Study Plan

Study 17: Sturgeon Habitat Mapping and Assessment Study Plan

Lawrence Hydroelectric Project

(FERC No. 2800)

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PATRIOT HYDRO

1 Sturgeon Habitat Mapping and Assessment Study

1.1 Study Requests

Essex Company, Inc. (Essex) filed a Pre-Application Document (PAD) with the Federal Energy Regulatory Commission (FERC) on June 16, 2023 and the Proposed Study Plan (PSP) on November 28, 2023 and the Revised Study Plan (RSP) on April 10, 2024. The National Marine Fisheries Service (NMFS) and Massachusetts Division of Fish and Wildlife (MassWildlife) submitted formal requests for Essex to complete a Sturgeon Habitat Mapping Assessment Study within the Lawrence Project boundary, including the Project impoundment and downstream approximately 10 river miles, as shown in Table 1-1. Essex is proposing this study in response to these study requests with modifications as recommended by FERC in the Study Plan Determination issued on May 10, 2024.

Table 1-1. Aquatic Resource Study Request

Requestor	Requested Study	Date
NMFS	Sturgeon Habitat Mapping Assessment Study in (NMFS Letter Request No. 3) Comments on the Revised Study Plan for the Lawrence Hydroelectric Project (P-2800-054) Comments on Proposed Study Plan for Lawrence Hydroelectric Project (P-2800)	October 16, 2023 April 24, 2024 March 8, 2024
MassWildlife	Sturgeon Habitat Mapping Assessment Study (MassWildlife Letter Request No. 7) Comments on the Revised Study Plan for the Lawrence Hydroelectric Project (P-2800-054)	October 16, 2023 March 11, 2046

1.2 Goals and Objectives

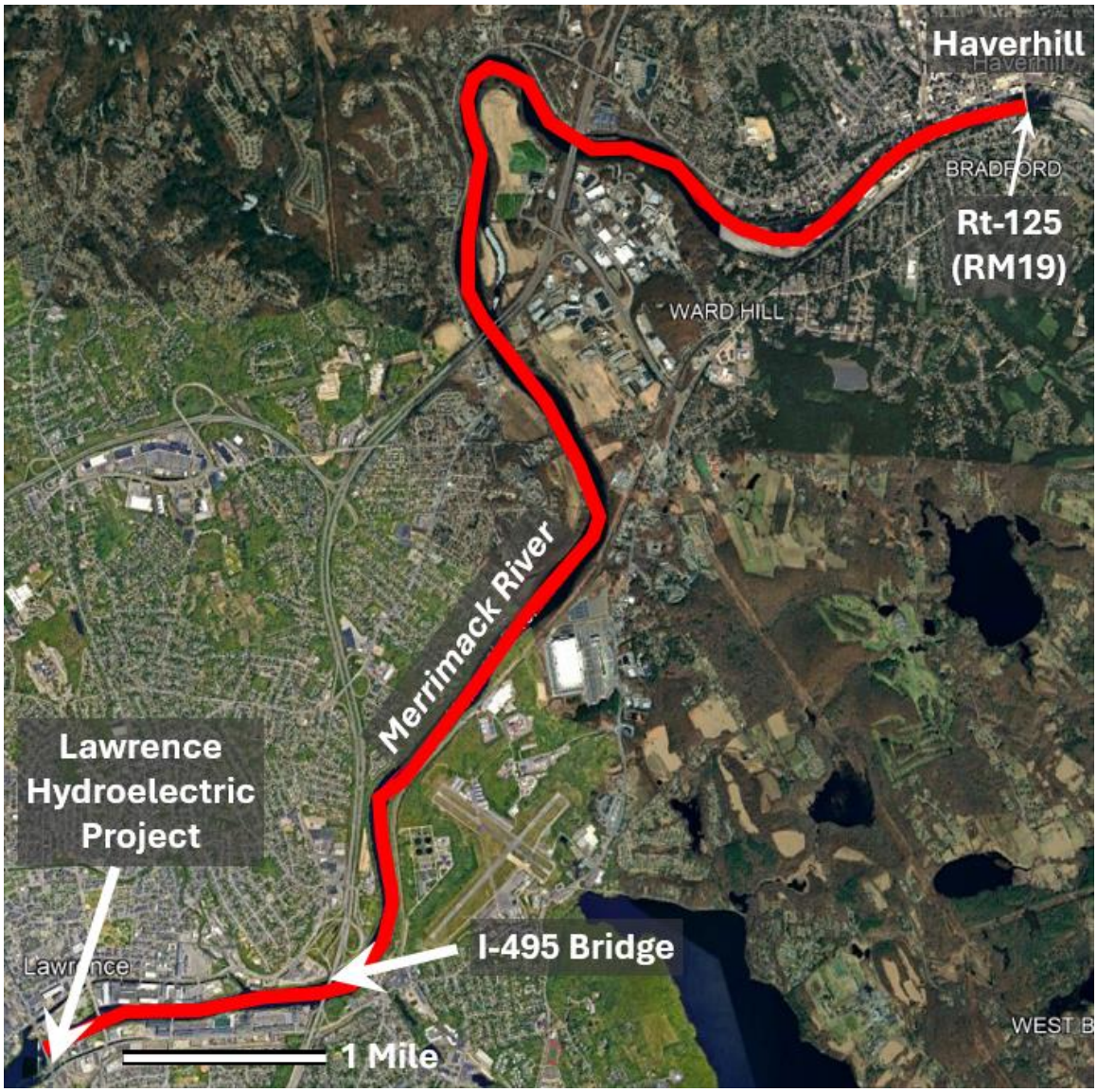
This study plan is designed to address the recommendations by FERC in the SPD to conduct a Sturgeon Habibat Mapping and Assessment Study based on data collected from a side-scan sonar (SSS) survey separate from Sturgeon Distribution and Project Interaction Study (Study 5). The objectives are to (1) map the benthic habitat features of the Merrimack River downstream of the project, from the project dam (Essex Dam) to RM 19 (Basilere Bridge on Route 125); and (2) quantify *the area of juvenile rearing habitat, spawning habitat, and foraging habitat for Atlantic (Acipenser oxyrinchus oxyrinchus*) and shortnose sturgeon (*A. brevirostrum*) are in this reach based on substrate type and water depth.

