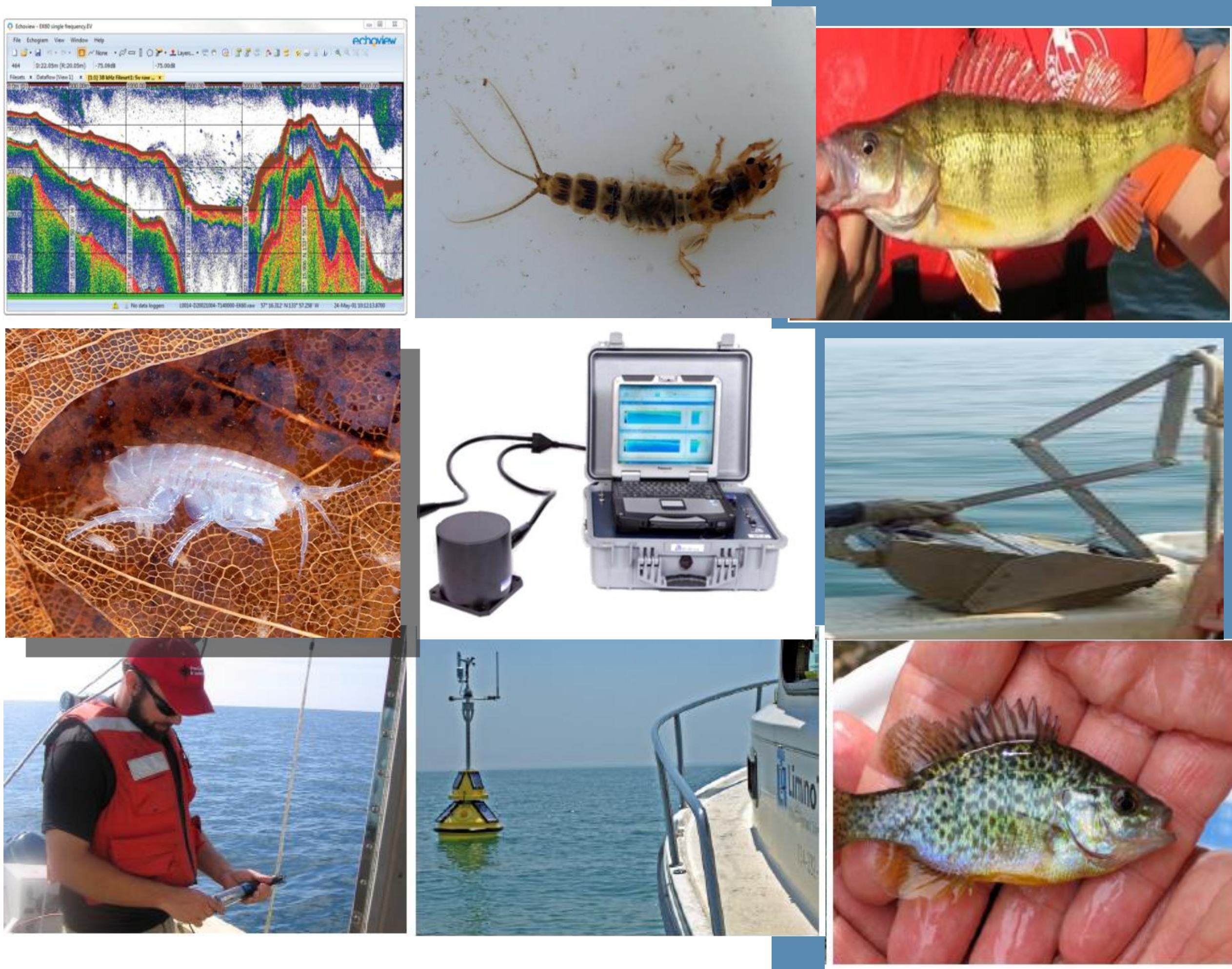
Appendix E
Final LimnoTech Report



Report: Results of 2016 Aquatic Sampling

Icebreaker Wind

Prepared for:
Icebreaker Windpower, Inc.

March 9, 2017

LimnoTech

Water | Scientists
Environment | Engineers

Blank Page

LimnoTech
Water | Scientists
Environment | Engineers

501 Avis Drive
Ann Arbor, MI 48108
734.332.1200
www.limno.com

Report: Results of 2016 Aquatic Sampling

Prepared for:
Icebreaker Wind

Under Contract to:
Icebreaker Windpower, Inc.

March 9, 2017

Prepared by:
LimnoTech
Ann Arbor, Michigan

Blank page

FIGURE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Blank Page

1 Introduction

The purpose of this report is to document the field methods, results, and analysis carried out in 2016 to support the Icebreaker Wind project. LimnoTech, under contract to Icebreaker Windpower, Inc., led a multi-disciplinary team of researchers to collect site specific data at the site of and in the vicinity of the proposed Offshore Wind (OSW) demonstration project in Lake Erie.

The report includes the following major sections:

- Project introduction (Section 1)
- Sampling methods (Section 2)
- Results and discussion (Section 3)
- Conclusion (Section 4)
- References (Section 5)
- Appendices

1.1 Project Description

The proposed Icebreaker Wind demonstration project will include installation of six wind turbines, 8 to 10 miles offshore of Cleveland, Ohio in the Central Basin of Lake Erie. The turbines will be placed in water depths ranging from 58 feet to 63 feet, each with a nameplate capacity of 3.45 megawatts (MW) for a total generating capacity of 20.7 MW. The facility is expected to operate for approximately 8,200 hours annually, and have an approximate capacity factor of 41.1%, generating approximately 75,000 megawatt-hours (MWh) of electricity each year. A 2.3-mile buried electric cable will connect the six turbines, and an approximate 9.3-mile buried electric cable will connect the turbines to the Cleveland Public Power Lake Road substation. Figure 1 shows the project location within the Central Basin of Lake Erie offshore of Cleveland and the bathymetric contours.

