From: Strait, Kenneth A. <Kenneth.Strait@pseg.com>
Sent: Wednesday, June 10, 2020 4:51 PM
To: Grange, Briana
Cc: Lynn (lynn.lankshear@noaa.gov); Julie Crocker - NOAA Federal
Subject: [External_Sender] Salem Generating Station Section 7 Consultation Sonar Pilot Studies Summary Report
Attachments: LR-E20-0074-NRC Section 7 Consultation Pilot Study Summary Report.pdf

Briana:
As discussed with the NRC and NMFS during the May 4th conference call concerning the Salem and Hope Creek Generating Station Section 7 Consultation, PSEG promised to provide a copy of the attached study results as soon as possible. Please let me know if you have any questions concerning this matter. I am working remotely, so email is the best way to reach me. Thanks.

Ken

****
Kenneth A. Strait
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PSEG Nuclear Environmental Affairs Fax: 856.339.3905
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Hearing Identifier: NRR_DRMA
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Created By: Kenneth.Strait@pseg.com

Recipients:
"Lynn (lynn.lankshear@noaa.gov)" <lynn.lankshear@noaa.gov>
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Tracking Status: None
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SEND VIA EMAIL

June 11, 2020
LR-E20-0074

Briana A. Grange
Conservation Biologist & ESA Consultation Coordinator
U.S. Nuclear Regulatory Commission
Environmental Center of Expertise
Office of Materials Safety and Safeguards
Washington, DC 20555-0001

Dear Ms. Grange:

SALEM GENERATING STATION
DOCKET NOS.: 50-272 AND 50-311
RE-INITIATION OF SECTION 7 CONSULTATION
PILOT SONAR STUDIES SUMMARY REPORT

As discussed by the U.S. Nuclear Regulatory Commission (NRC) and the National Marine Fisheries Service (NMFS) during a May 4, 2020 teleconference[1], the NRC will be requesting re-initiation of Section 7 Consultation relating to operation of PSEG Nuclear's Salem Generating Station Units 1 and 2[2]. During this teleconference PSEG described several studies that were being implemented to better understand Atlantic sturgeon distribution in the vicinity of the cooling water intake structure and to potentially reduce incidental takes. PSEG committed to share the results of these studies with the regulatory agencies, and is now submitting the enclosed summary report for the completed pilot sonar studies.

---

[1] Summary of April 23, 2020, Teleconference with NMFS Regarding Incidental Take of Atlantic Sturgeon at Salem Nuclear Generating Station, ADAMS Accession No. ML20125A165

[2] National Marine Fisheries Service. Endangered Species Act Section 7 Consultation Biological Opinion for Continued Operation of Salem and Hope Creek Nuclear Generating Stations. NER-2010-6581. July 17, 2014. 246 p. ADAMS Accession No. ML14202A146; NMFS to NRC, Clarification of Allowable Sea Turtle take specified in Salem and Hope Creek Biological Opinion, November 23, 2018. ADAMS Accession No. ML18348A467

Additional detail can be found in the summary report, but the in-river side scan sonar survey identified a number of possible sturgeon targets dispersed throughout the survey area, with no aggregations in the immediate vicinity of the Salem cooling water intakes. Intake configuration, velocity, and turbulence made the collection of sonar images from the circulating water intake structure deck difficult; however, some trash bar observations were successful using high resolution sonar imaging. No impinged fish were observed, but fish activity was observed in the water column adjacent to the trash bars. All observed fish were swimming normally around and within the inspected areas. The report contains a number of images showing observed conditions.

Should you or your staff have any questions on this matter, please feel free to contact Ken Strait, Manager - Biological Programs at (856) 339-3929.

Sincerely,

Charles V. McFeaters

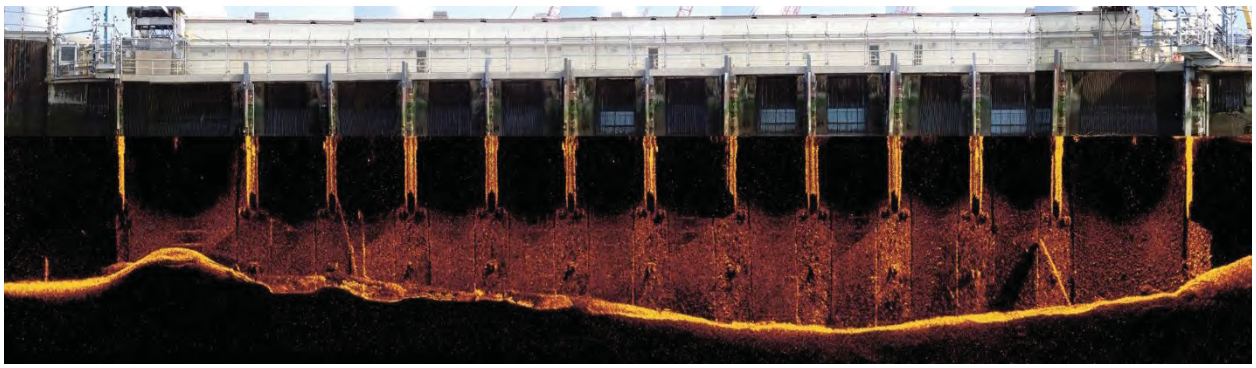
Charles V. McFeaters
Site Vice President - Salem

Enclosure

C Julie Crocker, NMFS, Endangered Fish Recovery Branch Chief (via email)
Lynn Lankshear, NMFS, Atlantic Sturgeon Coordinator (via email)

Pilot Study Summary Report
Salem Generating Station
Circulating Water System Intake Unit 1 & Unit 2
PSEG Nuclear, Hancocks Bridge, NJ

May 2020



Prepared by:

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Environmental Research and Consulting, Inc.
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Pilot Study Summary Report Salem Generating Station Circulating Water System Intake Unit 1 & Unit 2

PSEG Nuclear, Hancocks Bridge, NJ

DOCUMENT NO. H-7926000-01- DRAFT

Version	Date	Description	Prepared by:	Reviewed by:	Approved by:
01	04/27/2020	Initial draft for team review	M. Klein,		
02	04/29-30/20	Merged Draft	M. Klein, H. Brundage, E. Hughes	Field Team	
03	04/30/20	Send to Hudson Document Production			
04	06/02/20	Final Revisions	H. Brundage		

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report presents the results of a pilot study conducted at the Circulating Water System (CWS) Intake of the Salem Generating Station (Salem) in response to an unprecedented increase in the incidental take of juvenile Atlantic sturgeon during removal of debris from the CWS Intake trash rack during late March and early April 2020.

PSEG retained S. T. Hudson Engineers, Inc. (Hudson) with their scientific partners Environmental Research and Consulting, Inc. (ERC) and CSA Ocean Sciences Inc. (CSA) as members of the response survey team to perform sonar surveys in an attempt to evaluate conditions at and around the CWS Intake for Unit 1 and Unit 2 at the Salem facility.

The pilot study included a one (1) day side scan sonar survey in the river, and four (4) days of planned in-plant testing using various sonar methods and observing current plant operations and adjusting around such operations as needed.

It should be noted that all field work was completed during a refueling outage at Unit 2 and state-wide COVID-19 restrictions. Dates of the survey are included in the report.

As with all pilot studies, equipment selection, deployment, data collection and analysis, and overall performance were considered. Site-specific constraints on certain monitoring approaches also were identified and will be an important consideration in any future application of these technologies.

Primary observations resulting from the pilot studies were:

1. The in-river sonar survey identified a number of possible sturgeon targets dispersed throughout the survey area, with no aggregations in the immediate vicinity of the intake on the date of survey.

2. Intake velocity, turbulence, and configurations make the collection of sonar images from the circulating water intake structure deck difficult. However, some trash bar observations were successful using high resolution sonar imaging. Fish activity was observed in the water column near and adjacent to the trash bars. Detailed description and documentation of species or concentrations were beyond the scope of this initial pilot study.

3. Biofouling and debris were observed on the trash bars using high frequency sonar. This condition was observed at Unit 1 while in operation, and at Unit 2 which was in a refueling outage. Sample images are provided.

4. Fish were observed during inspections in the vicinity of the trash bars. No impinged fish were observed or determined with sonar during this limited effort. All fish were observed swimming on or around the inspected areas. Sample images are provided.

With further refinement, the sonar technology and approaches tested during the Pilot Study may be useful for indicating the presence/absence of fish in the capture zone areas, and could be used to determine biofouling, detritus buildup, and rake use efficiency.

1.0 INTRODUCTION

This report presents the results of a pilot study conducted at the Circulating Water System (CWS) intake of the Salem Generating Station (Salem) in response to an unprecedented increase in the incidental take of juvenile Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) during removal of debris from the CWS intake trash rack during late March and early April 2020. PSEG has previously consulted with the National Marine Fisheries Service (NMFS) regarding the impact of the Salem (and the nearby Hope Creek Generating Station) on federally-listed endangered and threatened species, including Atlantic sturgeon and shortnose sturgeon (*Acipenser brevirostrum*), and certain take of sturgeon is exempted by an Incidental Take Statement (ITS) issued by NMFS on July 17, 2014 and amended on November 23, 2018.

The study was conducted by S. T. Hudson Engineers (Hudson), with technical support from Environmental Research and Consulting, Inc. (ERC) and CSA Ocean Sciences Inc. (CSA), in an attempt to evaluate conditions at and around the CWS Intake for Unit 1 and Unit 2 at the Salem facility.

The pilot study included a one (1) day side scan sonar survey in the river, and four (4) days of in-plant testing using various sonar methods and observing current plant operations.

2.0 PROJECT LOCATION AND SITE DESCRIPTION

The Salem Generating Station (Salem) is located on the Delaware River at the southern end of Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey (**Photo 1**). Salem consists of two pressurized water nuclear reactors (Units No. 1 and 2) each with an electrical capability of approximately 1,100 megawatts per unit. Unit No. 1 began commercial operation during June 1977 and Unit No. 2 during October 1981.

Cooling water for the station is withdrawn from the Delaware River through two separate shoreline intakes. The CWS intake, the location of this investigation, provides cooling water for the main condensers of both units, while a service water system (SWS) intake provides cooling water for safety-related heat exchangers and coolers within the station (**Photo 2**). Cooling water from both systems is discharged via subsurface discharge pipes, which discharge 500 ft offshore.

The CWS intake, which serves both units, consists of twelve (12) separate, independent intake bays, each containing a circulating water pump and a vertical traveling water screen. A fixed trash rack prevents large debris and mats of detritus (primarily *Phragmites* reeds) from entering the intake bays. The racks are made from 0.5-inch steel bars placed on 3.5-inch centers, creating a 3-inch clearance between each bar. Debris is periodically removed from the trash rack using a mechanical, mobile clamshell-type rake. The trash rake system includes a hopper that stores and transports

removed debris to a pit at the end of each intake, where it is dewatered and disposed off-site.

Removable ice barriers can be installed in front of the trash rack to prevent damage during severe river icing conditions. The barriers extend from the deck of the intake structure to a depth of approximately 11-feet below Mean Low Water and are typically put into place in the winter and removed in early spring.

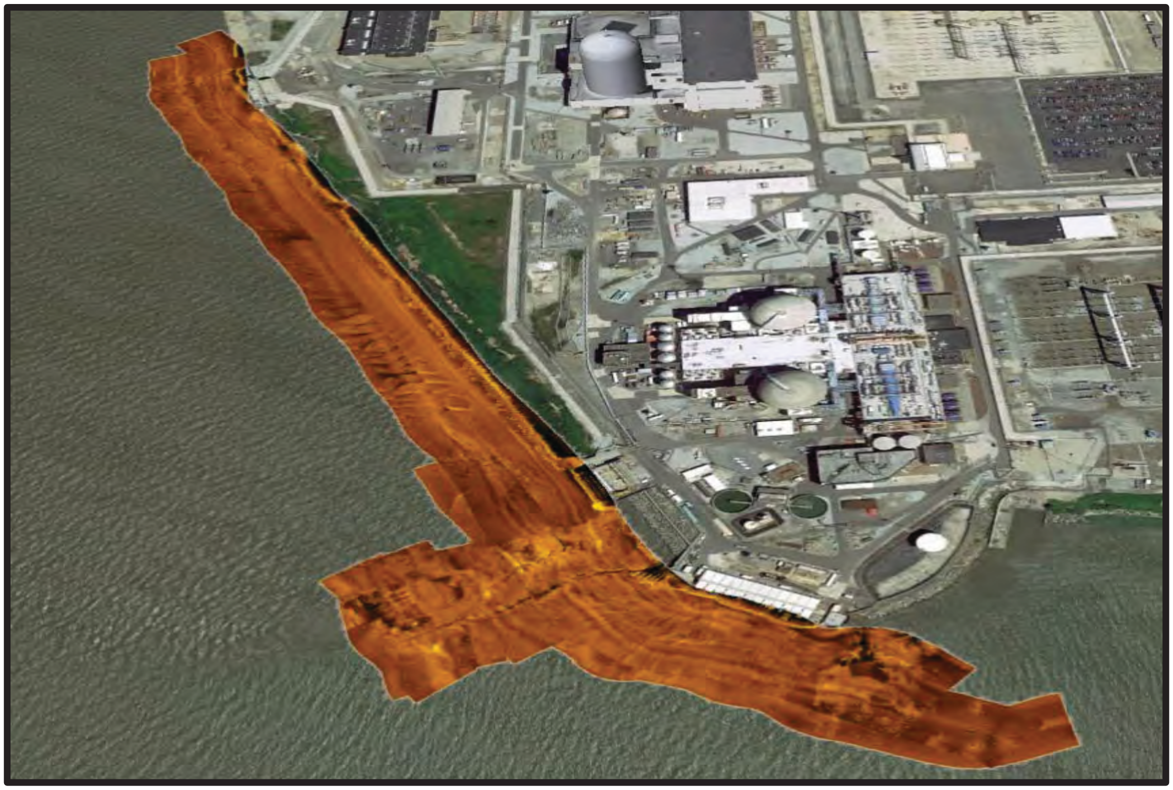


Photo 1: Aerial view of general project location – PSEG Salem Generating Station (Salem) along the Delaware River, Salem County, NJ. Note the brown feature is a side scan sonar mosaic of the river bottom discussed later in the report.

