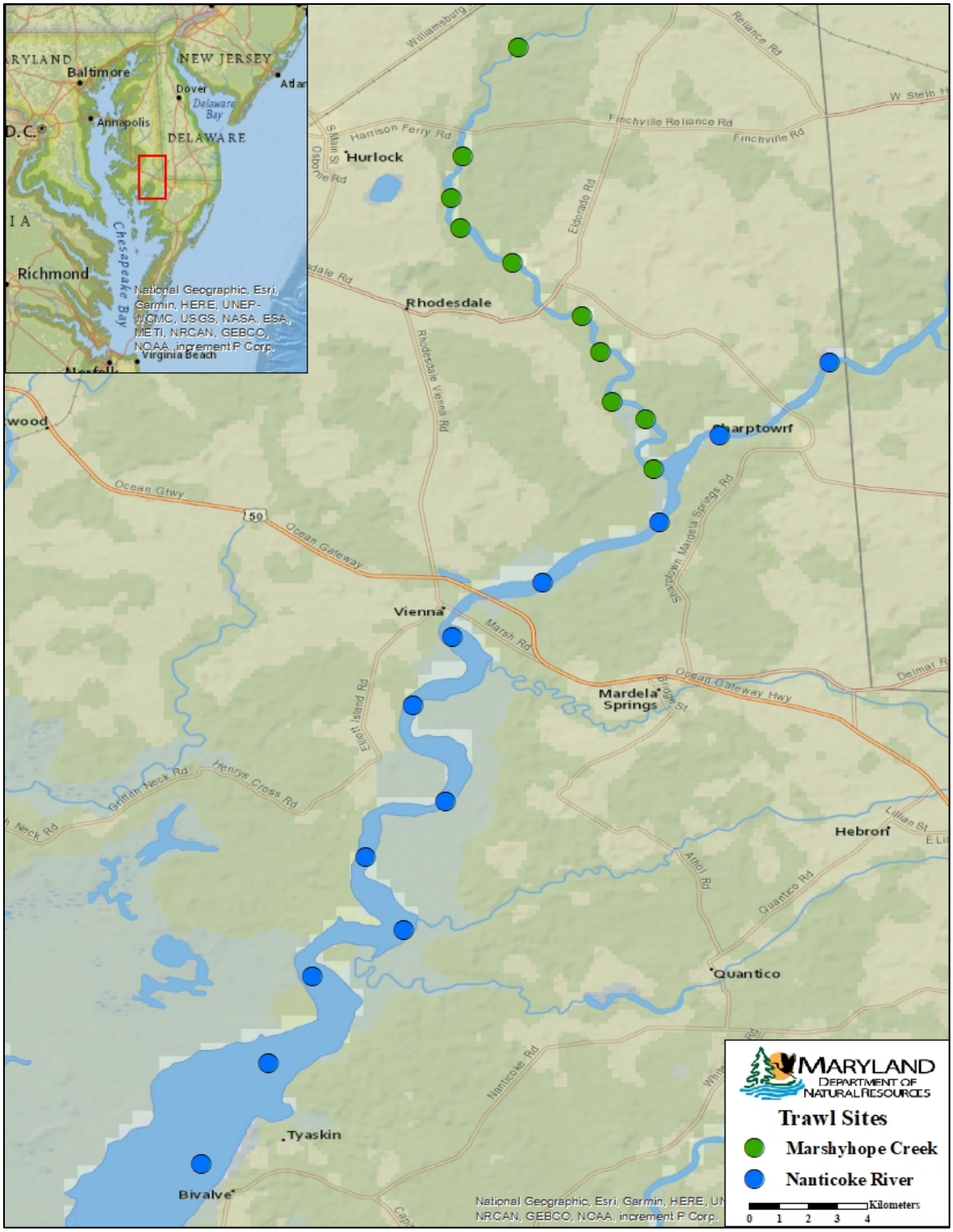

Figure 9. *Maryland Department of Natural Resources proposed juvenile Atlantic Sturgeon trawl sites in the Nanticoke River and Marshyhope Creek.*

Literature Cited

Kahn, J and M. Mohead. 2010. A Protocol for Use of Shortnose, Atlantic, Gulf, and Green Sturgeons. NOAA Tech, Memo. NMFS-OPR-45.