1.2 Project Team

This section describes the project team in further detail. The project team is led by LimnoTech, an environmental engineering and science firm headquartered in Ann Arbor, MI. As a leader in environmental science and water quality management for nearly three decades, LimnoTech has helped clients assess, create and implement workable strategies for identifying and addressing aquatic impacts on scales both large and small. Our experts offer diverse technical skills, experience, and expertise that enable us to provide a full range of services for monitoring and evaluating these complex environments. The LimnoTech team is led by Ed Verhamme with support from Greg Peterson, Jen Daley, Cathy Whiting, John Bratton, and Greg Cutrell. Additional staff from the Ann Arbor office supported the fieldwork as needed. LimnoTech is responsible for all project deliverables, communication with Icebreaker Windpower, and management of additional team members.

The Ohio State University (OSU) – Stone Lab was established in 1895, and is the oldest freshwater biological field station in the United States. It is the center of Ohio State University's teaching and research on Lake Erie. The lab serves as a base for more than 65 researchers from 12 agencies and academic institutions, all working year-round to solve the most pressing problems facing the Great Lakes. Justin Chaffin, Chris Winslow and Stu Ludsin support the collection of juvenile fish and also process the nutrient and water samples.

The Cornell University Bioacoustics Research Program develops and uses digital technology, including equipment and software, to record and analyze the sounds of fish and wildlife. By listening to wildlife, their research advances the understanding of animal communication and monitors the health of wildlife populations. Policy makers, industries, and governments use this information to minimize the impact of human activities on fish and wildlife and natural environments. Aaron Rice assists with the development of the underwater soundscape/noise survey as well as with data processing and interpretation.

BSA Environmental Services, Inc. is an environmental consulting firm specializing in aquatic plankton and larval taxonomy. John Beaver of BSA assists LimnoTech with processing and identifying organisms from the phytoplankton, zooplankton, and larval fish surveys.

Biosonics is an environmental company that specializes in hydroacoustics. They offer a wide range of scientific equipment for fisheries research and aquatic habitat assessments. They are experts in understanding and post-processing acoustics data and have a wide range of experience throughout the country.

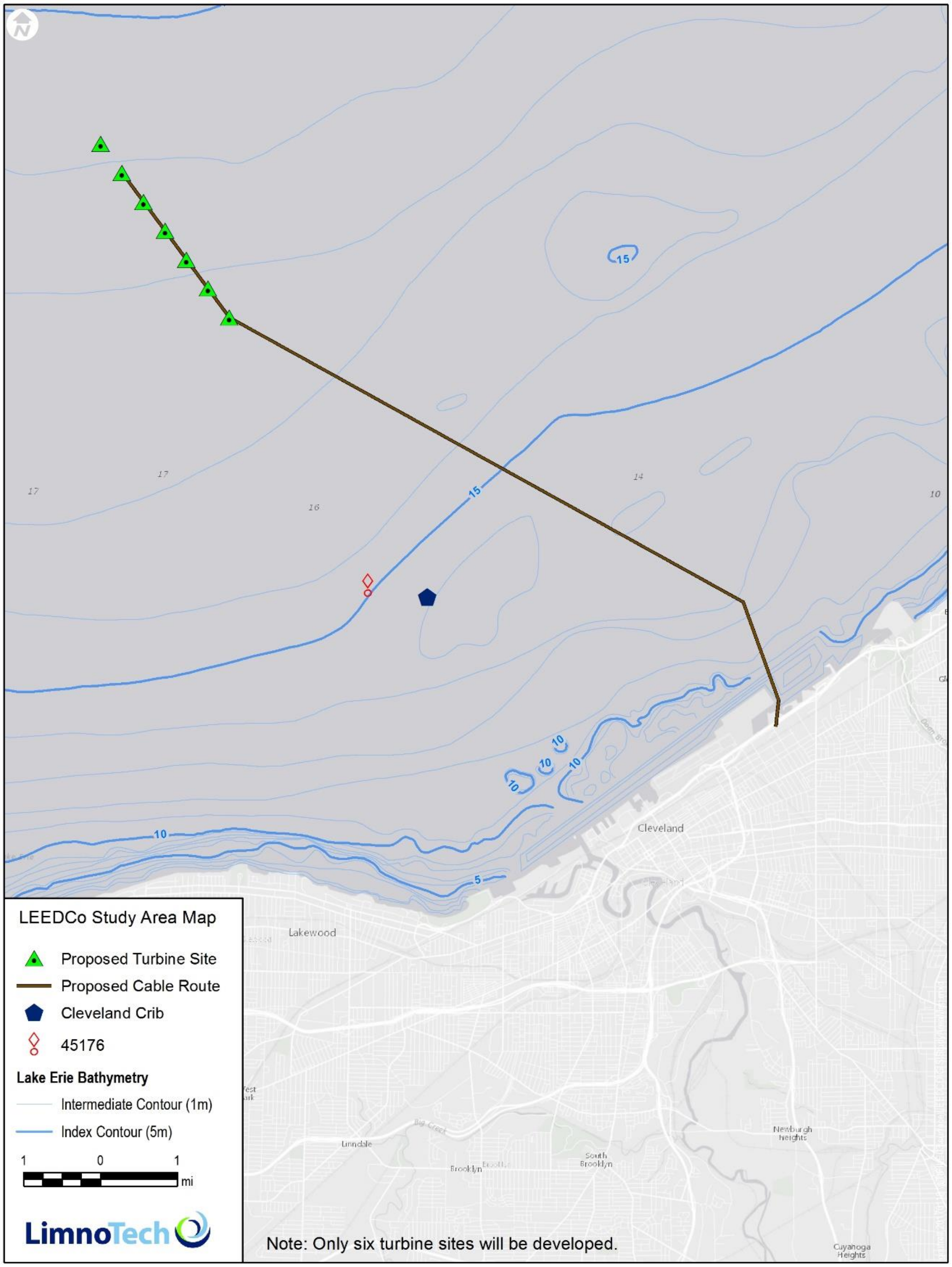


Figure 1. Project location map.