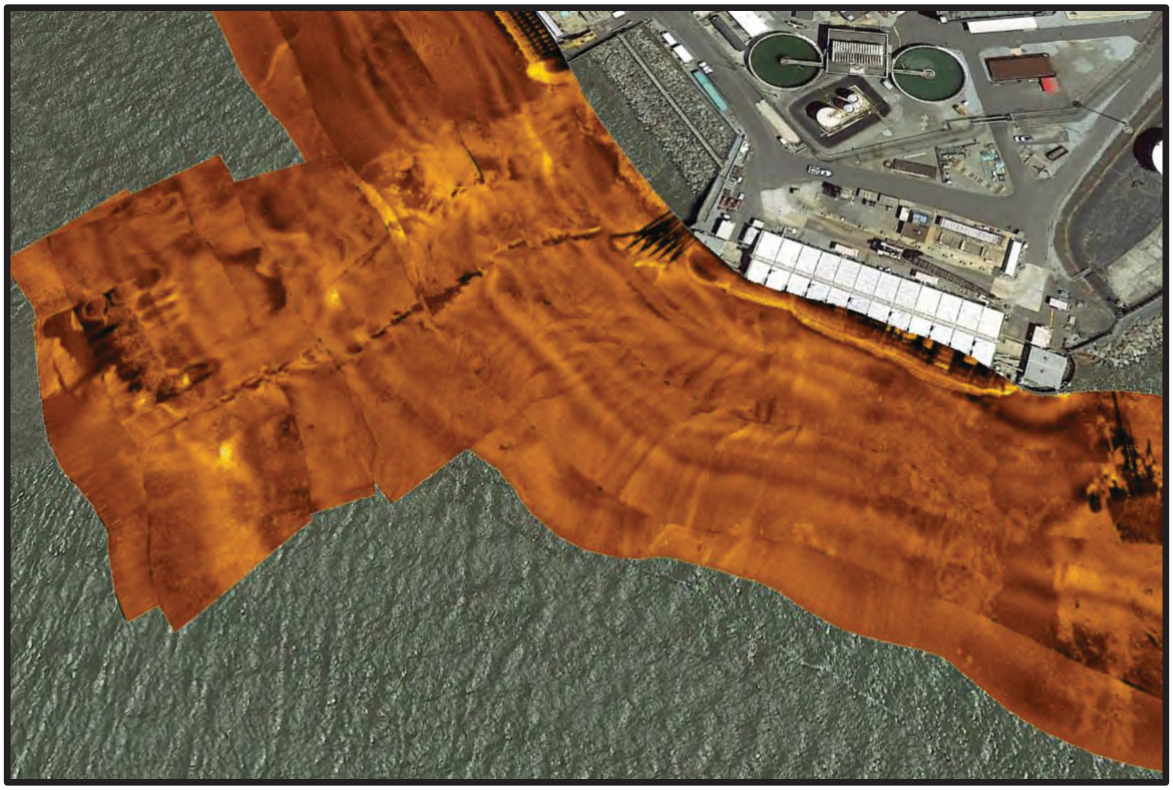


Photo 2: Aerial view of the circulating water system (CWS) intake (housed under the white roof structure. Note the brown feature is a side scan sonar mosaic of the river bottom discussed later in this report.

3.0 IN-PLANT TRASH BAR STUDIES

3.1 Background

The list of potential sonars that were initially considered for use for in-plant trash bar studies is provided in **Table 1**. These sonar technologies had been previously used at similar plant facilities to monitor structural conditions at intakes, verify fish activity, including silt and debris build-up. Sonars previously used at PSEG facilities included the scanning sonars from Kongsberg and TriTech to verify intake screen conditions as part of annual surveys from the river at the face of the intake. Side scan sonar units from Marine Sonics were used to characterize river bottom conditions as part of ongoing spring and fall hydrographic surveys since 2001.

Table 1. Sample List of Sonar Technologies that were Considered for the Pilot Study [1,2,3]

Model	Manufacturer	Type	Frequency	Beam Geometry
ARIS Explorer 3000	**Soundmetrics**	**High resolution multibeam imaging sonar**	**3.0 MHz/1.8MHz**	**0.25° beam width, 128 beams Horizontal field of view: 120°-140°**
Gemini 720 i	Tritech	Multibeam imaging sonar	720 kHz	0.20° vertical
SeaKing Hammerhead	Tritech	Scanning sonar	675 kHz/935 kHz	30° vertical, 0.9° horizontal at 675 kHz 20° vertical, 0.6° horizontal at 935 kHz
Micron	Tritech	Scanning Sonar	700 kHz	35° vertical, 3° horizontal
SeaPrince	Tritech	Scanning Sonar	Max bandwith 500 kHz to 900 kHz (default of 675 kHz)	38° vertical, 2.3° horizontal
StarFish 450F	Tritech	Side Scan Sonar	450 kHz	Vertical beam 60° nominal width (@ -3db signal level) Horizontal beam 1.7° nominal width (@ -3db signal level)
StarFish 990F	Tritech	Side Scan Sonar	1000 kHz	Vertical beam 60° nominal width (@ -3db signal level) Horizontal beam 0.3° nominal width (@ -3db signal level)
MS1000	Kongsberg-SIMRAD	Scanning Sonar	675 kHz	Vertical beam 2.5° Horizontal field of view 120°
Mesotech M3	Kongsberg-SIMRAD	Multibeam Imaging Sonar	500 kHz	Vertical beam 3° Horizontal field of view 120°
Seascan HDS	**Marine Sonic Technology**	**Side Scan Sonar**	**600 kHz, 1200 kHz**	**Vertical: 40° at 600 and 1200 kHz Horizontal: 0.4° @ 600 and 1200 kHz**
Humminbird 900c HD	**Humminbird**	**Sideview Sonar**	**83/200/455/800/50 kHz**	**using 360° transducer**
BlueView[3]M900-2250	Teledyne	High-Resolution Multibeam Imaging Sonar	2,250 kHz/900 kHz	Beam width 1° x 20° Beam spacing 0.18°

[1] Sonars not listed in order of significance.
[2] Pan and tilt, mounting brackets are not addressed with this table.
[3] BlueView sonar was available for use but not tested due to satisfactory results of the Aris 3000.

Some general sonar concepts that were used in evaluating and selecting the best suited sonar technologies for this effort are depicted in **Figure 3.1**. Several key points that are considered during the selection process include factors such as range and resolution of images from a sonar head, data management, and supporting software. As briefly illustrated in **Figure 3.2**, there are some tradeoffs in range and positioning of the sonar system, specifically when selecting imaging sonars operating at higher frequencies which result in higher resolution but shorter ranges as a result of signal attenuation. In general, no one system can typically meet all goals in all conditions, so it is common to use more than one type of system.

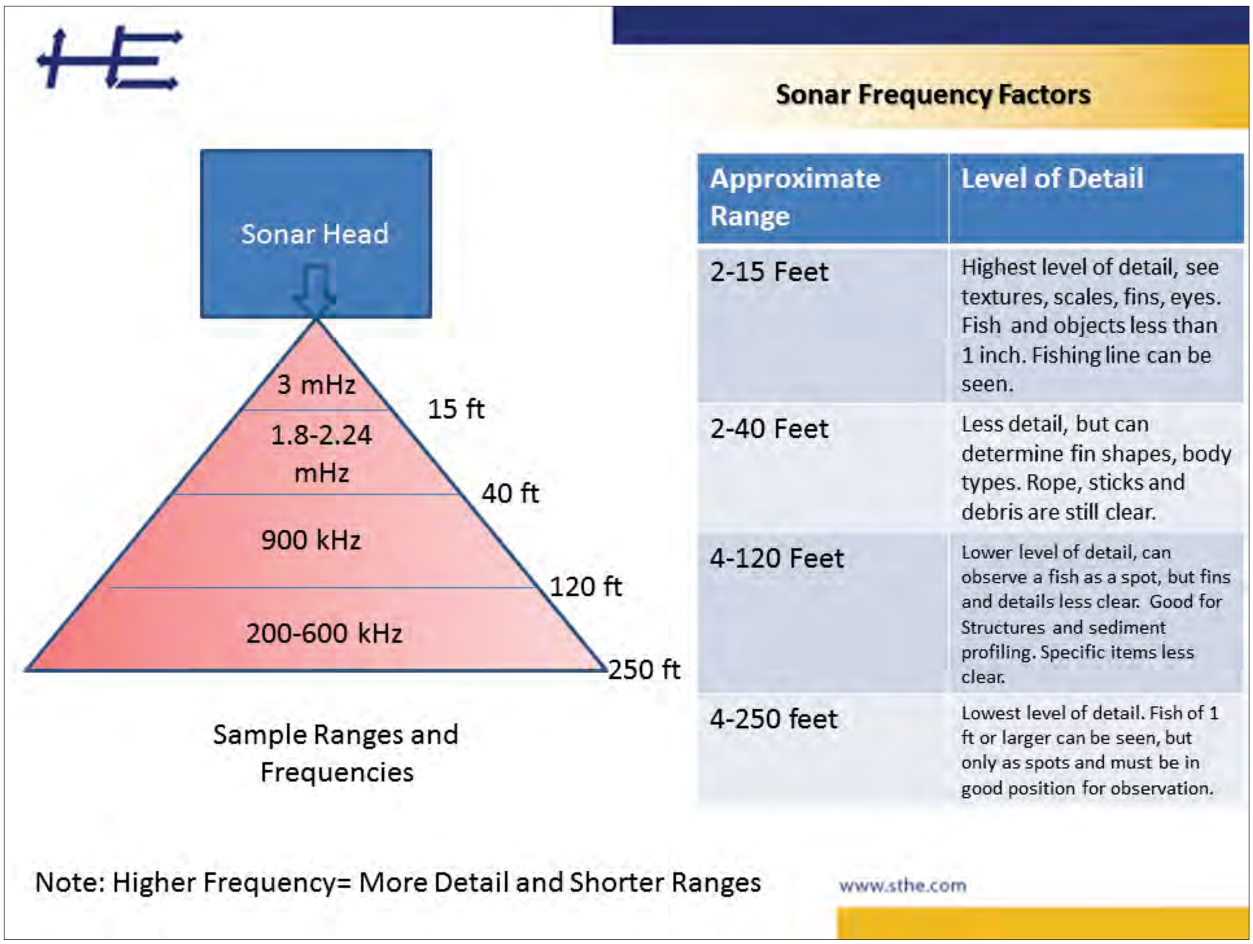


Figure 3.1: Sonar frequency factors. The figure shows the limits of range of sonar frequencies. Higher frequencies provide greater resolution but have a limited range. Location and position of the device is therefore important in collecting beneficial information related to targeted areas of inspection.

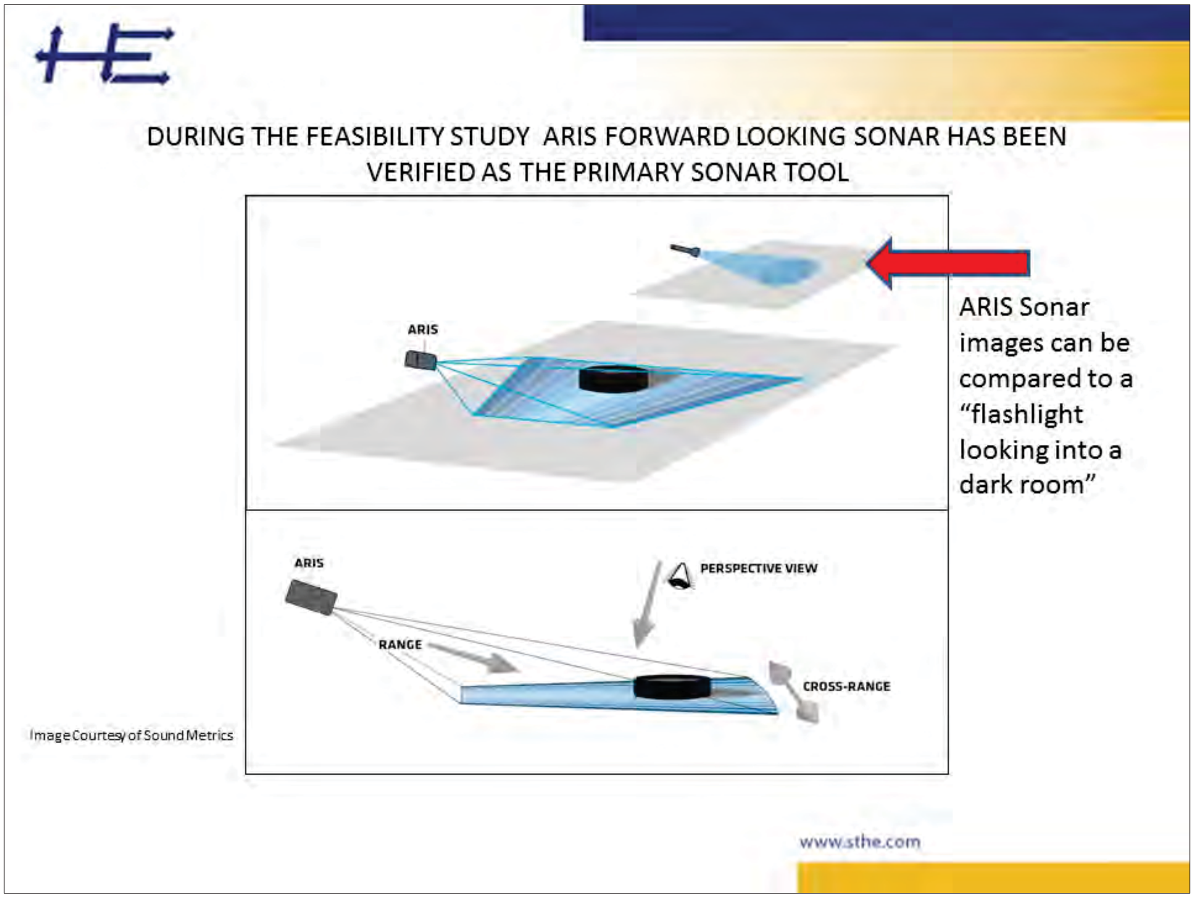


Figure 3.2: This figure shows the perspective, range, geometries, and acoustic shadows cast by objects involved with using a forward-looking sonar, such as the ARIS sonar. A forward-looking sonar differs in that it is not vertically mounted, pointing directly downward like more traditional multibeam sonars.