1.3 Study Area

The study area will include the section of the Merrimack River located immediately downstream of the Project (Essex Dam, also known as Great Stone Dam), extending approximately 10.1 river miles downstream to RM 19 at Basiliere Bridge on Route 125 in Haverhill, Massachusetts (

Figure 1-1). Access for sampling near the O'Leary Bridge on Broadway, Essex Dam and tailrace will be dependent on field conditions and safety concerns.

Figure 1-1. The 10-river-mile reach (red polyline) for the Sturgeon Habitat Mapping and Assessment Survey on the Merrimack River downstream of the Lawrence Hydroelectric Project to River Mile 19 in Haverhill.



1.4 Background and Existing Information

The Merrimack River downstream from the Lawrence Project has an amphidromous population of shortnose sturgeon (Kieffer and Kynard 1993). A study of the overwintering population of sturgeon in the Merrimack counted 3,786 individuals in 2020-2021 season and 3,424 individuals in the 2022-2023 season (Stantec 2023). Shortnose sturgeon movement in the lower Merrimack has been documented up to the I-495 Bridge in Lawrence (Stantec 2023) with documented spawning occurring near Haverhill between river kilometer 30 and 32 (Kieffer and Kynard 1996). The detections at the I-495 Bridge in Lawrence occurred during the spawning season, suggesting that habitat between the I-495 bridge and the Essex Dam may be used for spawning or pre-spawning habitat. Post-spawn and juvenile shortnose sturgeon are present in the river throughout the year (Kieffer and Kynard 1993).

The Merrimack River downstream from the Lawrence Project is utilized by Atlantic sturgeon from late May to early October for foraging (Kieffer and Kynard 1993; Wippelhauser et al. 2017). Kieffer and Kynard (1993) found that sub-adult Atlantic sturgeon used only one discrete section of the Merrimack River each year. Sub-adult Atlantic sturgeon during study were determined to frequent the “lower islands” section of the Merrimack River, located between river kilometers 5-10 and approximately 25 km downstream from Essex Dam. Overwintering in the Merrimack River has been documented for one individual (Wippelhauser et al. 2017).