1.3 Agency Coordination

LimnoTech coordinated with the Ohio Department of Natural Resources (ODNR) and U.S. Fish and Wildlife Service (USFWS) to develop a 2016 monitoring program to assess ecological resources at the proposed project site and initiate the baseline characterization monitoring. Meetings were held on the following dates to discuss the proposed project and the 2016 Sampling Plan:

- April 11 – Initial in-person meeting in Columbus, OH with Ohio Power Siting Board (OPSB), ODNR, and USFWS to review proposed project and identify key monitoring objectives.
- May 3 – Meeting in Columbus, OH at ODNR headquarters with OPSB (phone), and USFWS to review proposed 2016 Sampling Plan and finalize key monitoring objectives for the Icebreaker Wind site.
- August 11 – Meeting in Sandusky, OH at ODNR field station with OPSB (phone), and USFWS (phone) to discuss fish behavior and velocity monitoring.
- September 14 – Phone call with ODNR to review 2016 Sampling Plan with ODNR staff.

The monitoring conducted in 2016 forms the basis for a multi-year monitoring program to assess potential project impacts through the construction and post-construction monitoring periods, which is discussed in the 2016 Monitoring Plan (LimnoTech, 2017). The plan was prepared in response to the requirements of the ODNR "Aquatic Sampling Protocols for Offshore Wind Development for the Purpose of Securing Submerged Land Leases" (ODNR, 2013) (the ODNR Protocol). The ODNR Protocol describes specifically what types of data ODNR stipulates to be collected as part of a submerged lands lease agreement. By letter dated February 1, 2017, the ODNR Division of Wildlife indicated that all of its comments were addressed in the Monitoring Plan (attached as Appendix D). The USFWS participated in discussions to design the study protocol and 2016 Monitoring Plan.

Icebreaker Windpower will work to develop adaptive language in a forthcoming Memorandum of Understanding (MOU) between ODNR, the USFWS, Icebreaker Windpower, and LimnoTech that obligates Icebreaker and LimnoTech to fully implement the agreed-to monitoring plan. The MOU will include provisions for an annual performance review, a comprehensive analysis of data, and an option to adjust the monitoring plan based on changes in project design and/or results-driven knowledge gained from the monitoring work.

1.4 Reports and Memorandum

The following reports and memorandum were completed in 2016 and 2017. Copies of each item were emailed to ODNR and USFWS throughout the season. The list is presented here to document the deliverables completed as part of the 2016 sampling season.

- Report: Lake Erie Monitoring Plan –January 25, 2017
- Memorandum: Summary of Current Information Related to Electromagnetic Field Impacts –June 29, 2016
- Quarterly Report: Quarterly Report for Aquatic Sampling –July 25, 2016
- Memorandum: Recreational Boat Slip Assessment –September 26, 2016
- Quarterly Report: Quarterly Report for Aquatic Sampling - November 21, 2016
- Report: Aquatic Ecological Resource Characterization and Impact Assessment - January 24, 2017
- Report: 2016 Aquatic Data Report (this document)

2
Sampling Methods

This section reviews the sampling methods for each major monitoring category. The methods presented in this section were included in the 2016 Sampling Plan (LimnoTech, 2017) and approved by ODNR. Any deviation from the sampling plan is noted in each section.

2.1 Stations

Sampling stations are listed below in Table 1 and a graphical depiction of the stations is shown in Figure 2. Table 2 lays out, by category, which stations or transects were sampled for each type of monitoring. The GPS coordinates for each sampling station are included in Table 2. The transects are located down the center (C) of the project grid, and to the east (E), and west (W) in adjacent Reference areas. The transects have a southeast to northwest orientation, and are aligned down the axis and parallel to the proposed turbines. Transect C extends from stations ICE1 to ICE7, transect W extends from stations REF2 to REF3, and transect E extends from stations REF4 to REF6.

Table 1. Sampling stations by sample type.

Task Description		Reference Stations (REF)						Turbine Stations (ICE)							Transects		
		1	2	3	4	5	6	1	2	3	4	5	6	7	C	E	W
Fish Community	Mobile Acoustic														x	x	x
Fish Community	Larval Fish	x							x				x				
Fish Community	Juvenile	x							x				x				
Fish Community	Zooplankton	x	x	x	x	x	x		x		x		x				
Fish Community	Phytoplankton	x	x	x	x	x	x		x		x		x				
Fish Community	Benthos	x							x				x				
Physical	Chemistry (discrete)	x	x	x	x	x	x		x		x		x				
Physical	Chemistry (discrete sonde profiles)	x	x	x	x	x	x	x	x	x	x	x	x	x			
Physical	Chemistry (continuous)	x						x (DO)	x (DO)		x			x (DO)			
Physical	Substrate Mapping	See substrate mapping section															
Physical	Hydrodynamic	x									x						
Fish Behavior	Acoustic telemetry	See acoustic telemetry section for map															
Fish Behavior	Fixed Acoustic	x								x							
Fish Behavior	Noise	x									x						
Fish Behavior	Aerial Surveys	See aerial survey section for description of locations															

Table 2. Table of sampling stations and latitude and longitude

Turbine Station	Latitude	Longitude	Depth (feet)	Reference Station	Latitude	Longitude	Depth (feet)
ICE1	41.60072	-81.80055	58	REF1	41.60867	-81.8255	61
ICE2	41.60616	-81.80602	59	REF2	41.62539	-81.8421	63
ICE3	41.61159	-81.8115	60	REF3	41.59184	-81.8089	58
ICE4	41.61702	-81.81697	61	REF4	41.60899	-81.7915	58
ICE5	41.62246	-81.82245	61	REF5	41.62493	-81.8081	61
ICE6	41.62789	-81.82793	62	REF6	41.6399	-81.8237	63
ICE7	41.63333	-81.8334	63	Nearshore*	41.55016	-81.76528	53

*Nearshore station was selectively sampled in 2016. See notes in each section.