For this pilot study, the Soundmetrics ARIS Explorer 3000 (ARIS) was the primary device with limited testing of the Humminbird 900C HD. Based on previous experience at similar facilities, the ARIS sonar provided the best detection results for the near-field environment, including debris conditions and potentially impinged fish on intake trash racks. The Humminbird provides images at lower resolution but with a broader synoptic view of the immediate area and structural surroundings, all as a relatively low-cost system that can be configured in more challenging environments.

3.2 Equipment and Field Methods

The trash bar study was scheduled for total four (4) days and entailed an initial reconnaissance of the topside structures at both units to determine sonar equipment configuration. The remaining days were used to collect sonar imagery and test mounting methods primarily with the ARIS.

Day 1 (April 14, 2020) was used for mobilization and an initial walk down to determine dimensions and potential positions of sonar devices. No sonar imaging was conducted.

Day 2 (April 15, 2020) consisted of securing the ARIS system onto a pan and tilt mounted to a 28-ft long ladder bracket at Unit 2, in Bays 22A and 21B. Acoustic images were collected immediately upon deployment, which was done opportunistically during the refueling outage at Unit 2 and between crane and dive operations at the intakes. Refer to **Photos 3-6**.

Day 3 (April 21, 2020) continued the use of the ARIS system utilizing the same bracket configuration as Day 2. Imaging was conducted at Unit 1, at Bays 13A and 13B with circulating water pumps in full service. Refer to **Photos 7-10.**

Day 4-5 (April 28 and May 1, 2020) included stand by time for plant operations removing ice barriers and testing of the Humminbird system mounted on the rake itself to observe trash bar cleaning operations below the rake. Unfortunately, the sonar head was damaged beyond use after 10 minutes of testing. The rake rolled and crushed the transducer at approximately -10 ft below surface, effectively ending the pilot studies.

Photo 3: Topside view of intake bays at the CWS intake. Arrows show the general location of trash rack bars. Hatches are opened to clean via trash rake. Circle is trash rake on rail system. Day 2, Unit 2 area.

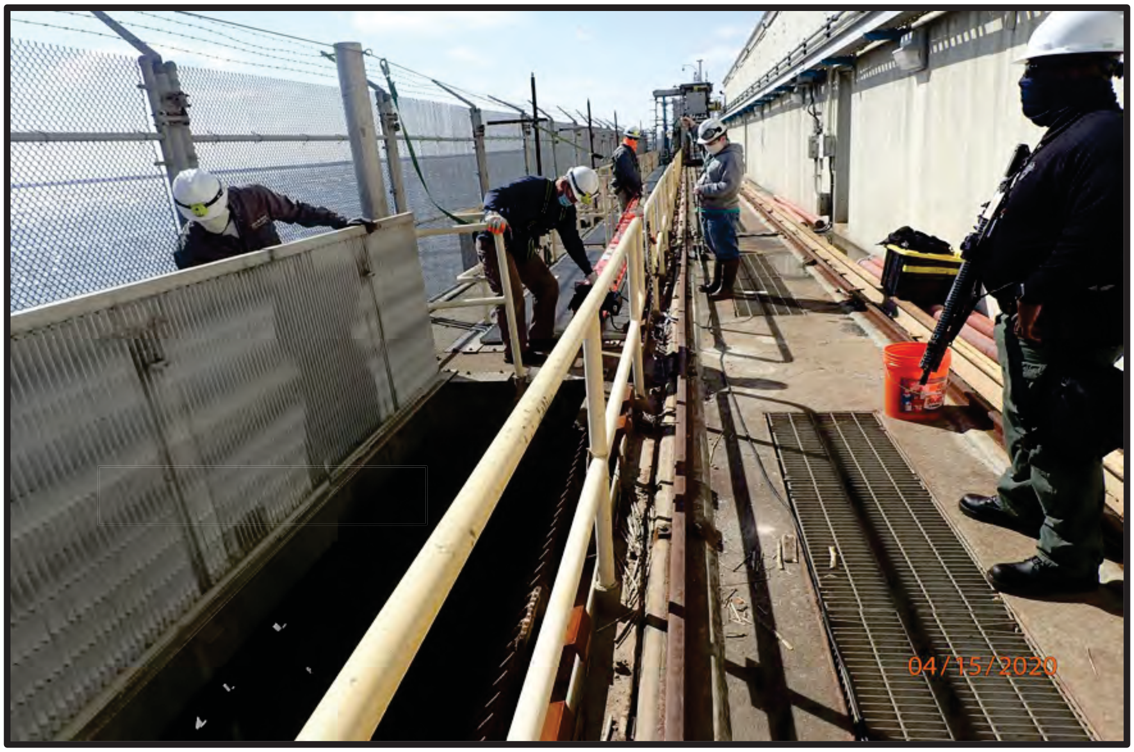


Photo 4: Unit 2 testing on Day 2 without trash rake operations during the refueling outage. Crew placing sonar device and bracket into 22A.

Photo 5: Looking into open hatch at 22A at Unit 2. Trash bars are to the right.

Photo 6: ARIS sonar with AR2 pan and tilt mounted on a ladder bracket prior to placement into bay.

Photo 7: Trash rake operations at Unit 1; Day 3 prior to sonar testing.

Photo 8: Trash rake being lowered into the water. Notice upwelling and turbulent flow prior to cleaning attempts.

Photo 9: Typical detritus/debris collected during trash bar cleaning operations.

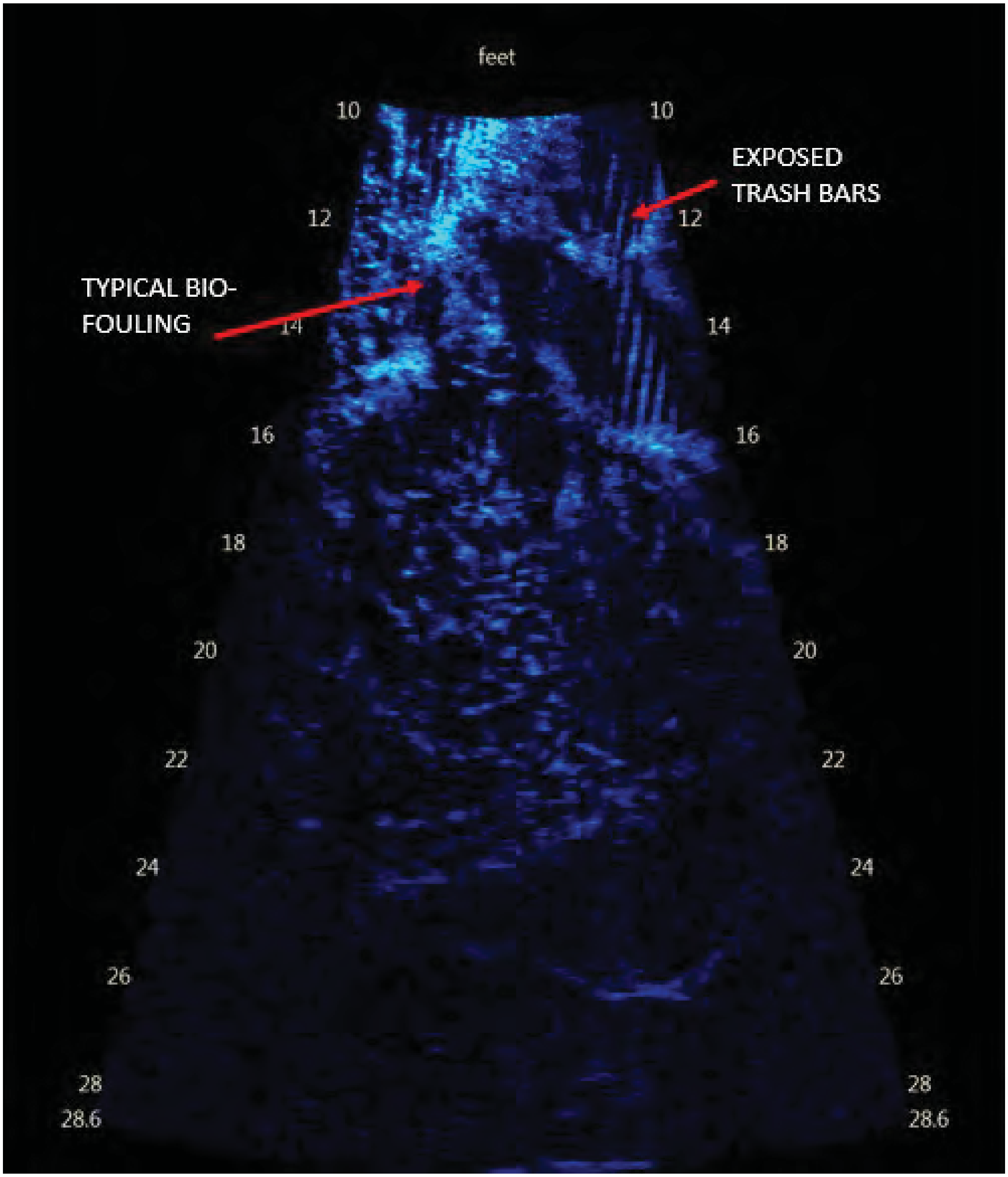
Photo 10: Sonar deployed at Unit 1 - 13B. Strong velocities affected ladder position. Sonar was able to collect data and observed biofouling and fish activity in the area of the trash bars. Arrow added to show localized flow after rake operations initiated.

3.3 Observations and Data Collected

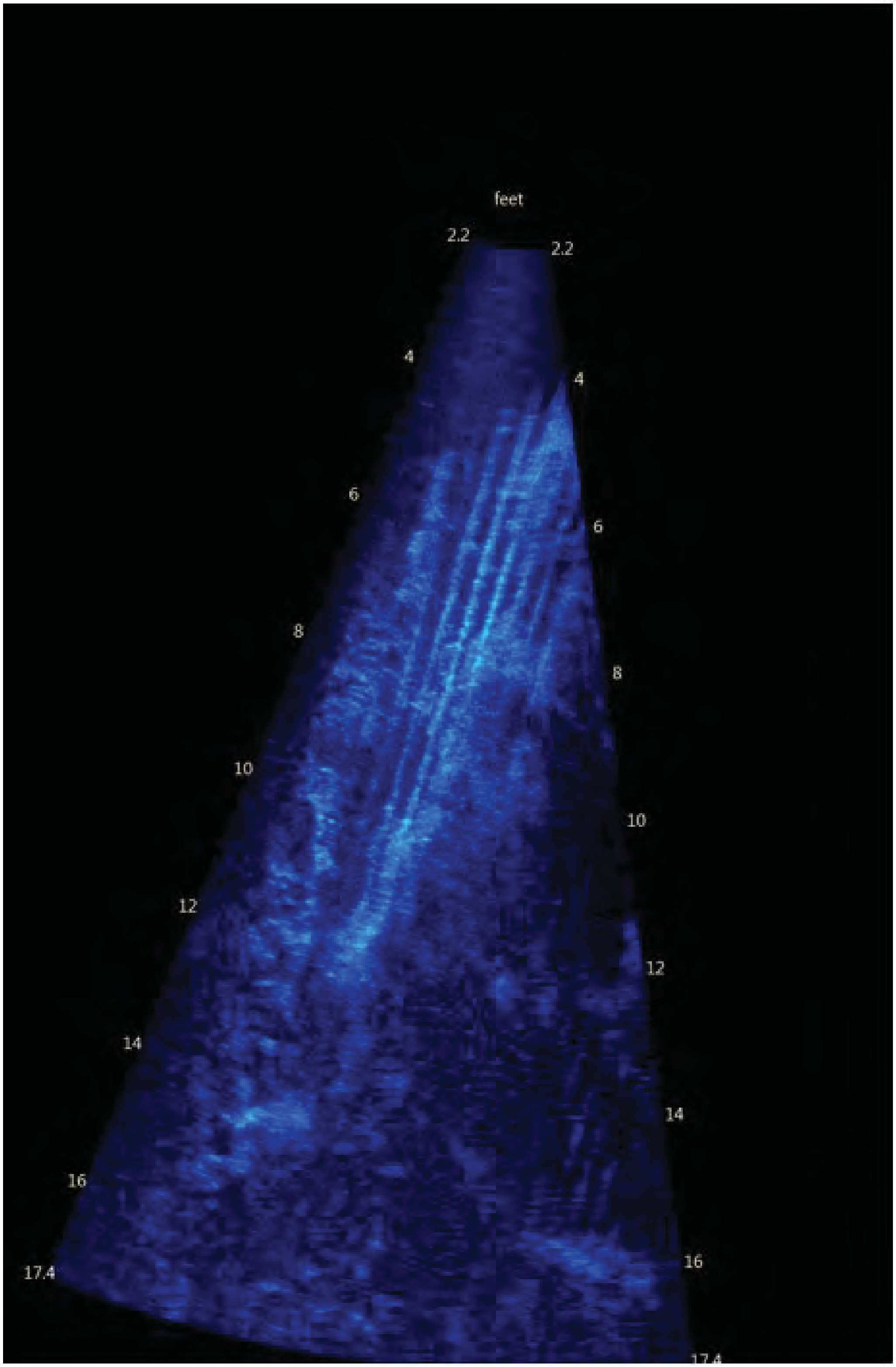
Acoustic imaging using the ARIS sonar was successful in observing real-time subsurface conditions including the immediate environment at the trash racks located at the several bays examined at Unit 1 and Unit 2. Significant biofouling and debris build-up were noted. Fish (potentially sturgeon) were observed swimming unencumbered in the vicinity of the trash rack. Flow characteristics were also observable as characterized by air bubbles and debris movement relative to flow.

Of additional note, trash rake operations and turbulent water flow were observed during the acoustic survey performed at Unit 1. At one-point, turbulent flow pushed the rake free of the trash rack and the rake collided with the ARIS sonar and bracket. Acoustic images using the ARIS were collected of the trach rack, but it was not possible to secure the bracket for viewing below the rake. It was also noted that two (2) Atlantic sturgeon were collected during raking operations on the same day of the survey.