Previous studies have assessed the movements and habitat use of shortnose and Atlantic sturgeon in the Merrimack River (Kieffer and Kynard 1993; 1996). In those studies, shortnose sturgeon began to move from overwintering to spawning sites in April when river temperature reached 7 °C and discharges decreased to 570 m^3/s (approximately 20,000 cfs). Shortnose sturgeon spawned in the Haverhill area when river temperature warmed to 9.6–14.0 °C and river discharge decreased to 240–390 m^3/s (approximately 8,500–14,000 cfs). Foraging habitat for shortnose sturgeon was characterized as areas with silty or muddy bottom that were optimal for its predominant prey (freshwater mussels). Although Kieffer and Kynard (1993; 1996) did not observe spawning habits or characterize spawning habitat of Atlantic sturgeon in the Merrimack River, spawning habitat for Atlantic sturgeon is typically freshwater reaches just upriver of the salt front in the main channel areas with flowing oxygenated (>6 mg/L) waters over hard substrate (rock, cobble, boulder, gravel) that are 1.2 m deep or more (NMFS 2017). Juvenile and adult Atlantic sturgeon forage on benthic prey items found in soft substrate (NMFS 2017). This study aims to map and estimate the amount of benthic habitat suitable for spawning and foraging by both sturgeon species based, in part, by these studies described above.

1.5 Project Nexus

The Project is located within the historical range for both Atlantic and shortnose sturgeon and the dam and powerhouse define the upstream boundary of NMFS-designated critical habitat for Atlantic sturgeon. Data collected in this study will provide a baseline to inform

on the location and area of benthic habitat immediately downstream of Essex Dam to RM 19 (Route 125) and to determine if measures are necessary to minimize potential operational effects (e.g., effects of changes to operational flows on sediment transport dynamics and water velocities) for any new license issued for the Project.

1.6 Methodology

1.6.1 Survey Design

As requested by MassWildlife and NMFS and recommended by FERC in the SPD, the Sturgeon Habitat Mapping and Assessment Study will use SSS to collect data for mapping benthic habitat features and quantifying the nursery, spawning and foraging habitat for Atlantic and Shortnose Sturgeon based on substrate type and depth. Substrate type, size and embeddedness inferred from visual classification of SSS imagery will be verified by underwater video and grab samples. Bathymetric data will be combined for interpolation to create a GIS gridded depth layer (grid resolution to be determined during processing) that coincides with the GIS substrate layer. Secondary to habitat classification, if sturgeon are identified in the SSS imagery, then their location and estimated length will be documented.

The survey will use established methods appropriate for sturgeon habitat characterization, as cited in the SPD and agency requests, and described in other peer-reviewed literature. Side-scan sonars used in riverine systems for habitat characterization or sturgeon abundance estimates include dual-frequency survey-grade systems such as the EdgeTech 4125-P (Flowers and Hightower 2013, 2015; Kazyak et al. 2020; Stantec 2023) or recreational-grade SSS such as the Humminbird 1198c SI or Helix 10 models (Litts & Kaeser 2016; Walker and Alford 2016; Andrews et al. 2020; Battaile et al. 2024). While a vessel-mounted 600/1600 kHz EdgeTech 4125i portable SSS was used in Study 5 to survey for the presence of sturgeon downstream of the Project from the Route 28 Bridge to the I-495 Bridge, in this study, a Humminbird SSS (or equivalent recreational grade SSS) will be used to create imagery of the riverbed for characterizing the substrate of the riverbed. The recreational-grade SSS was selected because when compared to survey-grade SSS, it is easier to deploy in shallower habitats and lower cost yet retaining adequately high resolution with frequency modes greater than 1,000 kHz. The size of the transducer and sonar interface of the Humminbird SSS models is less bulky than the survey-grade SSS equipment, which is advantageous given that an underwater video camera and Ponar grab sampler will be deployed from the same shallow-draft vessel (e.g., a 5.5-m [18-ft] aluminum open-hull vessel with a 60-horsepower outboard engine).