Appendix

Project Title:

Spawning movement behaviors, habitat dependencies and run size of Nanticoke River Atlantic sturgeon

University of Maryland Center for Environmental Science report on Objectives 3 and 4.

Progress by Objective

3. Deploy a fixed-station acoustic (ARIS) censusing station designed to intercept the fall spawning run.

A site was identified in the lower Marshyhope Creek at the Henson Boy's Scout Reservation, 3 km upriver to its connection with the Nanticoke River. The Camp Director provided long-term access to the Camp's 60 m pier, which allowed us to securely deploy the ARIS camera with an energy supply. In mid-August a deck box was constructed for the ARIS camera to provide security and cooling fans for a controlling laptop. This system was tested at Chesapeake Biological Laboratory's research pier for a 3-day period during warm summer days, prior to its deployment at the Henson Reservation.

On 26 August 2019, UMCES scientists deployed the camera using a pipe-bracket assembly to the end of a floating pier. Tests to optimize the camera angle and evaluate range were conducted in cooperation with MD DNR, utilizing a 1-m total length frozen sturgeon carcass (Sturgeon Salvage ID Aoo080012019MD) floated at 10-40 m distant from the camera. Tests conducted with the frozen sturgeon carcass indicated large fish could be detected up to 39 meters from the camera lens. Therefore, the camera range was set to approximately this distance and the camera angle was optimized to accommodate this distance. This distance represented 36% of the channel width (108 m) at this site. Maintenance and data downloads occurred twice weekly during the deployment period: 26 August to 9 September. During the maintenance check on 9 September, it was discovered that the ARIS had become inoperable on 8 September, so deployment was discontinued a week earlier than the intended 3-week deployment. Later it was discovered that a cable connection had been severed and the ARIS was repaired for its next deployment.

During the 14-day period of deployment, more than 280 hours of footage were recorded, representing 595 GB of data. A scan of the data showed incidence of large fish passing the intercept location (Figure 3.2), but more careful analysis is required to confirm species identity.

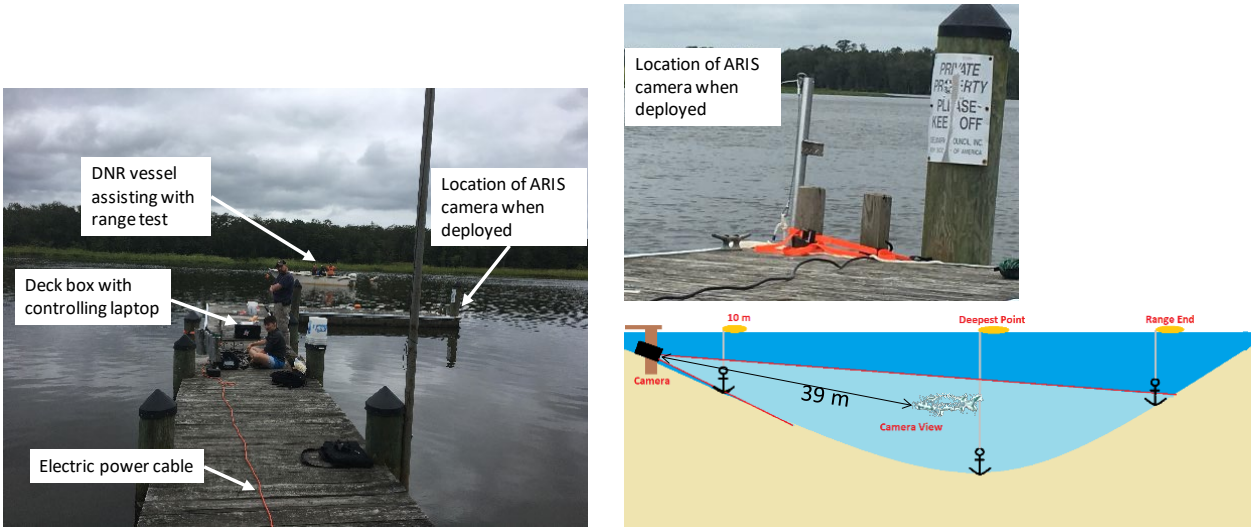

Figure 3.1. Deployment (26 August 2019) of ARIS camera at Henson Scout Reservation near the mouth of the Marshyhope Creek. ARIS camera was deployed on a floating pier at the end of a long fixed pier, held in place by a specially fabricated pipe-bracket assembly and ratchet straps. Also shown is conceptual figure of camera angle adjustments made to try to maximize river bed coverage.