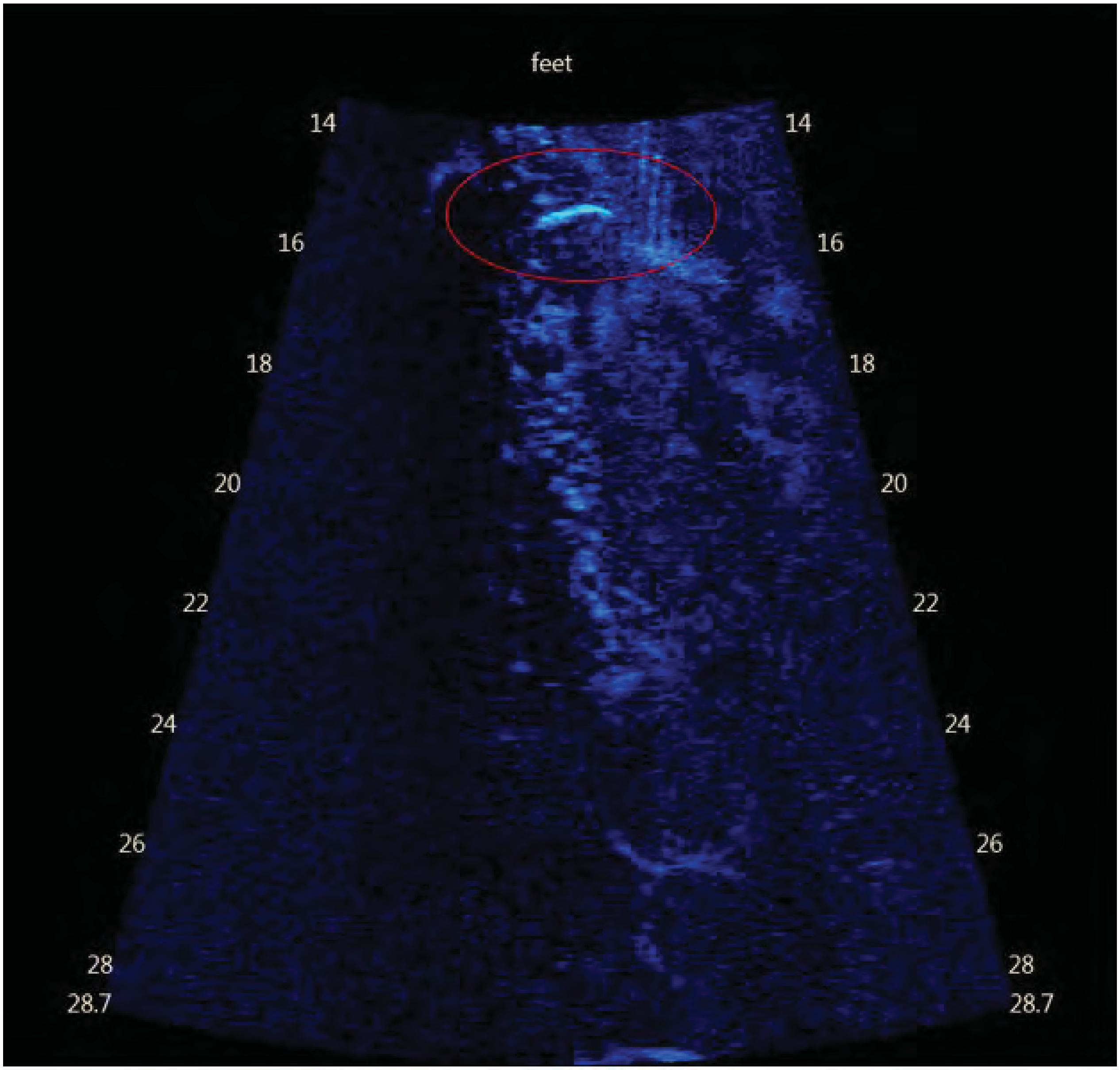
Acoustic data were collected in digital format as sonar recordings for additional review and discussion. Example frame grabs from the recorded sonar imaging are provided below (**Sonar Images 1- 5**).



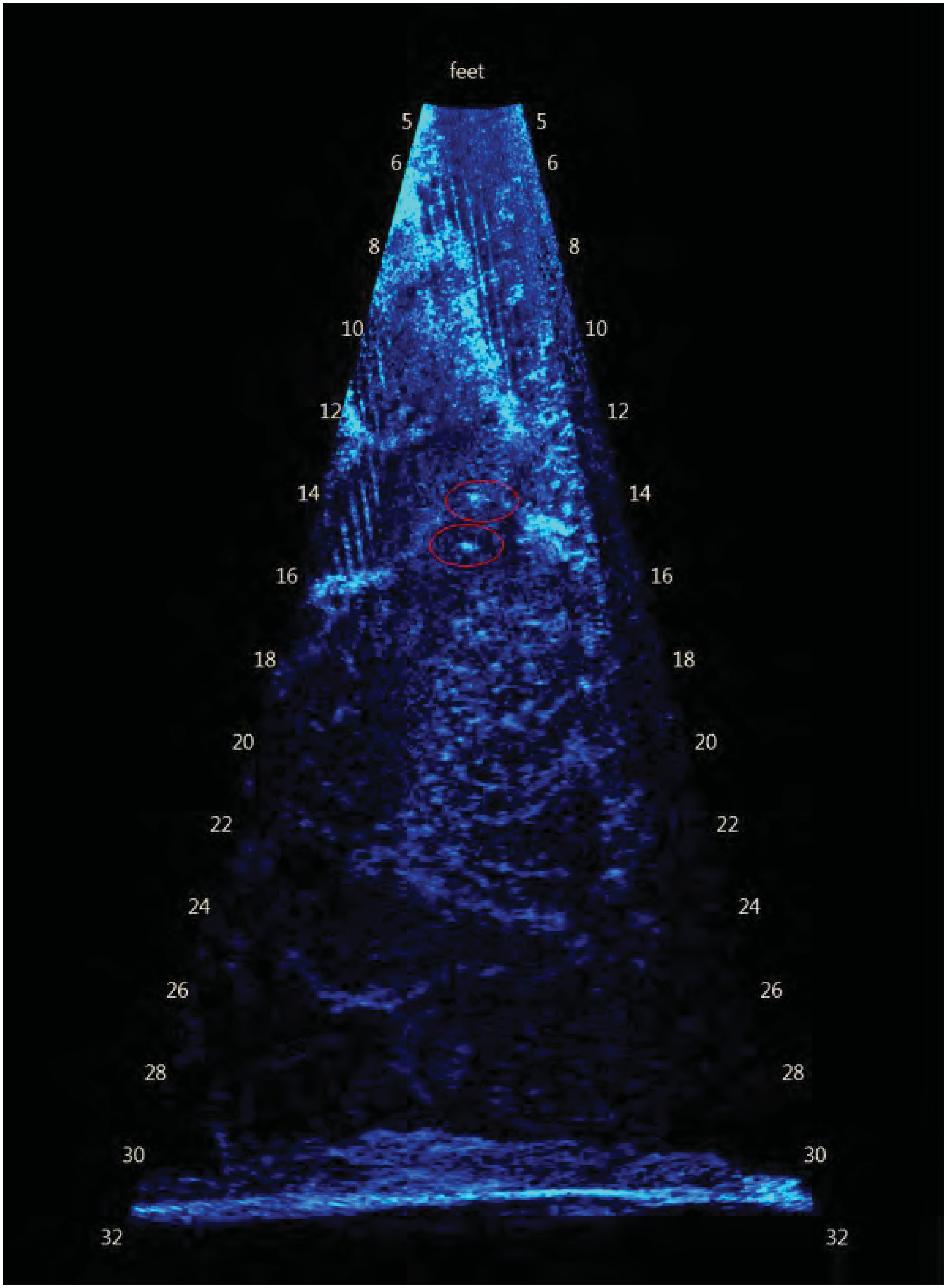
Sonar Image 1: Typical ARIS sonar view from real time sampling. Significant biofouling and detritus were observed on the trash bars, specifically near the bottom. Note cleaned trash bars elevation 16-feet and above. For orientation, numeric values indicate distance (ft) from ARIS sonar head.



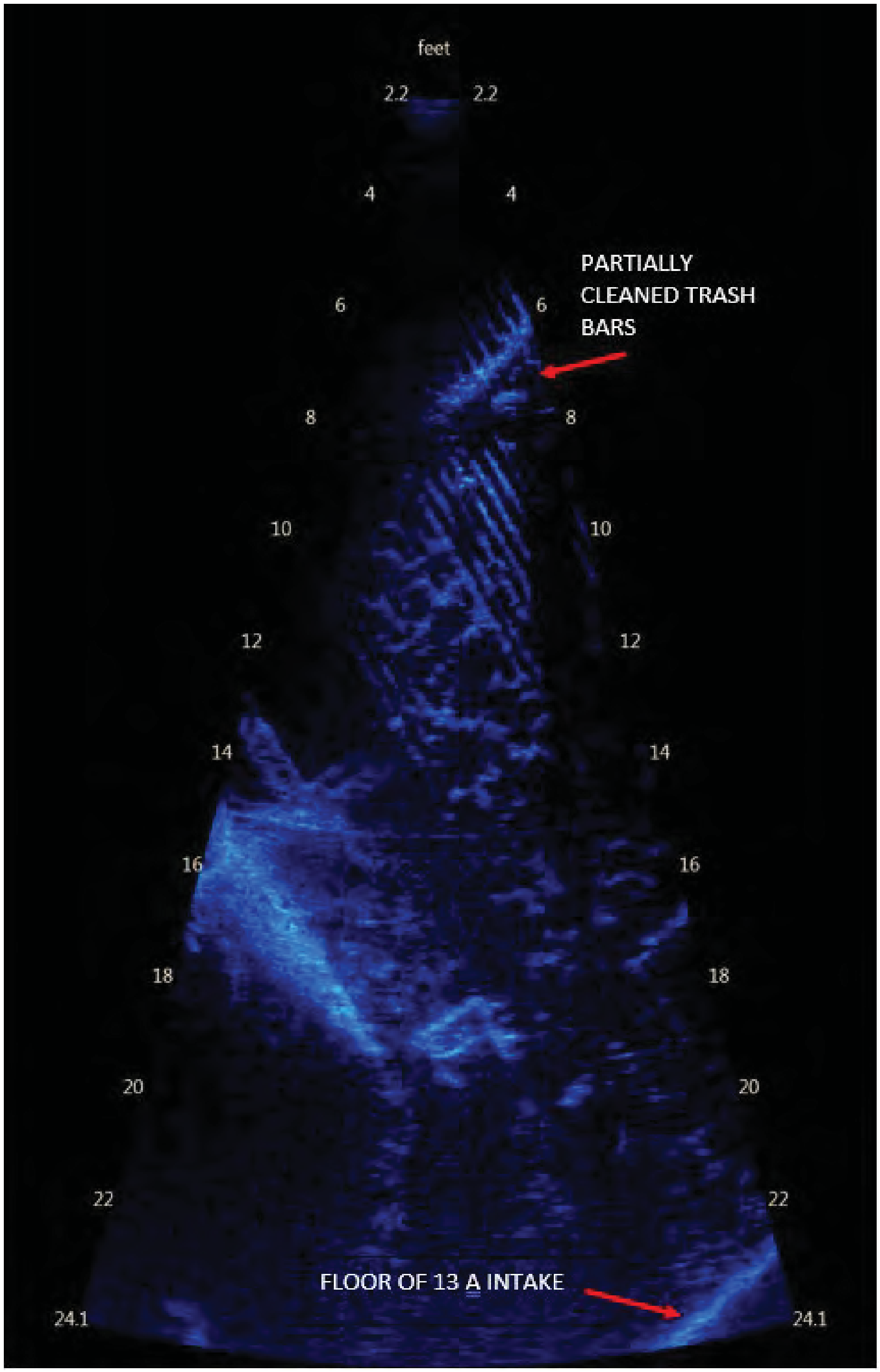
Sonar Image 2: Sample ARIS sonar image showing biofouling and partially cleaned trash rack. Day 2 Unit 2, Bay 22A. For orientation, numeric values indicate distance (ft) from ARIS sonar head.



Sonar Image 3: Potential sturgeon (red circle) swimming near trash bars at Unit 2, Day 2. For orientation, numeric values indicate distance (ft) from ARIS sonar head.



Sonar Image 4: ARIS sonar image at Unit 2 showing exposed concrete footer at base of trash rack, biofouling and partially cleaned trash bars. Potential fish noted in red circles. For orientation, numeric values indicate distance (ft) from ARIS sonar head.



Sonar Image 5: Unit 1 in full operational service on Day 3. Image is skewed approximately 45 degrees due to bracket movement in heavy upwelling. Note partially exposed trash bars after cleaning effort. Note biofouling in adjacent areas. For orientation, numeric values indicate distance (ft) from ARIS sonar head.

3.4 Results

Primary results of the trash bar studies are as follows:

1. Intake velocity, turbulence, and configurations make the collection of sonar images from the circulating water intake structure deck difficult. However, some trash bar observations were successful using high resolution sonar imaging. Fish activity was observed in the water column near and adjacent to the trash bars. Detailed description and documentation of species or concentrations were beyond the scope of this initial pilot study.

2. Biofouling and debris were observed on the trash bars using high frequency sonar. This condition was observed at Unit 1 while in operation, and at Unit 2 which was in a refueling outage. Sample images are provided in the previous section.

3. Fish were observed during inspections in the vicinity of the trash bars. No impinged fish were observed or determined with sonar during this limited effort. All fish were observed swimming on or around the inspected areas. Sample images are provided in the previous section.

4.0 IN-RIVER SIDE SCAN SONAR SURVEY

4.1 Background

Unlike fixed sonar devices previously described, side scan sonar used for covering larger areas such as the in-river areas utilizes acoustic transducers contained within a torpedo-shaped towfish, which is towed behind a survey vessel. The transducers emit pulses of high frequency acoustic energy in thin fan-shaped beams that are narrow in the horizontal plane and broad in the vertical plan. The acoustic signals are projected over the river bottom on both sides of the towfish. Echoes from targets on the bottom and the bottom itself are received by the towfish, amplified, and transmitted through a cable to a top side processor where they are integrated to form a seamless graphic record. The sonar image is displayed on a monitor and written to a hard drive for future viewing and analysis.