This selection is consistent with the sonar methods recommended by NMFS in their comments to the PAD (Kaeser et al. 2012) and PSP (Litts and Kaeser 2016). In Litts and Kaeser (2016), spawning substrate for Atlantic and Shortnose Sturgeon was mapped using a Humminbird 1198c SI system mounted from the bow of a 5-m johnboat with the transducer lowered to 10-13 cm depth. Based on Litts and Kaeser (2016) surveying up to 50 km in a day at a speed of approximately 8 km/h (4.3 knots) along multiple passes on

parallel transects in some areas of river width greater than the maximum swath for the Humminbird 1198c SSS (98 m), the proposed survey anticipates collecting the SSS imagery within the 10 river miles (16.1 km) downstream of the Project in one day.

This study will use SSS imagery to map benthic features (substrate types) and depth as recommended by FERC in the SPD, but the data source for water depth was not specifically identified by FERC. To classify sturgeon habitat based on substrate type and depth, a SSS survey must be complemented with bathymetry of the surveyed river reach. In absence of known bathymetric data sources, this study will collect single-beam bathymetry to integrate with the SSS imagery for mapping sturgeon habitat.

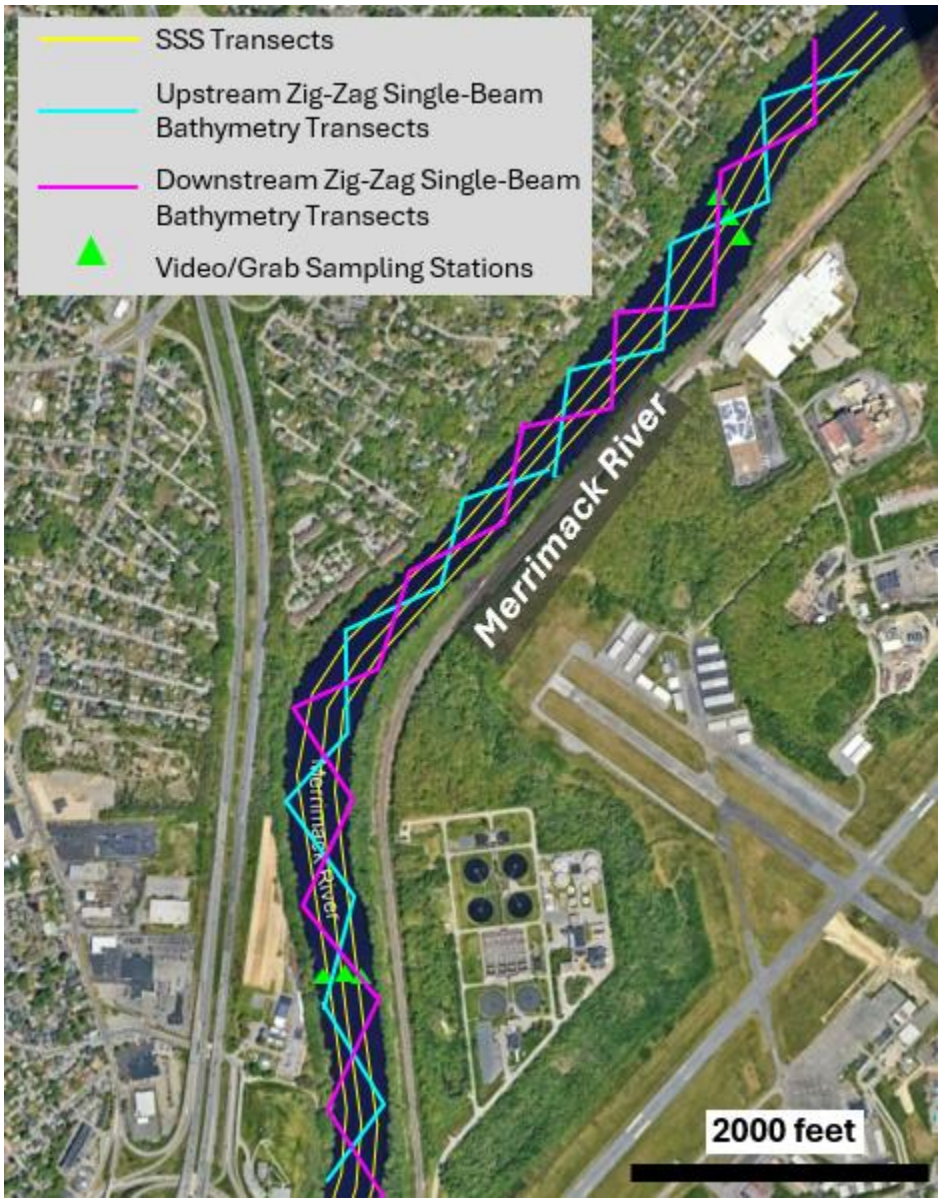
The Humminbird SSS model to be selected will include a narrow echosounder beam to collect single-beam bathymetry along the vessel track lines. By example, Litts and Kaeser (2016), depth was collected by soundings every 3 seconds (i.e., 0.33 Hz) along the vessel track following parallel along-channel transects. However, depth soundings collected along the along-channel SSS survey transects will provide insufficient cross-river coverage to effectively use depth to define sturgeon habitat types. This survey design will include an additional field day to collect single-beam soundings along zig-zag transects designed to be achievable in a single day (approximately 8 hours on the water). A depth reading will also be obtained at each verification sampling location. The bathymetric data from these three efforts (SSS Survey, additional zig-zag transect, and verification sampling locations) will be combined for interpolation to create a GIS gridded depth layer that coincides with the GIS substrate layer bounded by the spatial extent of the SSS imagery.