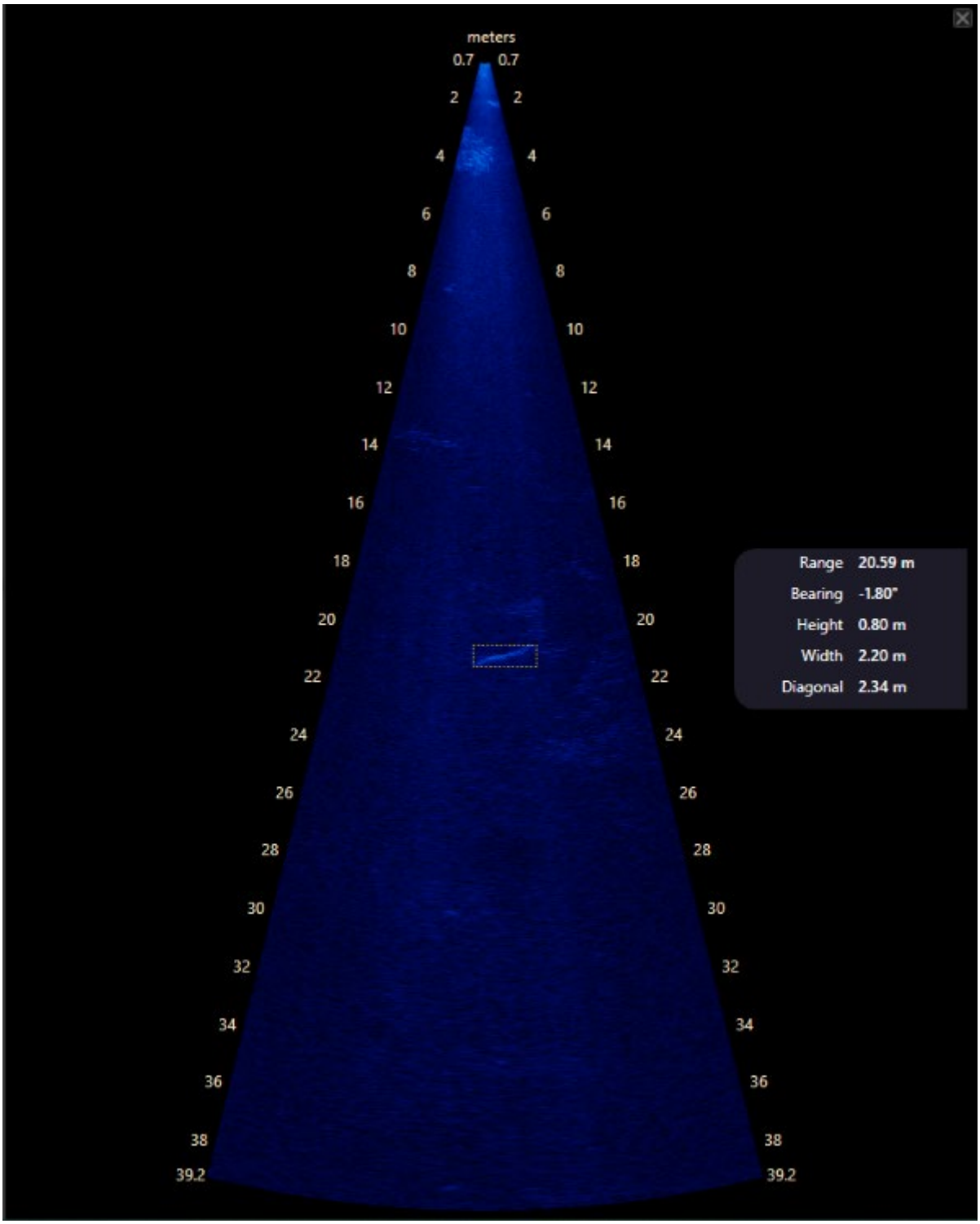

Figure 3.2. Detection of a possible sturgeon as seen in ARIS data recorded on 29 August 2019. The fish is indicated by the yellow bounding box. The fish is approximately 2.34m long, as indicated by the length of the diagonal of the bounding box. It can be seen moving through the water column approximately 21m from the camera lens.