The side scan sonar output shows echo returns from both right and left channels, separated by a black area that represents the water column. Targets with high acoustic reflectivity appear on the sonar image as bright objects, moderately to weakly reflective targets appear in darker shades, and areas with no acoustic return appear black. Many targets show a black acoustic shadow that aids in discrimination of the object. Differences in bottom type and topography (e.g., sand ridges) are readily apparent in the sonar image. An example of a side scan sonar image showing a possible sturgeon target is given in **Figure 4.1**.

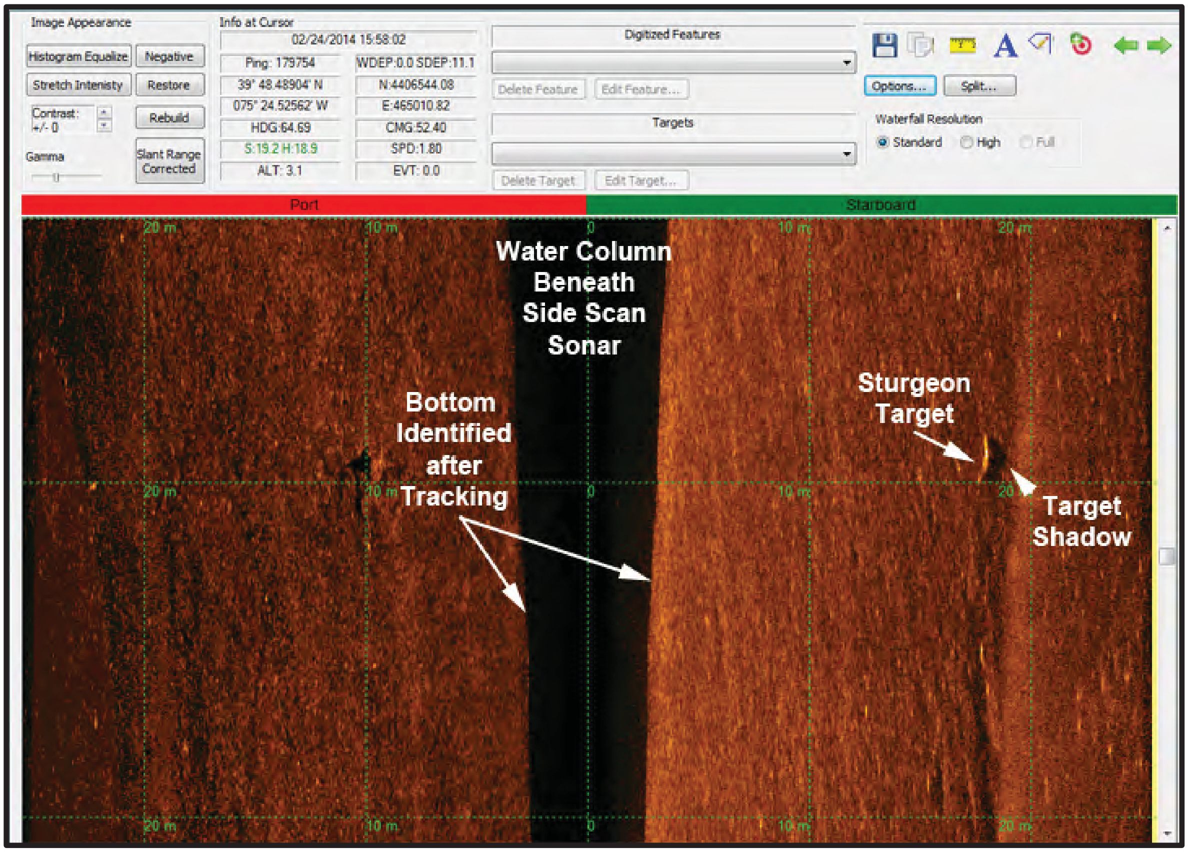


Figure 4.1: Example of a side scan sonar image showing a possible sturgeon target and its acoustic shadow. Source: Brundage and O'Herron, 2014.

4.2 Equipment and Field Methods

The sonar survey was conducted using a Marine Sonic HDS dual frequency (600/1200 kHz) side scan sonar. Sonar data was collected adjacent to the entire PSEG Artificial Island complex (**Fig. 4.2**) but focused on the area in front of the Salem CWS intake. The sonar unit was operated at a 70 ft range to provide comprehensive coverage and detail of the water intakes. Overlapping parallel survey lanes were completed along the length of the shoreline of the Salem plant. Spacing between lanes was less than 100 ft, providing comprehensive 200% overlap coverage of the river bottom. Marine Sonic data acquisition software was used to merge the acoustic data with real-time positioning data. Data were further processed used Chesapeake Technology, Inc. software.

Figure 4.2: Sonar mosaic showing the area surveyed on April 17, 2020.

Hypack, a laptop PC-based software package, in conjunction with a Differential Global Positioning System (DGPS) onboard the survey vessel provided positioning accuracy for the survey area of +/- two (2) feet. The computer converted positioning data from the DGPS to New Jersey state plane coordinates in real time. These X,Y coordinates were used to guide the survey vessel precisely along predetermined tracklines. While surveying, vessel positions were continually updated on the computer monitor to assist the vessel operator, and the processed X,Y data were continually logged on computer disk for post-processing and plotting. Project horizontal reference is the New Jersey State Plane Coordinate System, NAD 83, in feet.

The high resolution (1200 kHz) sonar data were reviewed to identify possible sturgeon targets using Marine Sonic Sea Scan Survey software (V5.10). Potential sturgeon targets were

identified based on the presence of a high-amplitude linear return, characteristics of the acoustic shadow, target length ≥ 0.5 m, and position relative to the bottom. These characteristics have proven useful for sturgeon identification in previous side scan sonar studies on the Delaware River (ERC, 2006; Comer et al., 2013; Brundage and O'Herron, 2014) and other rivers (Flowers and Hightower, 2013; Kazyak et al., *in review*). All sturgeon targets were measured to the nearest centimeter using the measurement tool in the Sea Scan Survey software.

4.3 Results

The side scan sonar survey was conducted on April 17, 2020. Water temperature and salinity on the day of the survey ranged from approximately 11.6-12.2°C and 2.1-3.3 ppt, respectively, at the USGS Reedy Island station, located approximately 5.5 km upriver of the SGS. Sonar mosaics showing details of the area surveyed at 1200 kHz are presented in **Figures 4.3 through 4.5**.

A total of 41 possible sturgeon targets were identified (**Table 4.1**) and their locations are plotted in **Figure 4.6**. The estimated length of the sturgeon targets ranged from 0.52-1.58 m, and averaged 0.74 m. Confidence in identification of the targets as possible sturgeon ranged from low to moderate, and varied with image quality, aspect angle, and the presence and characteristics of the shadow zone. Some of the targets had distinct slightly humpbacked acoustic shadows, which is characteristic of sturgeon, while others did not evidence a shadow, but had bright, linear direct returns. The diagnostic heterocercal shape of the tail fin in the acoustic shadow that is sometimes visible in sonar images of larger sturgeon (Flowers and Hightower, 2013) was not observed for any of the targets, probably because of the generally smaller size (<1.0 m) of the sturgeon present at the time of the survey. Images of representative sturgeon targets are provided in **Figures 4.7** through **4.15**.

Possible sturgeon targets were scattered throughout the survey area (**Fig. 4.6**) and were not densely aggregated, as has been observed in other areas of the Delaware River (Comer et al., 2013). One possible sturgeon target was located close (0.83 m) to the CWS trash rack and two were close (1.17 and 2.17 m) to the SWS trash rack, but otherwise they did not show a particular association with structures, including the 48-inch screen wash water discharge pipe. With the exception of the close proximity of one sturgeon target to the CWS trash rack, no conditions that might explain the anomalous take were observed.

Table 4.1. Possible sturgeon targets observed during the April 17, 2020 side scan sonar survey in the vicinity of the Salem CWS and SWS intakes

Target No.	File	Time	Channel	Distance from Centerline (m)	Latitude (N)	Longitude (W)	Estimated Length (m)	Estimated Height off Bottom (m)	Comments
1	0051	1:47	L	3.50	39° 27.6327	75° 32.1526	0.60	on bottom	0.83 m from CWS trash rack
2	0049	0:32	R	7.05	39° 27.6196	75° 32.1257	0.76	0.10	
3	0049	1:02	R	4.23	39° 27.6322	75° 32.1712	0.80	1.07	
4	0049	1:43	L	10.50	39° 27.6603	75° 32.2167	0.71	0.22	
5	0049	2:10	R	14.23	39° 27.6927	75° 32.2196	0.67	on bottom	1.17 m from SWS trash rack
6	0049	2:10	R	14.54	39° 27.6928	75° 32.2194	0.68	on bottom	2.17 m from SWS trash rack
7	0047	0:14	L	3.42	39° 27.7092	75° 32.2537	0.61	0.27	
8	0047	0:14	R	3.95	39° 27.7060	75° 32.2570	0.74	0.17	near tire
9	0047	0:14	R	8.85	39° 27.7041	75° 32.2594	0.81	0.10	
10	0047	0:54	R	4.83	39° 27.6719	75° 32.2283	0.80	0.93	
11	0045	1:21	R	6.95	39° 27.6130	75° 32.1637	0.78	1.85	distinct shadow
12	0043	4:19	R	14.29	39° 27.6409	75° 32.3172	0.67	0.04	
13	0043	4:20	R	7.49	39° 27.6399	75° 32.3220	0.75	on bottom	
14	0043	4:40	R	19.07	39° 27.6600	75° 32.3287	0.66	0.04	
15	0039	0:32	R	9.75	39° 27.6274	75° 32.2854	---	---	fish shaped shadow
16	0037	0:01	R	18.51	39° 27.6127	75° 32.2420	0.82	0.08	
17	0037	0:01	R	18.51	39° 27.6133	75° 32.2424	0.52	0.08	
18	0037	0:33	R	5.98	39° 27.6338	75° 32.2672	0.60	0.75	
19	0035	0.48	R	16.17	39° 27.6037	75° 32.2602	0.91	0.09	
20	0034	0:01	L	13.29	39° 27.6203	75° 32.2255	0.92	0.14	
21	0034	0:11	L	11.50	39° 27.6147	75° 32.2204	0.58	0.11	
22	0034	0:22	L	13.26	39° 27.6088	75° 32.2077	0.55	0.18	distinct shadow
23	0034	0:26	L	14.82	39° 27.6057	75° 32.1997	0.63	0.13	distinct shadow

Table 4.1. Continued.

Target No.	File	Time	Channel	Distance from Centerline (m)	Latitude	Longitude	Estimated Length (m)	Estimated Height off Bottom (m)	Comments
24	0034	1:03	L	16.79	39° 27.5781	75° 32.0909	0.83	on bottom	
25	0034	1:19	R	3.88	39° 27.5532	75° 32.1300	0.86	---	
26	0034	1:26	R	17.81	39° 27.5612	75° 32.1439	0.63	0.09	
27	0034	1:26	R	18.07	39° 27.5613	75° 32.1442	0.86	0.10	
28	0034	1:29	R	12.74	39° 27.5597	75° 32.1499	1.01	0.25	
29	0034	1:35	L	16.36	39° 27.5511	75° 32.1717	0.63	0.20	
30	0034	1:48	R	15.76	39° 27.5775	75° 32.1797	0.63	0.10	
31	0034	2:07	L	9.61	39° 27.5819	75° 32.2237	0.93	0.65	distinct shadow
32	0034	2:44	L	12.28	39° 27.6180	75° 32.2585	0.67	0.20	
33	0034	2:44	L	11.97	39° 27.6185	75° 32.2587	0.59	0.20	
34	0034	3:22	L	4.09	39° 27.6581	75° 32.2801	0.76	---	
35	0034	3:46	L	9.44	39° 27.6866	75° 32.3017	0.61	0.09	
36	0033	0:19	L	4.73	39° 27.6554	75° 32.2622	1.58	---	long linear target
37	0033	0:23	R	11.32	39° 27.6479	75° 32.2696	0.85	0.08	distinct shadow
38	0032	0:20	R	8.28	39° 27.6392	75° 32.2332	0.58	0.20	
39	0032	1:37	R	13.04	39° 27.7231	75° 32.2738	0.67	0.18	
40	0032	3:05	L	9.53	39° 27.6959	75° 32.2942	0.75	0.36	
41	0032	3:06	L	0.64	39° 27.6917	75° 32.2976	0.66	---	linear target in water column

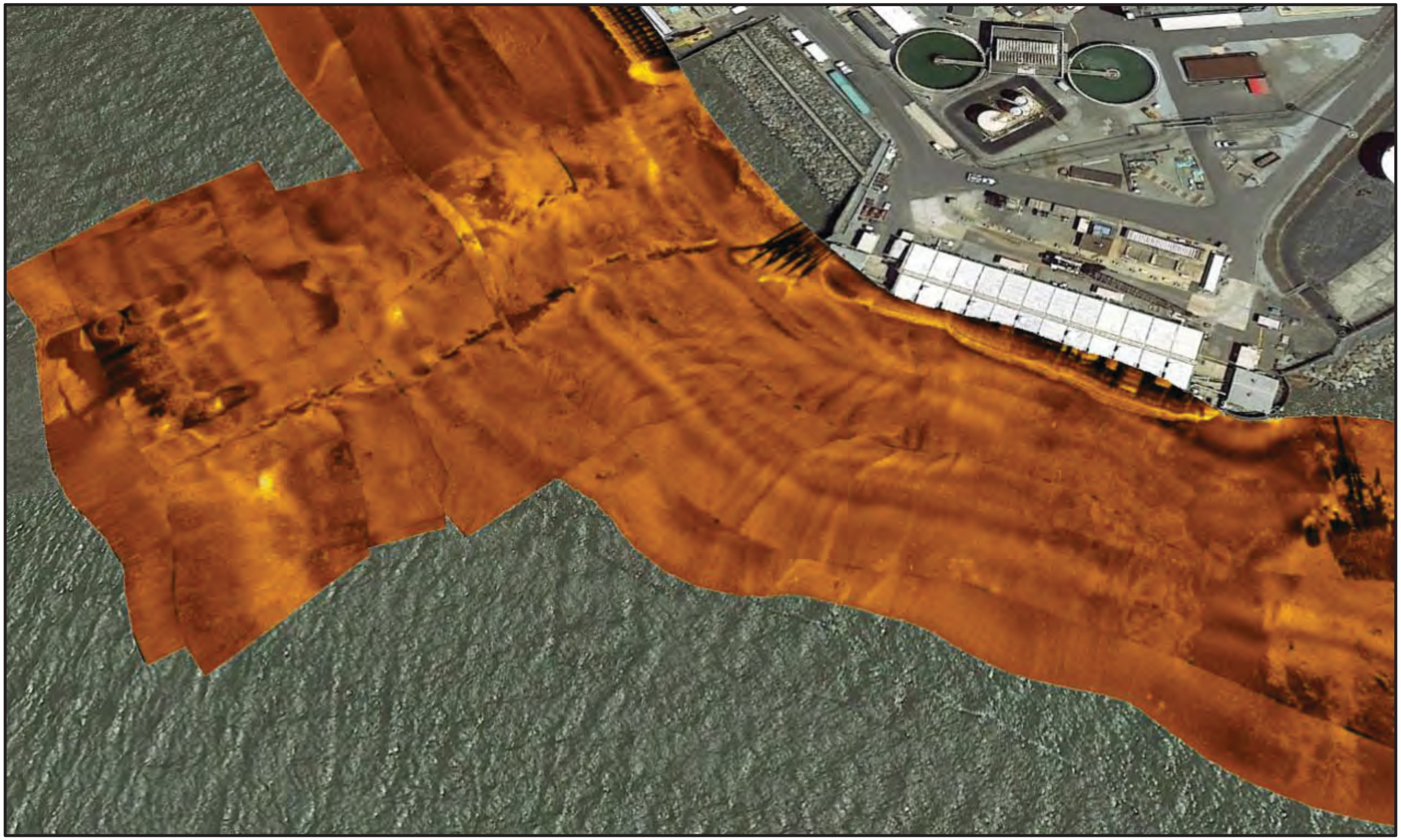


Figure 4.3. Sonar mosaic showing the 1200 kHz survey area, which included the Salem CWS intake, the thermal outfall, and the screen wash water discharge pipe.