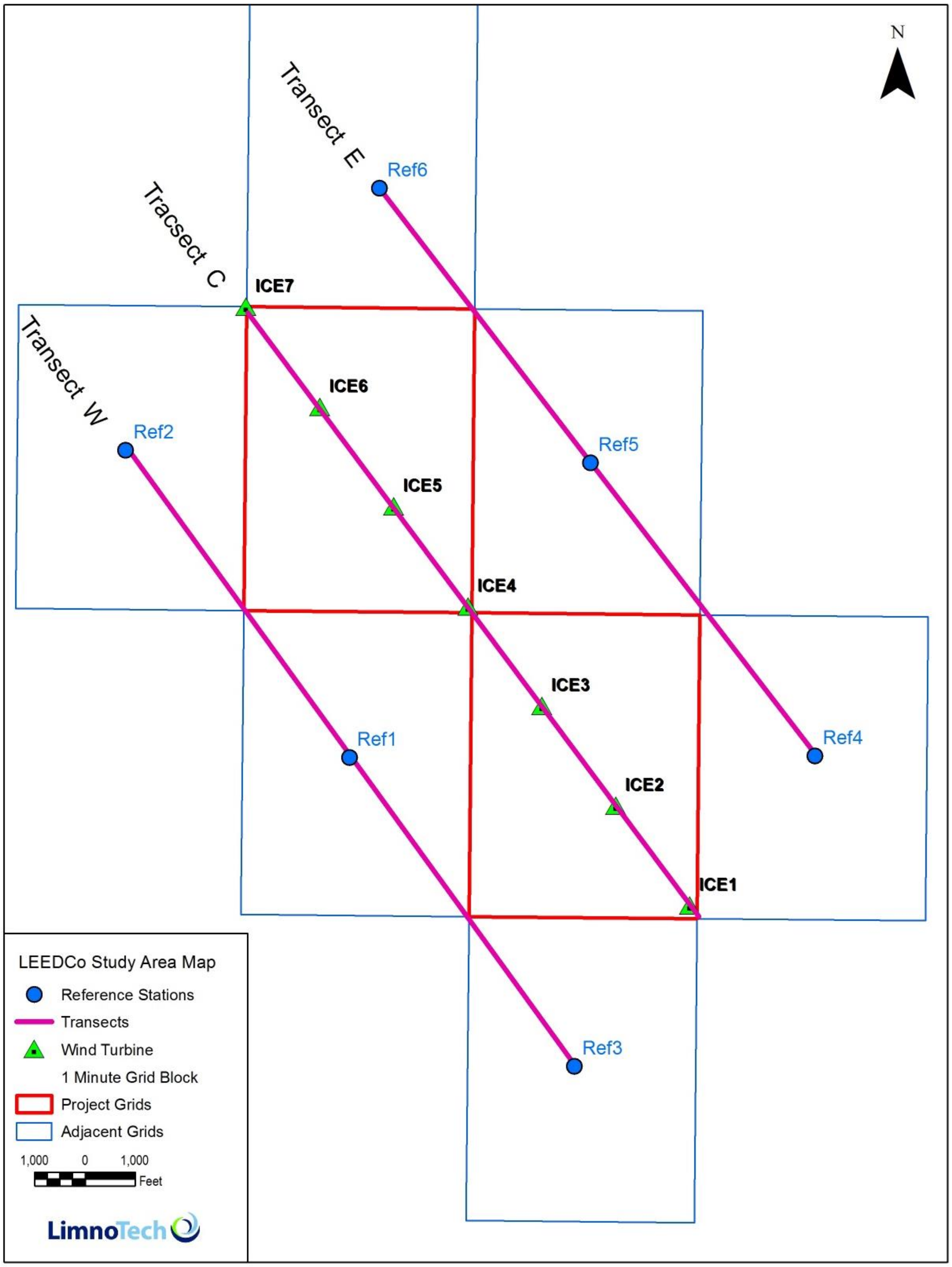


Figure 2. Map of project area, proposed turbine locations, sampling stations, and transects.

2.2 Field Events Summary

Table 3 provides a listing of the exact dates that each of the field tasks were completed for each month. Copies of field notes for each date are included in Appendix B.

Table 3. Dates of field activities by sample type for the current interim report

Sampling Category		May	June	July	August	September	October
Fish Community							
	Hydroacoustic	23-May	2-Jun	5-Jul	23-Aug	6-Sep	3-Oct
	Larval Fish	24-May	26-Jun	20-Jul	--	--	--
	Juvenile	21-May	--	--	8-Aug	--	3-Oct
	Zooplankton	10-May	16-Jun	7-Jul	17-Aug	7-Sep	19-Oct *
	Phytoplankton	10-May	16-Jun	7-Jul	17-Aug	7-Sep	19-Oct *
	Benthos	9-May	--	--	--	--	19-Oct
Physical							
	Chemistry (discrete)	10-May	16-Jun	7-Jul	17-Aug	7-Sep	19-Oct *
	Chemistry (continuous)	11-May	15-Jun	6-Jul	18-Aug	8-Sep	19-Oct
	Substrate Mapping	--	--	--	August	--	--
	Hydrodynamic	11-May	15-Jun	6-Jul	17-Aug	8-Sep	19-Oct
Fish Behavior							
	Fixed Acoustics	--	--	--	23-Aug	6-Sep	3-Oct
	Noise	11-May	15-Jun	6-Jul	17-Aug	8-Sep	19-Oct
	Acoustic Telemetry	--	--	--	--	--	19-Oct, 31-Oct
	Aerial Surveys	20-May, 22-May	5-Jun, 6-Jun, 30-Jun	3-Jul	28-Aug, 29-Aug	18-Sept, 21-Sept	15-Oct, 24-Oct

*Due to inclement weather only REF1, REF3, and REF6 and ICE4 and ICE6 were sampled.