4. Conduct mobile acoustic (ARIS) census surveys, simultaneous to the fixed site ARIS deployment.

In preparation for ARIS mobile surveys, available bathymetry GSI information from recent NOAA Chesapeake Bay Office mapping was collated by river segments to plan cruises and evaluate what we could feasibly cover in each week's survey (Figure 4.1). Bathymetry was incompletely measured for some segments, particularly upriver to Rt. 392 Bridge. Above the bridge, we discovered that depths were frequently < 3 m, which curtailed the effectiveness of ARIS camera beam coverage. Mobile surveys were conducted during 17-20 September and 24-27 September on the UMCES RV Aries by a crew of two scientists. The survey extended from river km 6 to 24 during both weeks. Individual sturgeon and sturgeon aggregations were both noted in real time during the surveys, often eliciting a flight response as the vessel passed their locations (Figure 4.2). Thirty-five hours of camera footage was collected during surveys representing over 224 GB of data.

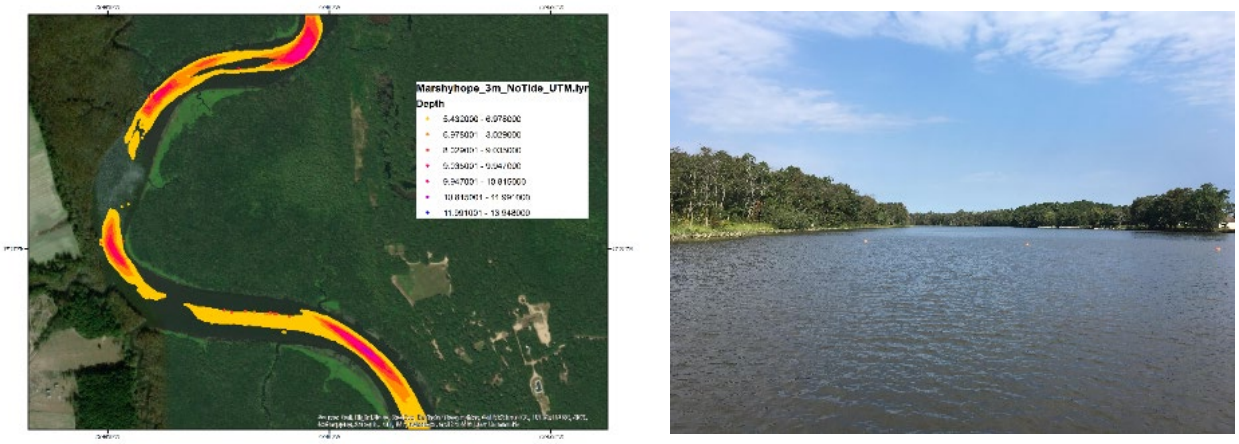

Figure 4.1. Example bathymetry plot used to plan transect deployments during mobile ARIS surveys (left) and use of line-of-sight buoy markers to conduct transect passes. Bathymetry was incompletely mapped by NOAA Chesapeake Bay Office for the Marshyhope Creek, particularly for segments above Rt. 392 Bridge. Still, they were useful in adjusting the tilt of the ARIS camera for each assessed angle. Within the field, transects were set at 10-15 meter spacing. This provided for about 30% coverage in most segments.