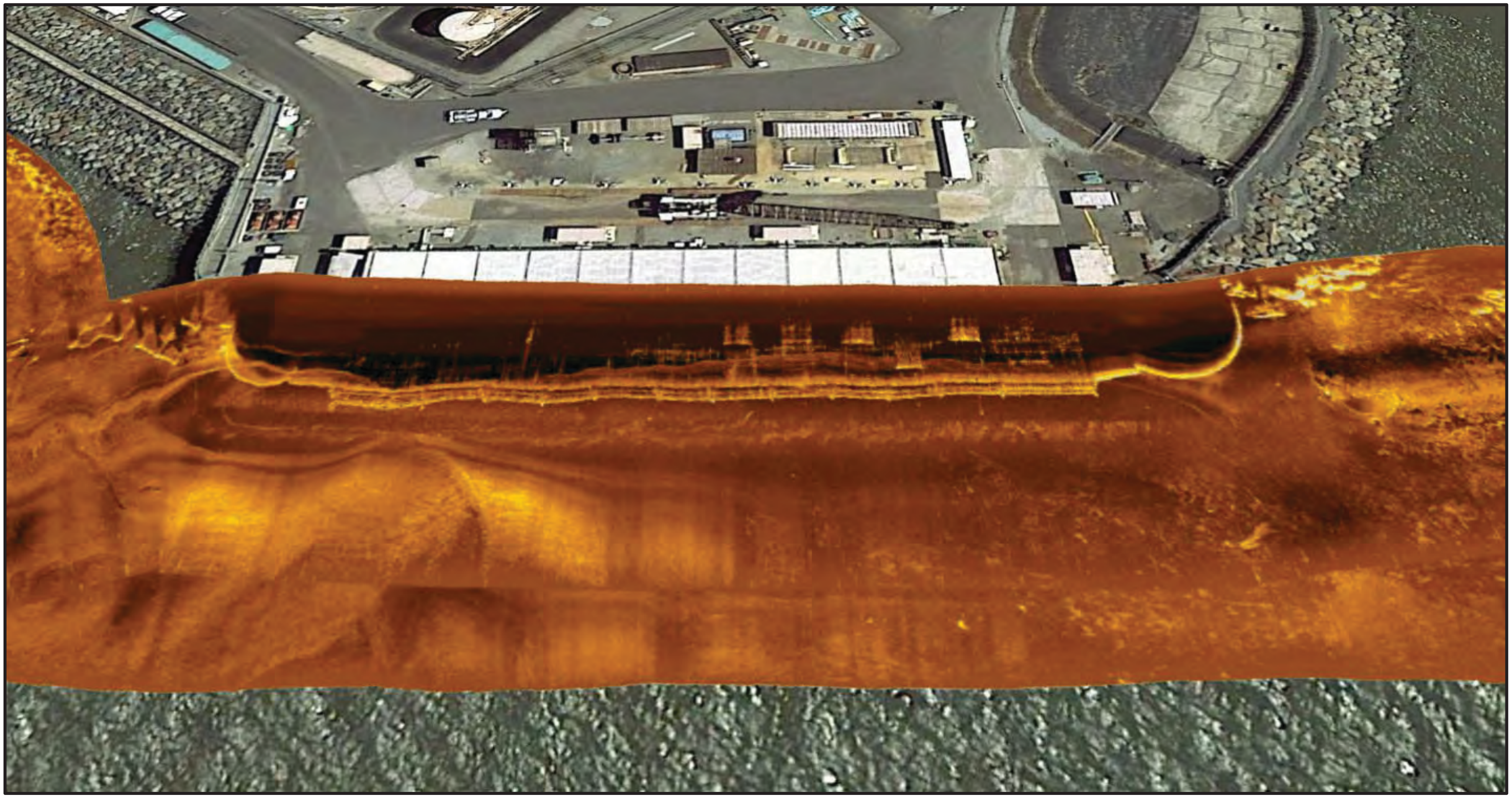


Figure 4.4. Sonar mosaic of Salem CWS intake area – view offshore.

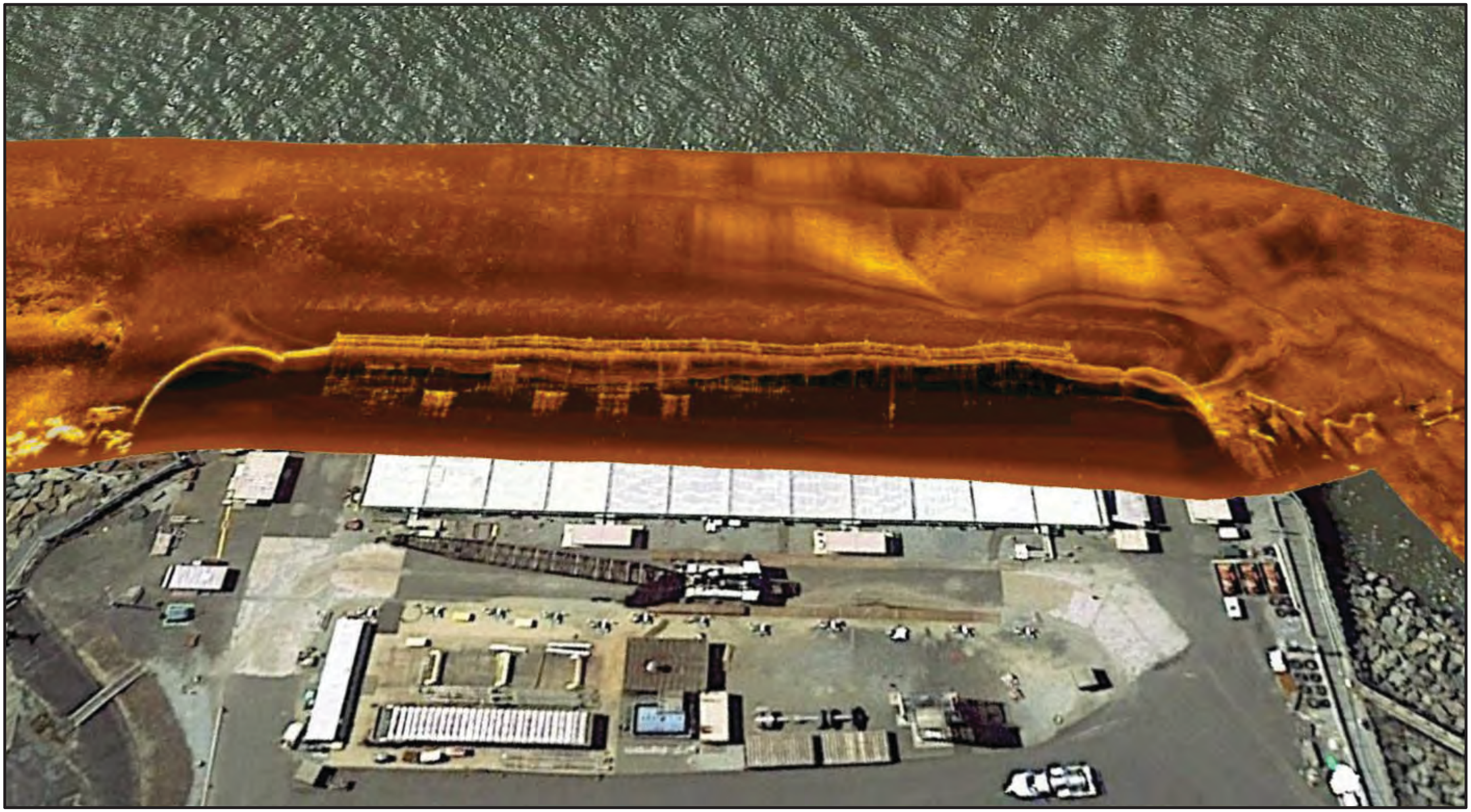


Figure 4.5. Sonar mosaic of Salem CWS intake area – view onshore.

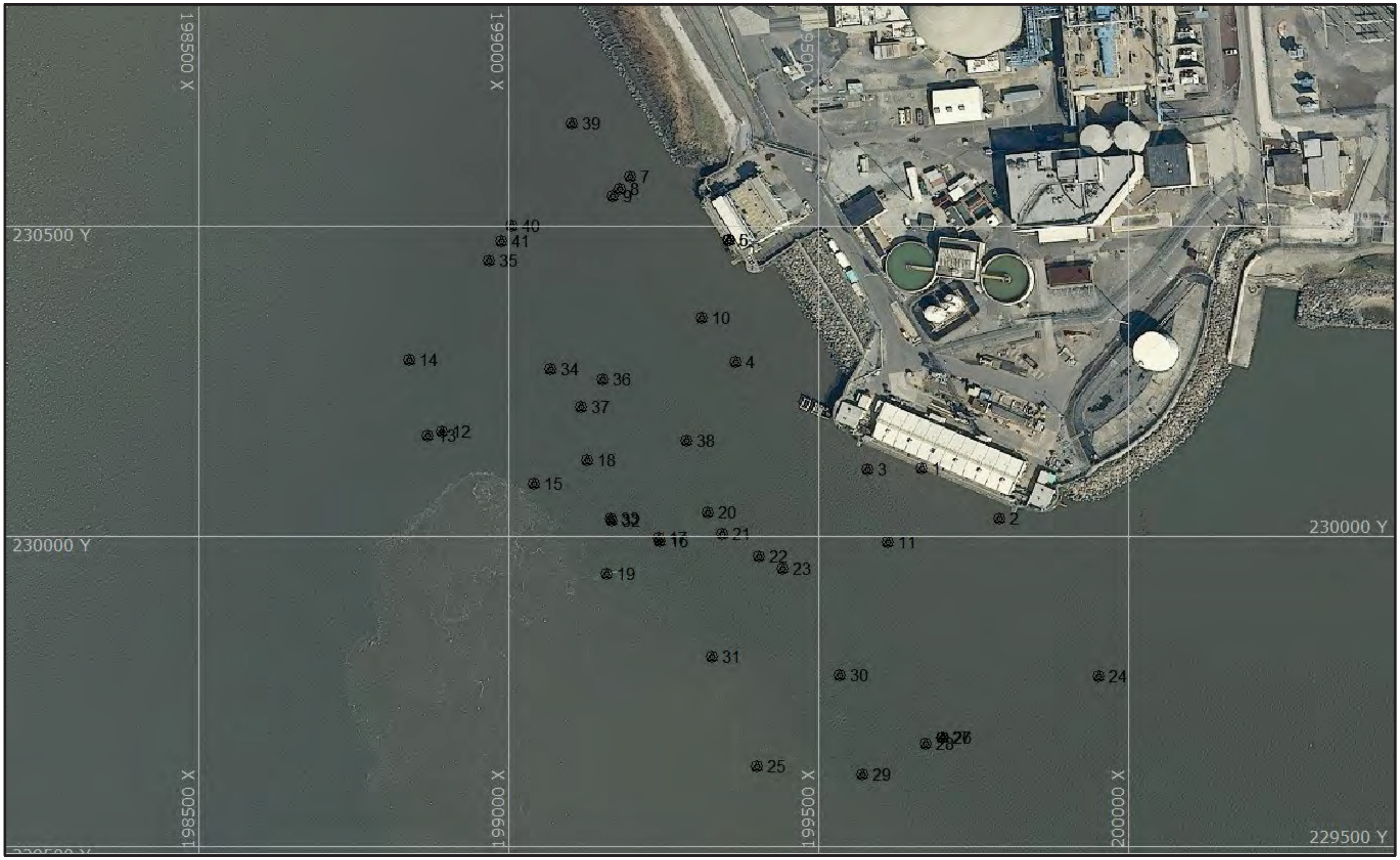


Figure 4.6. Locations of possible sturgeon targets in the vicinity of the Salem CWS and SWS intakes based on the side scan sonar survey conducted on April 17, 2020.