2.3 Fish Community/Lower Trophic

LimnoTech undertook sampling of the fish and lower trophic community (zooplankton, phytoplankton, benthos) throughout the spring, summer and fall of 2016 to gain baseline data on existing conditions. This data can be compared to sampling conducted during and post construction project phases to determine if the project is having any potential impacts on the fish and lower trophic communities in the project area.

2.3.1 Hydroacoustic

Photo 1. Hydroacoustic data collection.

Photo 2. Biosonics DT-X instrument.

Hydroacoustic monitoring was conducted monthly from May to October 2016 to assess the density and seasonal abundance of juvenile and adult fish. Sampling was completed on three transects, one down the center of the project grid and turbine locations, and two transects in adjacent grid cells to serve as reference areas. The map in Figure 2 shows the location of the acoustic transects (Transects W, C and E). Collection methods and sampling design followed the Standard Operating Procedure for Fisheries Acoustic Surveys in the Great Lakes (FASGL; Parker-Stetter et al., 2009). A BioSonics DT-X portable echo sounder surface unit with an emitting frequency of 120kHz with a 6° split beam transducer was pole-mounted and towed along the sampling transects at appropriate speeds (~4-5 mph). Equipment was calibrated prior to each survey following manufacturer protocols. Whenever possible the event was completed in calm conditions, a half hour after sunset and within five days of the new moon. The monthly hydroacoustic sampling was originally scheduled to begin in June. The plan was modified to begin in May, therefore the May hydroacoustic sampling was conducted later in the month (not within five days of the new moon). Unforeseen circumstances (i.e. inclement weather) precluded sampling within five days of the new moon during the month of August. Data analysis and fish density calculations were determined using Echoview software according to the Fisheries Acoustics Surveys in the Great Lakes (FASGL; Parker-Stetter 2009) guidelines.

2.3.2 Larval Fish

Larval fish sampling was conducted once per month during 2016, in May, June and July. Three replicate 5-minute tows were completed at two Turbine Stations (ICE2 and ICE6) and one Reference Station (REF1). A 1X2m frame, 500 micron neuston net was used to collect the fish according to the ODNR ichthyoplankton sampling protocols. Following collection, samples were concentrated and preserved in 95% ethanol. Samples were brought to the BSA Environmental lab, where they were separated for taxonomic identification. The main output from this task was an assessment of the density and composition of larval fishes within the project area and the adjacent areas.

Photo 3. Larval fish monitoring using the neuston net.

2.3.3 Juvenile Fish

Juvenile fish sampling was conducted once per month in May, August and October. Three replicate 10 minutes tows were conducted at two Turbine Stations (ICE2, ICE6) and one Reference Station (REF1). Following the sampling event the OSU boat captain indicated that the GPS coordinates from the ICE6 location from the initial trawling event in May might have been incorrectly entered into the boat GPS system. The location was actually due East of the coordinates they received by approximately one mile. Since the surrounding area in the vicinity of the project location is similar in topography we do not anticipate this minor error in positioning impacted the collection results. The August and October events were collected at the correct ICE6 location. A flat-bottom otter trawl with a 10.7 meter head rope and 12-mm bar mesh in the cod end was originally proposed as the dimensions that would be used to complete the bottom trawls according to ODNR bottom trawl techniques. However, given the limited availability of a net with these specifications, a 9.4 m foot rope; 7.8 m head rope; 12 mm bar mesh size in the cod end net was used for the 2016 season. A net mensuration study was completed during the October survey to help determine the appropriate scale factor to account for the smaller net used in 2016. Trawl catches were sorted by species and where appropriate age-category (AC 0-3, based on the ODNR Age Break protocol) and enumerated. A subsample of 30 individuals per species and age category were measured for total length (nearest mm) and weight (nearest 0.1 g). During days with larger waves, weights were estimated in the field and a subset of species preserved (in formalin) was brought back to the lab for more precise measurements.

Photo 4. Juvenile fish trawling.

Photo 5. Sample of fish collected during the juvenile trawl.

2.3.4 Zooplankton

Zooplankton sampling was conducted monthly from May to October 2016. Samples were collected at six Reference Stations and three Turbine Stations. Sampling protocols followed the Lake Erie Coordinated Lower Trophic Level Assessment. Briefly, a weighted zooplankton net (0.5 m in diameter, 64 micron mesh), with a flow meter was used to complete the sampling. The net was lowered to the lake bottom and then pulled up so the plankton were collected along the way down and up. The net was washed with filtered water so all plankton were within the collection jar. Samples were concentrated through a 64 micron screen and preserved with 5% Lugols's Iodine solution, which was the preservative recommended by BSA Environmental. Samples were stored in 200 mL jars and three 2 to 5 mL sub-samples were removed for plankton identification to taxonomic genus and enumerated. Any exotic species were identified to species level. Laboratory protocols for identification, enumeration and biomass estimates followed the methods that BSA Environmental Services has been using for several years.

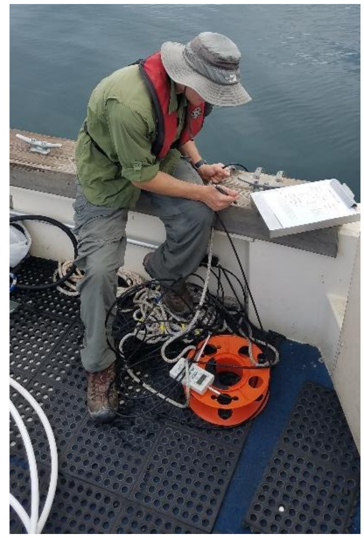


Photo 6. Water quality sampling.

2.3.5 Phytoplankton

Phytoplankton sampling was conducted monthly from May to October 2016. Samples were collected at six Reference stations and three Turbine stations. Sampling and laboratory protocols followed the Lake Erie Coordinated Lower Trophic Level Assessment. An integrated tube sampler at two times the Secchi depth was used to complete the sampling. Samples were concentrated and preserved with 4% Lugols solution. Samples were processed according to the BSA Environmental Services Laboratory method, which follows the (OSU) Aquatic Ecological Lab processing protocols.