Substrate classification (type, size and embeddedness) of the SSS imagery will be informed and verified by two direct sampling methods: underwater video and sediment grab sampling. While verification samples will be collected at the end of the SSS survey day, time permitting, an additional day immediately after the SSS survey (river conditions/weather permitting) will be spent dedicated to verification sampling (i.e., ground-truthing) with a goal of collecting at least 30 video recordings and grab samples. Following preliminary processing and mosaicking of the SSS imagery, another day will be anticipated to target specific locations of interest to verify habitat classification for study total of up to 60 video and grab samples across two non-consecutive days of verification sampling (i.e., a day of planned sampling to aid if visual classification of sonar imagery and a later day to target areas to identify and ground substrate classes). A low-light, high-definition underwater video camera, a dual-laser scale marker and LED light(s) will be mounted inside a small, weighted aluminum or schedule-80 heavy-duty polyvinyl chloride (PVC) frame and serve as a drop video camera for recording video of the riverbed. The video system will be lowered at the designated verification waypoints to collect short recordings (15-30 seconds) at each station. Prior to deploying the camera overboard, a large label containing the station reference number and local time will be recorded to identify each station’s video footage. A stainless-steel petite Ponar grab will be used collect a bottom substrate sample of fine sediments, sand, gravel, and clay at each verification waypoint. The petite Ponar gab weighs 10.8 kg (24 pounds) empty and has a sampling dimension of 15.2 x 15.2 cm (6 x 6 inches) used to sample 231 cm2 or 2.4 L of material. A subsample of approximately 100 mL of the upper 0-2 m layer will be

collected by a stainless-steel scoop and transferred to a 250 mL jar to be sent to a laboratory for sediment grain size analysis. A deckside/shoreside labeled photograph will be taken for each verification sampling station, unless the substrate is considered a hard substrate as defined by three consecutive empty valid grab samples. Bottom sediment samples will be handled following established guidelines (e.g., sample handling and custody protocols) and assumed to be hazardous require additional personnel protective equipment.