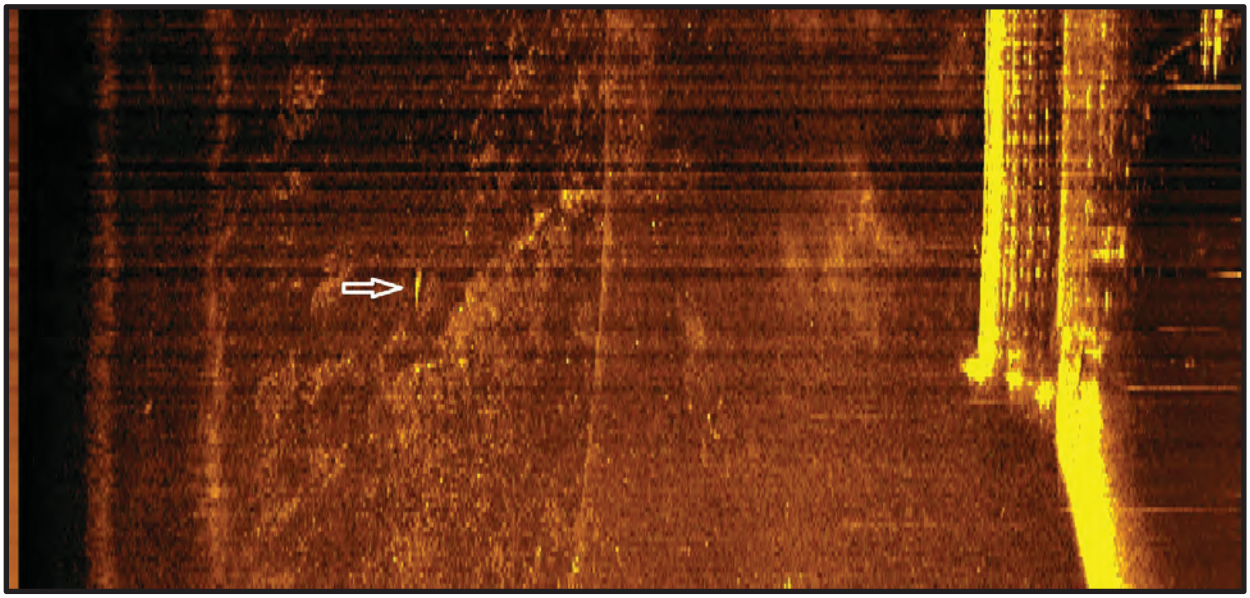


Figure 4.7: Locations of possible Sturgeon Target No. 2 (length – 0.60 m) and the Salem CWS Intake trash rack.

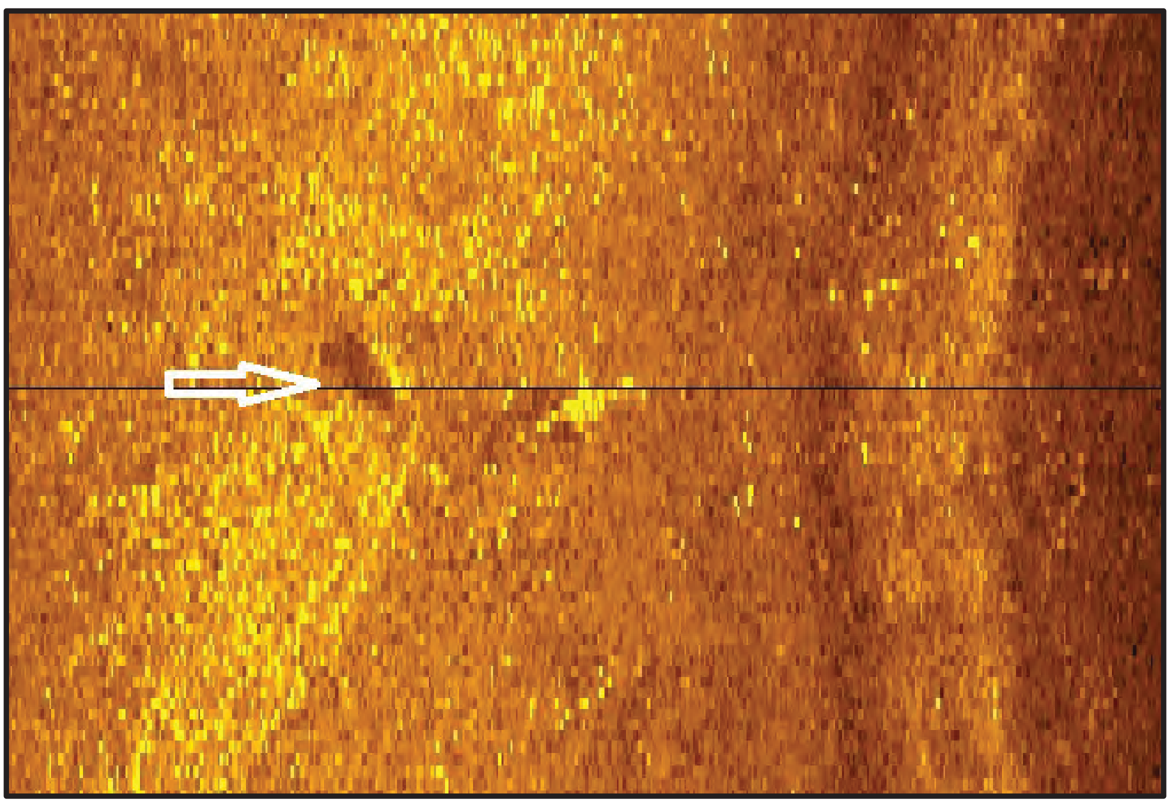


Figure 4.8: Possible Sturgeon Target No. 4 (length - 0.71 m).

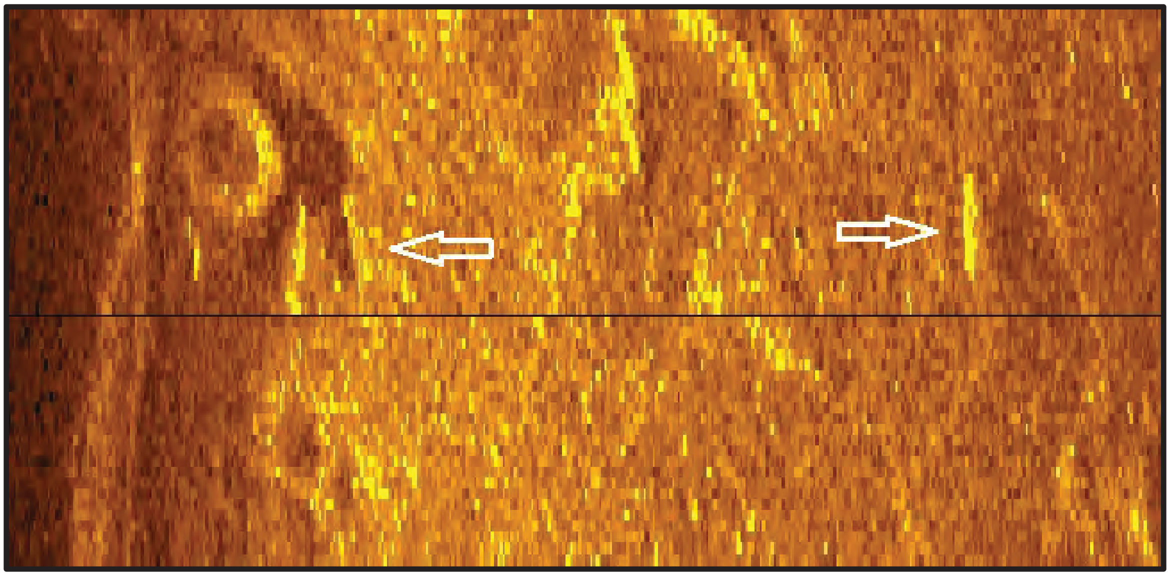


Figure 4.9: Possible Sturgeon Targets No. 8 (length - 0.74 m) and No. 9 (length – 0.81 m).

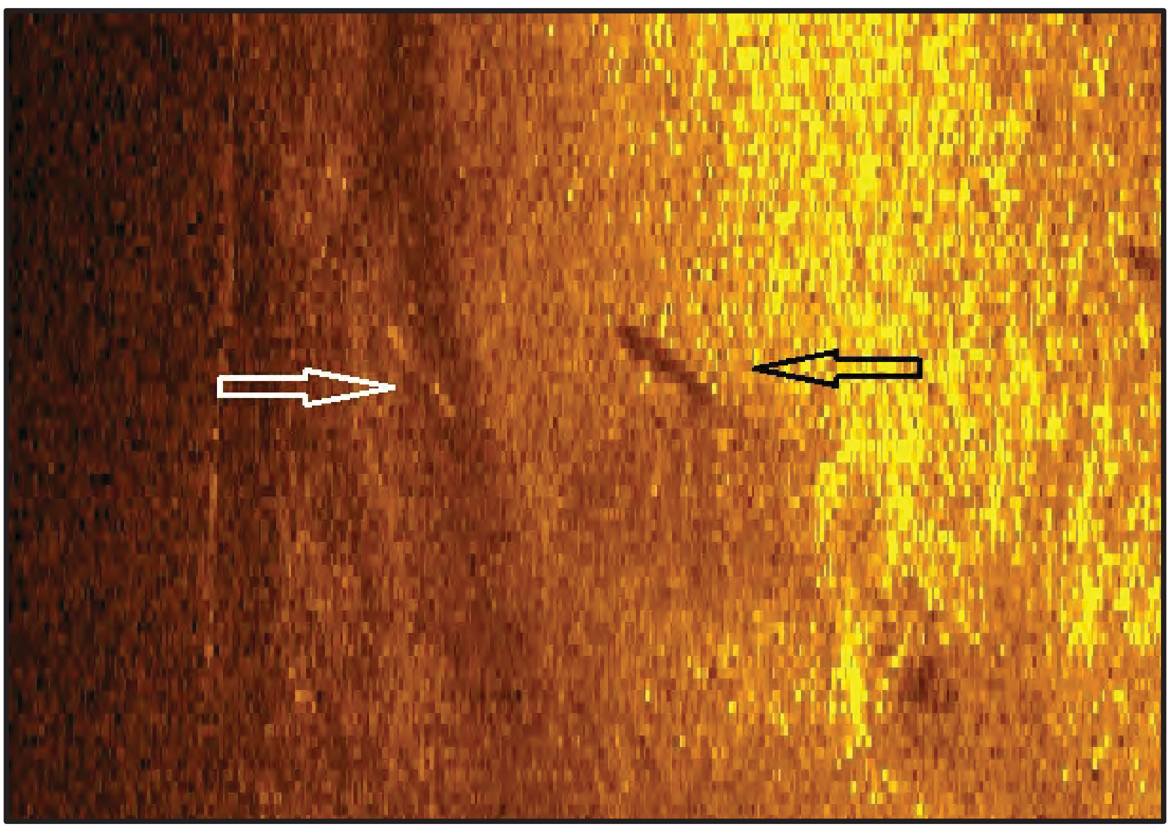


Figure 4.10: Possible Sturgeon Target No. 10 (length - 0.89 m); the target is denoted by the white arrow and the acoustic shadow by the black arrow.

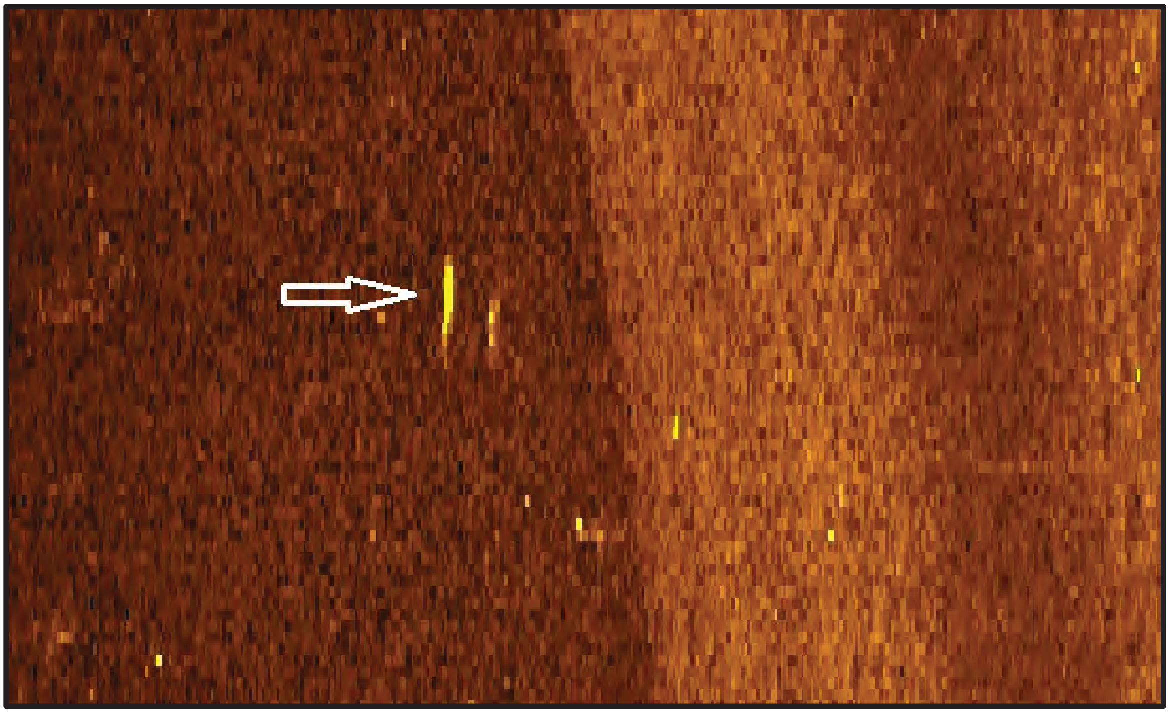


Figure 4.11: Possible Sturgeon Target No. 13 (length - 0.75 m).