2.3.6 Benthos

Sampling was conducted at one Reference Station and two Turbine Stations, in May and October of 2016. Sampling and laboratory protocols followed the Lake Erie Coordinated Lower Trophic Level Assessment. Three replicate grabs of bottom sediment were collected using a PONAR grab sampler. Benthos were removed, preserved, sorted to the nearest taxonomic order or aquatic functional group and enumerated.

Photo 7. Samples of benthos collected in May 2016.

2.4 Physical Habitat

Physical habitat sampling included characterizing bottom sediments, water currents, nutrients, and trends of light attenuation, temperature, and dissolved oxygen. These parameters are being monitoring to track changes in environmental conditions to assist with interpretation of trends that might be occurring in other biological data collected as part of this study. The trends reflect the dynamic nature of Lake Erie and not necessarily the impact from the Icebreaker Wind project.

2.4.1 Water Chemistry: Discrete

Discrete water sampling was conducted simultaneously with the collection of zooplankton and phytoplankton by three researchers. During each sampling event one researcher recorded and took integrated samples of water chemistry while another researcher prepped bottles for water samples, made notes, and measured photosynthetic active radiation (PAR). PAR measures the intensity of light in the band that are used by phototrophs (e.g. can excite chlorophyll). The third researcher measured Secchi depth and collected zooplankton.

Sampling the water column chemistry was conducted using an integrated tube with an inner diameter of 5/8 inch. The tube was lowered to the lake bottom and emptied into a stainless steel bucket to sub-sample water for two-1L bottles for chlorophyll-*a* and two-250 mL bottles for total phosphorus (TP) and total nitrogen (TN). Samples were collected at six reference stations (Ref 1 to 6) and three turbines stations (ICE2, ICE4, ICE6). The samples were collected monthly from May to October 2016. The only exception to the sampling was due to inclement weather on October 19 when only REF1, REF3, and REF6 and ICE4 and ICE6 were sampled. Sampling and laboratory protocols followed the Lake Erie Coordinated Lower Trophic Level Assessment. Samples were bottled and placed in an iced cooler along with a chain of custody form before sending the coolers overnight to the OSU's Stone Laboratory. Once the samples arrived at Stone Laboratory chlorophyll-*a* was immediately filtered through a Whatman GF-C filter using low vacuum pressure and initially measured using a fluoroprobe. Final chlorophyll-*a* concentrations were determined by placing the filtered samples into dimethyl sulfoxide "DMSO", heated, centrifuged, with absorbance being measured at 665, 649, and 580.

Beginning in August the integrated tube sampler material was switched from a rubber hose to a crosslinked polyethylene hose to decrease possible chemical leaching that was observed at low levels in an equipment blank. Equipment blanks (deionized water run through both types of hoses and into separate sample bottles) and sample blanks (deionized water poured directly into a sample bottle) were collected in August and sent to the National Center for Water Quality Research at Heidelberg University for analysis of total phosphorus concentrations.

Each water chemistry sampling station was supplemented with water clarity measurements using a Secchi disk and PAR. A Secchi disk was lowered into the water column until it was not visible to measure water transparency. A LI-COR LI-193 spherical submersible light meter was lowered on a LI-2009S lowering mount from the water surface at 0.5 -1.0 meters increments. PAR was displayed on a LI-250A and written in the field form to calculate light extinction.

In May profiles of temperature, dissolved oxygen, pH, conductivity, turbidity, chlorophyll-a, and blue-green algae were measured from the lake surface to the bottom by using an YSI EXO2 sonde at every sampling station. Beginning in June vertical profiles were collected at each turbine location during every discrete sampling event.

All field probes were calibrated prior to the first measurement. All sampling containers and field probes were thoroughly rinsed prior to each collection.

2.4.2 Water Chemistry: Continuous

Replicated stations were installed at ICE4 and REF1 in May to measure continuous dissolved oxygen, PAR, and water temperature. Once ODNR modified the sampling plan in July additional temperature and dissolved oxygen (DO) sensors (miniDO$_2$T) were deployed in July and August at ICE1, ICE2, and ICE7.

HOBO water temperature Pro V2's were deployed at stations ICE4 and REF1 to measure temperature at the water surface and one meter from the lake bottom once every ten minutes. Paired with the bottom water temperature both stations were equipped with YSI 600 OMS loggers with a DO sensor to record once every hour. To measure PAR at ICE4 and REF1 a submersible Odyssey logger was deployed approximately 14.3 meters above the lake bottom at both stations and recorded measurements every ten minutes. MiniDO$_2$T sensors deployed at ICE1, ICE2, and ICE7 measured and recorded temperature and

DO every ten minutes one meter from the lake bottom. An YSI EXO1 with a DO probe was initially installed at ICE2 on August 17, 2016. It was replaced on August 22, 2016 with a miniDO$_2$T sensor.

All field probes were calibrated prior to the first measurement and maintained throughout the field season.

Two instrument problems arose during 2016 that resulted in a deviation from the 2016 Sampling Plan. During maintenance on June 15, 2016 it was discovered that the DO logger at REF1 was not initialized to sample and record data prior to the initial launch on May 11, 2016. We also found the ICE4 PAR wiper was damaged in August, therefore the PAR sensor had to be re-installed without a wiper. The sensor was still relatively clean during a maintenance visit on September 6, 2016, but PAR values dropped sharply in the days after this visit due to biofouling of the sensor face from sediments and algae. Therefore data after September 6, 2016 is suspect at this station. A new wiper could not be delivered in time to be replaced in the field. A spare wiper will be kept on hand during the 2017 field season to avoid any future similar issues.

2.4.3 Substrate Mapping

A side-scan sonar survey of the lakebed within and adjacent to the Icebreaker Wind site was completed on June 24, 2015 by VanZandt Engineering. A total area of about 6,700 feet (2,050 m) by 100 feet (305 m) was surveyed in the project area. The line spacing for the survey was 30 meters with a 50 meter range for each side, which gave over 100 percent overlap of sonar coverage line to line. An Imagenex 872 YellowFin side-scan sonar system with digital data acquisition software was used to collect the side-scan data. An additional side scan sonar survey conducted by Canadian Seabed Research (CSR) of the proposed transmission line path was completed in August 2016 (CSR 2016). The CSR study included a complete geophysical investigation of the project area including sediment characteristics and bottom type evaluations.