The survey will be completed following this study plan with real-time field adjustments to the methods described herein only if needed (e.g., navigational hazards, safety, data quality and coverage). Figure 1-2 illustrates the configuration of sampling transects and video/grab sampling stations. The survey will be completed over four to five days (weather and river discharge permitting) during July 2025 and an additional day for targeted verification sampling in August−September 2025. The first day will be for testing survey operations and reconnaissance of field conditions. This will consist of rigging and launching the vessel and collecting data under field conditions to test and ensure the electronics and sampling gear are working as planned, and verifying the coverage is sufficient to meet the survey design. The vessel will cruise down the 10-mile river reach to scout field conditions and identify any navigational hazards or areas problematic to sampling at approximately 5 knots along the planned transects. The second day will be dedicated to completing the SSS survey. The third day will be spent verifying substrate type using underwater video and collecting petite Ponar grab samples at 30 planned locations (left of channel, mid channel, right of channel approximately every river mile). A fourth day will be dedicated to collecting single-beam soundings along a zig-zag pattern. A fifth day will be reserved as contingency day to fill in any data gaps in SSS surveying, bathymetry, and/or verification sampling. Once the SSS imagery is processed and substrate classes are preliminary determined, a sixth day will be dedicated to collect up to 30 additional video/grab samples in targeted areas of unknown or questionable substrate classification.

Figure 1-2. Example sampling transects and stations for the Sturgeon Habitat Mapping and Assessment.



1.6.2 Data Analysis and Reporting

Sonar data processing will follow the methods used by Kaeser et al. (2012), Litts and Kaeser (2016), Bodine et al. (2022) and Ridgway et al. (2024). In general, the SSS processing workflow consists of:

(1) recording raw data;

(2) initial processing such as bottom tracking (tracing the edge of the return signal separating the water column and the bottom), slant range correction, and gain corrections;
(3) georeferencing the sonar images (filtering and smoothing of navigation data and coordinate system transformations);
(4) image processing; and
(5) visual classification of the SSS imagery.

Open-source Python software toolbox called PING-Mapper (Bodine et al. 2022), or analogous software, will be used to:

(1) decode the raw proprietary sonar recoding;
(2) extract ping attributes;
(3) detect the rivered depth;
(4) remove no data regions (e.g., acoustic dead zone from the water column), make slant range corrections, and export sonogram tiles;
(5) georeference the sonograms (i.e., georectification) and export to sonograms in geospatial tag image file format (*.gtiff);
(6) plot maps of the mosaic images using ESRI ArcGIS software and other third-party software, if needed.

Substrate polygons will be classified based on visual interpretation of the image features such as texture, tone, shapes and patterns, and depth. An interpolated grid from depth soundings will provide a bathymetry layer bounded by the surveyed sections of the river reach. Underwater video clips will include a label identifier in the field of view corresponding to the station number (and coordinates) and will be used to inform the visual interpretation of the substrate in the SSS imagery. Sediment grain size (Wentworth scale) will be determined by a laboratory vendor. The substrate polygons suitable as sturgeon habitat will be identified based on habitat preferences in the literature (Crance 1986; Kieffer and Kynard 1993, 1996; Cooke and Leach 2004; Litts and Kaeser 2016; Wippelhauser et al. 2017; Johnston et al. 2019) and a separate GIS layer will be created for Atlantic and shortnose sturgeon benthic habitat.

A draft report will be prepared documenting the data collection, processing, analysis, products and relevant deliverables.

1.7 Schedule, Level of Effort, and Estimated Cost

The fieldwork for the Sturgeon Habitat Mapping and Assessment Study will be conducted over five consecutive days (weather and river discharge permitting) during mid-to-late July 2025 with a single additional day of targeted ground-truth sampling by underwater video and petite Ponar grab during August–September 2025. Data processing and preparation of a draft report will be completed by the end of December 2025. The anticipated labor for surveying includes approximately 12 hours per day (8-10 hours on the water/day) per person and three survey crew members (one boat operator and two scientists/technicians). The cost of the Sturgeon Habitat Mapping and Assessment Study in 2025 is estimated at approximately $175,000.

1.8 Discussion of Alternative Approaches

The proposed methods for this study are consistent with accepted professional practices. The overall approach is commonly used in relicensing proceedings and is consistent with generally accepted methods for and analytical techniques used by federal and state agencies. In addition, the proposed methods for this study are consistent with FERC study requirements under the integrated licensing process. No alternative approaches to this study are necessary.

1.9 References

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