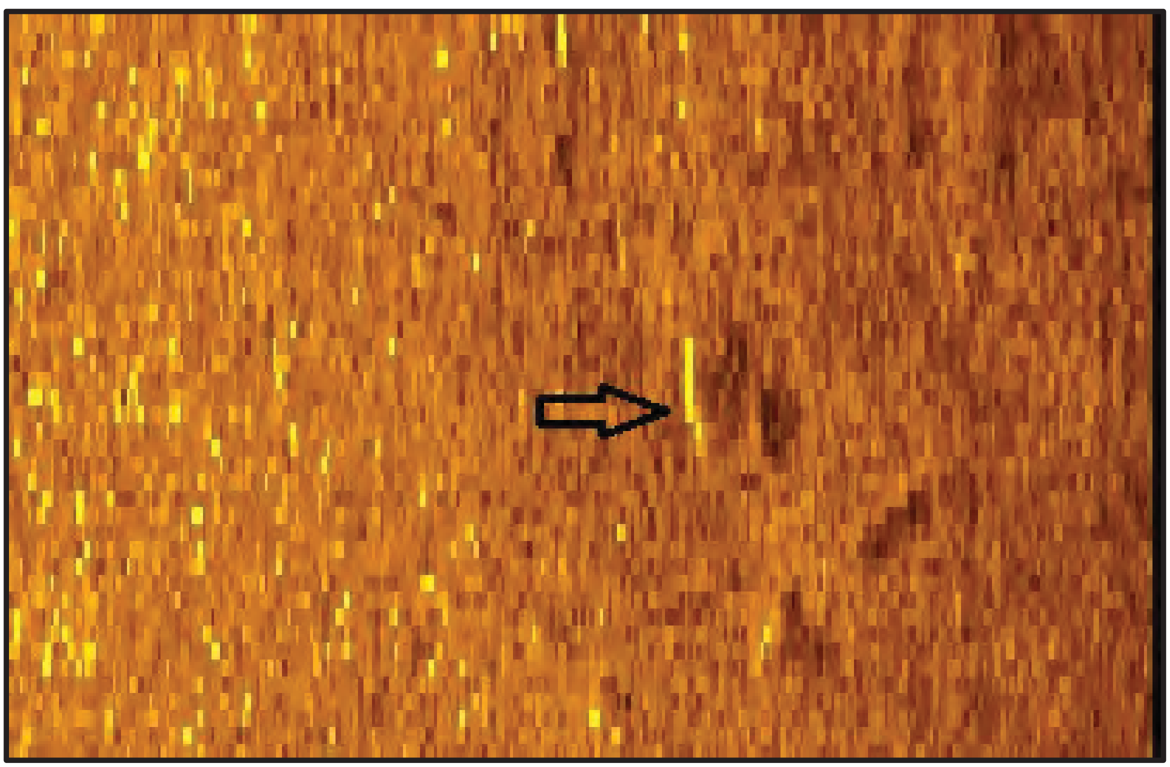


Figure 4.12: Possible Sturgeon Target No. 14 (length - 0.66 m)

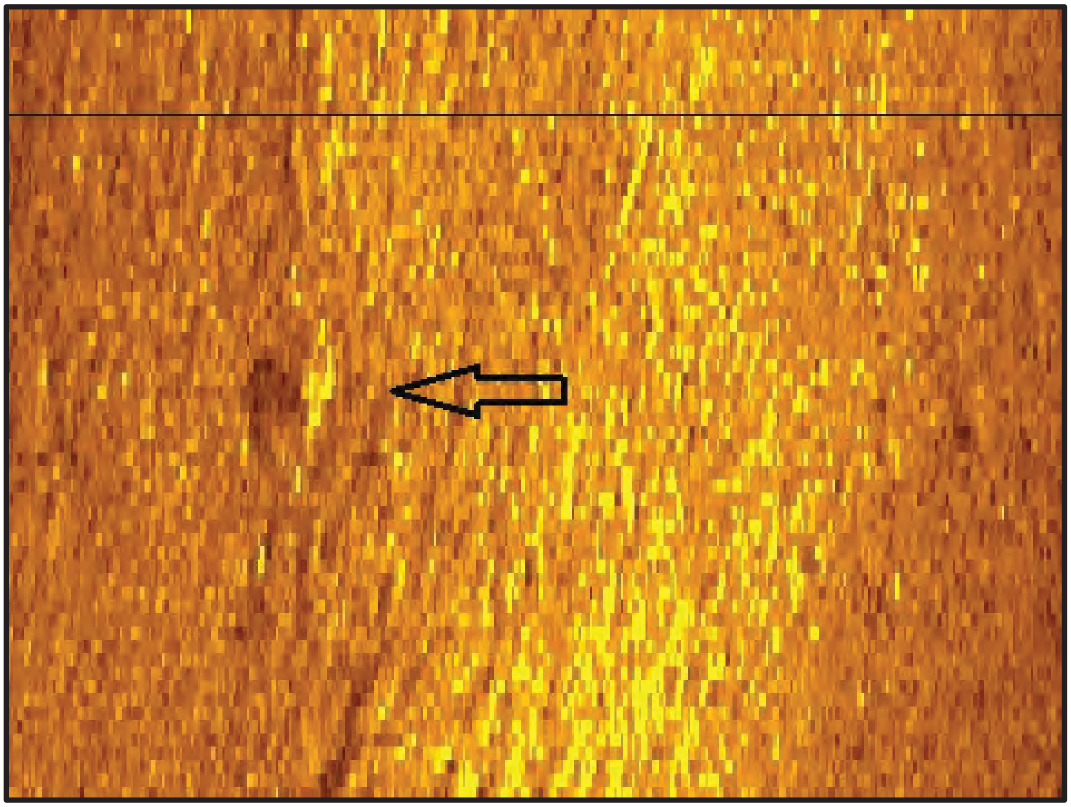


Figure 4.13: Possible Sturgeon Target No. 20 (length - 0.92 m).

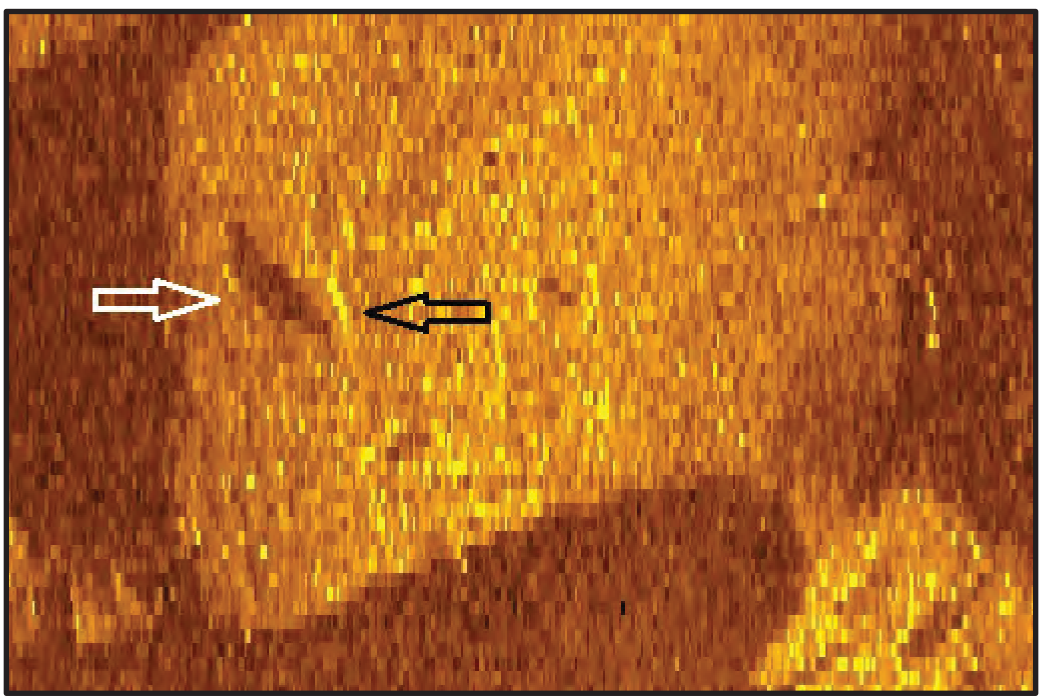


Figure 4.14: Possible Sturgeon Target No. 22 (length - 0.55 m); the target is denoted by the black arrow and the acoustic shadow by the white arrow.

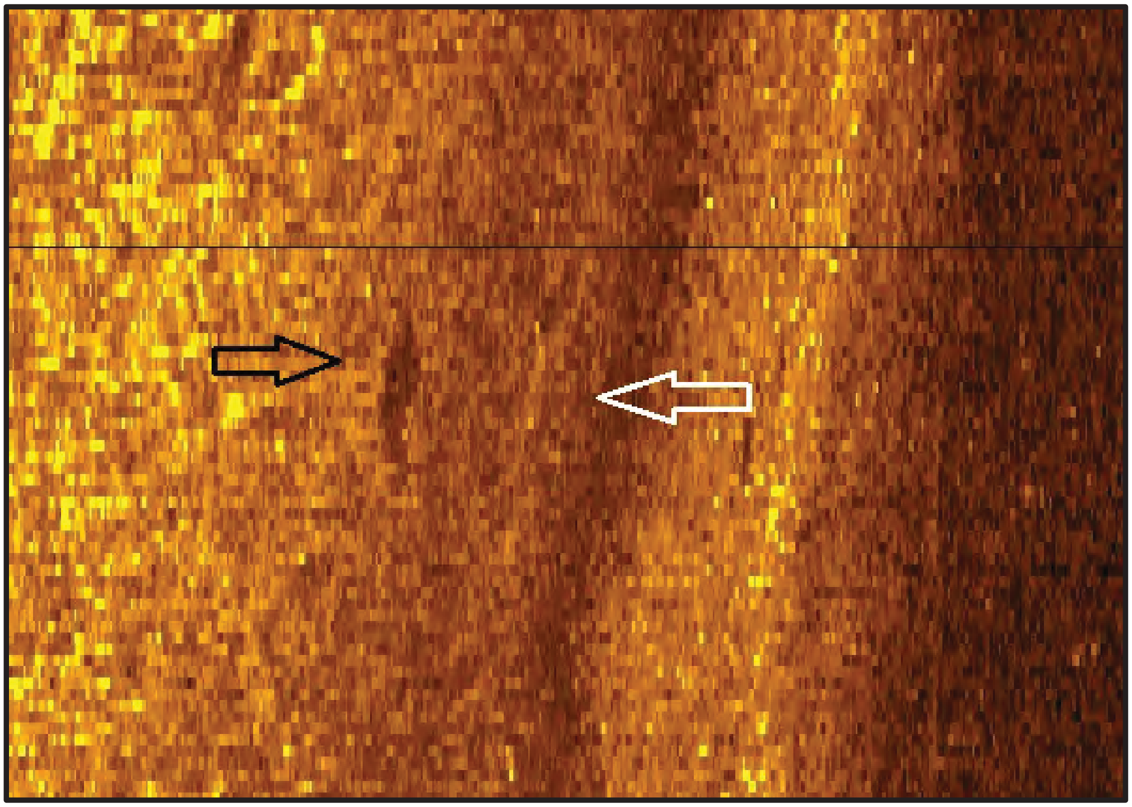


Figure 4.15: Possible Sturgeon Target No. 31 (length - 0.93 m); the target is denoted by the white arrow and the acoustic shadow by the black arrow.

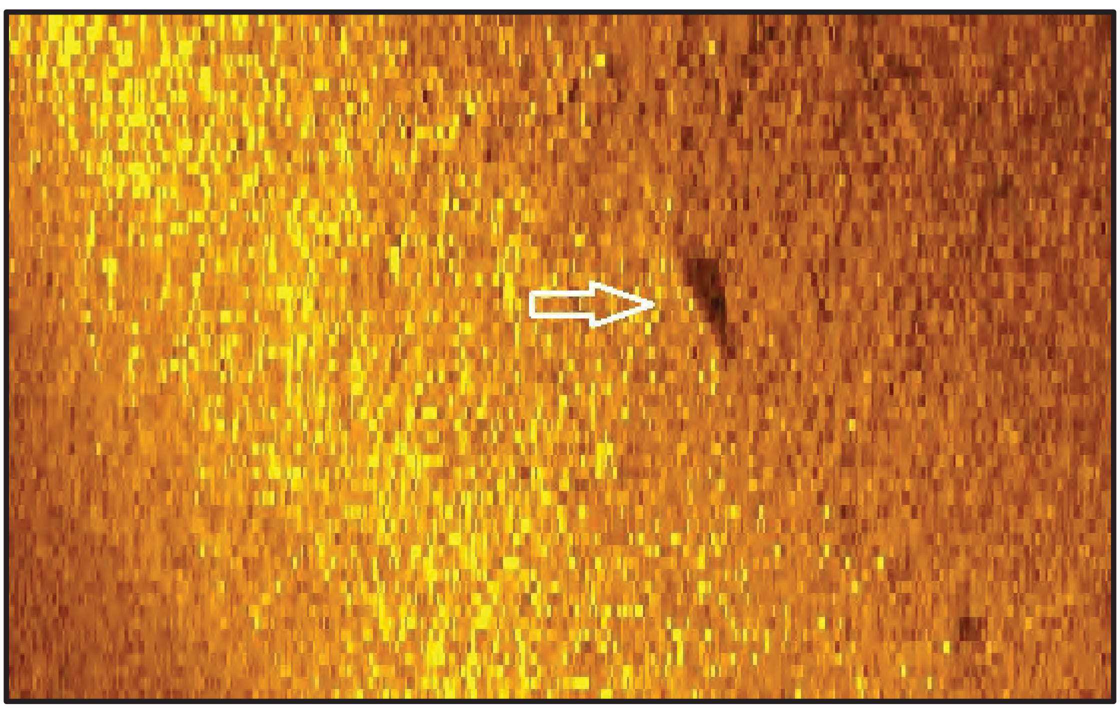


Figure 4.16: Possible Sturgeon Target No. 37 (length - 0.85 m).

5.0 SUMMARY AND RECOMMENDATIONS

We conclude that side scan sonar, used during the in-river survey, is a feasible method of investigating the presence/absence and approximate distribution of possible sturgeon targets in the vicinity of the CWS intake. This survey identified a number of possible sturgeon targets dispersed throughout the survey area, with no aggregations in the immediate vicinity of the CWS or SWS intakes. Further surveys and verification may be considered to verify observations during this single day of survey.

Confidence in identification of targets as sturgeon could be improved by using a boat-mounted high-frequency imaging sonar, such as the Soundmetrics ARIS, together with appropriate mosaicking software. Imaging sonar can also record motion, which can assist discrimination of sturgeon from other fish (sturgeon evidence a relatively distinctive "Acipenserform" swimming motion), as well as allow elucidation of behavior.

With further refinement, the imaging sonar technology and the approaches tested during the in-plant-component of the pilot study may be useful for providing an indication of trash rack conditions and could be used to determine biofouling, detritus buildup, and provide information to improve rake efficiency.

The configuration of the Salem circulating water intake structure and trash bars may preclude permanent deployment of sonar technology on the intake face but this pilot study demonstrates that sonar imaging can be used to determine the presence/absence of sturgeon in the vicinity of the trash bars.

6.0 LITERATURE CITED

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