2.4.4 Hydrodynamic

Two ADCPs were deployed from May through October 2016 to monitor lake currents. One ADCP (Nortek AWAC AST 1MHz Aquadopp Z-cell) was deployed at the center turbine location (ICE 4) and the second ADCP (RDI Workhorse Sentinel 1200kHz) was deployed at REF 1. Both ADCPs were attached to an anchor and placed in a cage mount with buoys attached to keep the ADCP vertical. The ADCPs measured lake currents on an hourly basis in one meter increments from the surface to the bottom of the lake. Both ADCPs were re-deployed October 31 for the winter to sample water movement prior to and during the presence of ice, once every three hours.

Photo 8. REF1 ADCP mooring.

2.5 Fish Behavior

Fish behavior and movements are driven by several factors. Fish often make daily movements between feeding and resting habitats, seasonal movements to summer and winter habitat and annual movements to spawning areas. Fish also respond to direction and rate of water movement by their lateral line which contains nerve endings and acts as radar, allowing the fish to detect the size, shape, direction and speed of objects. Fishes may trade-off food acquisition to decrease the risk of predation, so that a habitat with lower food availability may be used to reduce risk. Understanding normal fish behavior and movement is critical to being able to predict how a population may respond to variable environmental conditions. The purpose of the sampling in this case is to understand whether the turbines and associated structures have any impact on fish behavior and movement.

2.5.1 Acoustic Telemetry

Acoustic telemetry will be used to determine whether installation of the turbines and submerged inter-array and export electric transmission cables could affect fish behavior during and post-construction. An acoustic telemetry system involves two main components: the moving transmitter tags attached to fish that broadcast a unique numeric ID and the fixed hydrophone receivers that log the unique ID as fish pass by. Icebreaker Windpower supported the installation of a local array of hydrophone receivers near the project site and transmission line.

Prior to deployment of the acoustic receivers, a small subset of receivers was deployed for a short period to perform a range test on Wednesday, October 19, 2016. This test was conducted over an 8 hour period in wave conditions that ranged from calm to 2 feet. A test transmitter from VEMCO was secured to a mooring line and positioned in the middle of the water column (30 feet off the bottom). Following the range testing, the full array was installed on October 31, 2016. Each receiver was suspended above the bottom using a 75 pound anchor, underwater floats, and a 200 foot drag line placed on the lake bottom (Figure 3). The drag line will be used for annual instrument retrieval and data downloading. To ensure on-going testing and verification of the system, two acoustic (sentinel) tags were installed permanently within the receiver array, roughly 500 meters from the closet receiver. These tags will allow continual range testing to occur.

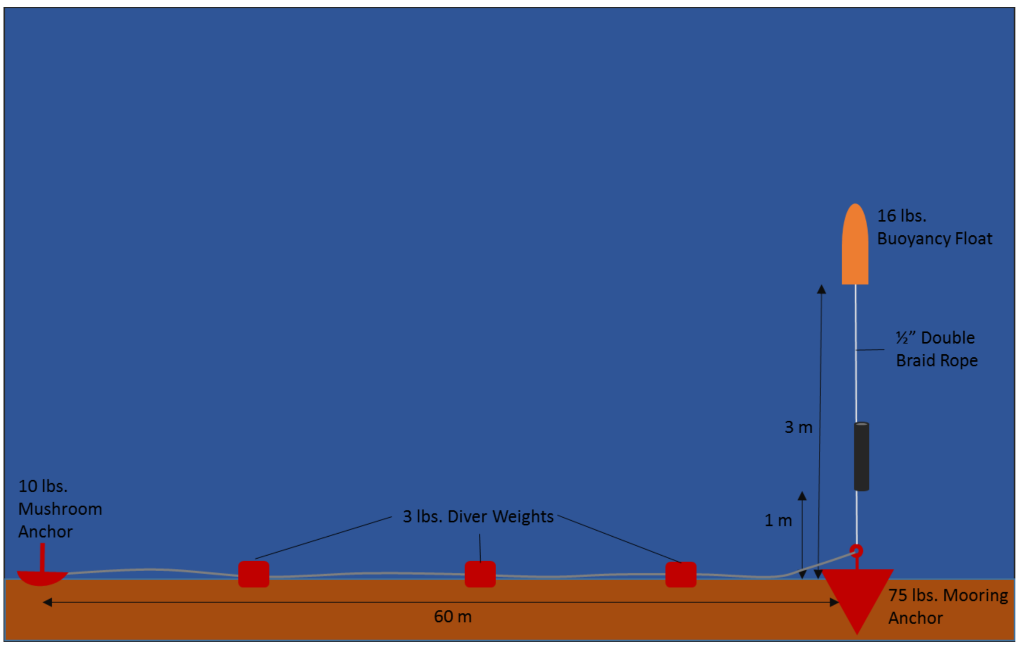


Figure 3. Acoustic telemetry mooring design.

The receiver array was designed to have two rows of hydrophones (26 total), one on each side of the turbine/transmission line as depicted in Figure 4. This configuration was designed to monitor the behavior of tagged fish in and around the turbine site and transmission line with sufficient density to capture fish moving through the turbine and transmission sites. This array configuration minimizes monitoring gaps within the study area and the double line of receivers array provides a better understanding of individual fish track as it moves from one side of the project site to the other. The distance between receivers along each transect is approximately 1,350 meters. The distance between the two parallel receiver lines is approximately 1,000-1,200 meters.