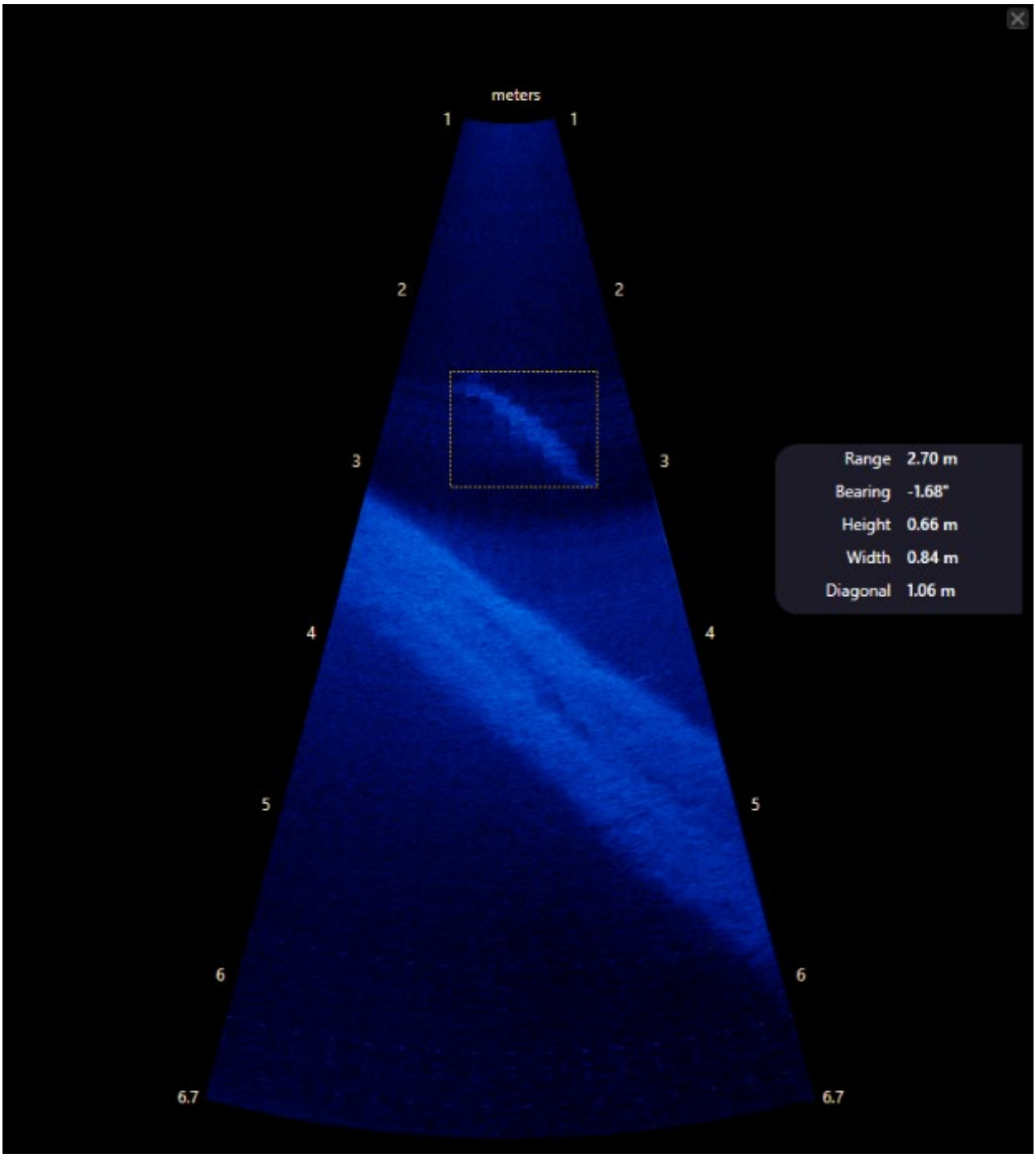

Figure 4.2. Detection of a possible sturgeon as seen in ARIS data recorded on 26 September 2019 near the Route 313 Bridge, Brookview MD. The fish is indicated by the yellow bounding box and is approximately 1.06 m long, as indicated by the length of the diagonal of the bounding box. It can be seen moving through the water column approximately 3m from the camera lens.

Outcomes, other developments

Mr. Nicholas Coleman was recruited as graduate student, whose thesis work will be attached to this project. He will start January 2020 in the UMCES Marine Estuarine and Environmental Studies Program as a NOAA Living Marine Resources Cooperative Science Center Graduate Fellow.