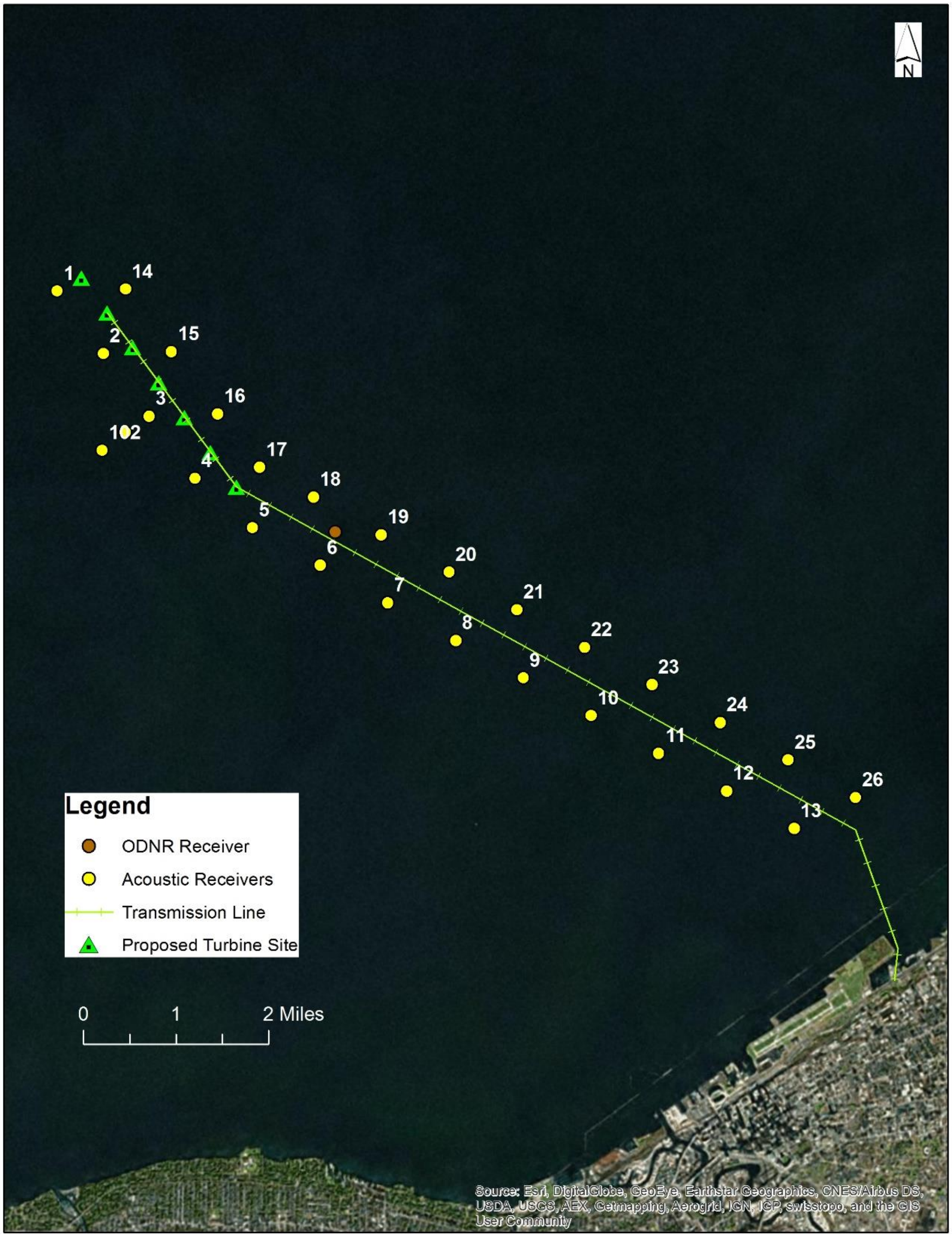


Figure 4. Map of the deployed array configuration. The yellow dots represent the receivers, the green triangles the turbines and the green line the transmission line. Receiver #102 is actually the location of the test transmitters.

2.5.2 Fixed Acoustics

Fixed hydroacoustic sampling was conducted on the same nights as the mobile acoustic surveys were conducted. Fixed surveys were completed by anchoring the boat for one hour at ICE3 and for one hour at REF1. The equipment and data settings remained the same as the mobile survey (section 2.3.1), with the exception that the collection ping rate was increased from five pings per second to 10 pings per second. Fixed acoustic data was collected monthly from August through October. The monthly hydroacoustic sampling plan was modified in late July to include monthly fixed hydroacoustics, therefore the sampling did not begin until August 2016. Data analysis and fish density calculations were determined using Echoview software according to the FASGL guidelines (Parker-Stetter et al. 2009).

2.5.3 Noise Production

Two underwater sound recorders were deployed on May 11, 2016 two meters from the bottom of the lake using Ocean Instruments Smart Hydrophone Soundtraps at stations REF1 and ICE4. The hydrophones recorded sound at 72 kHz for 30 minutes every hour. They were attached to an anchored four meter suspended rope to limit sound from mooring hardware.

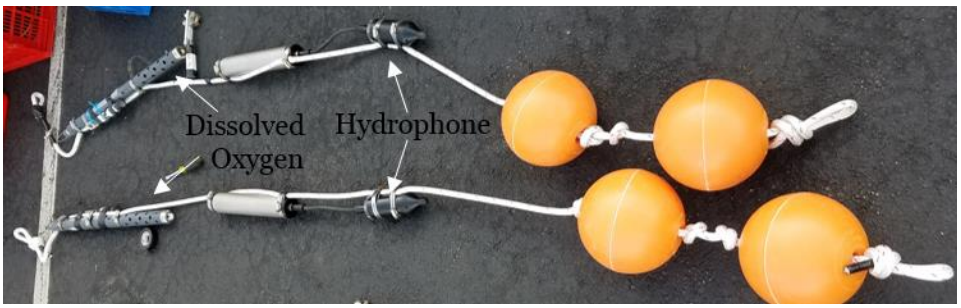


Photo 9. DO and hydrophone sensor setup.

Acoustic data were processed within the SEDNA toolbox (Dugan et al. 2011) in MATLAB using a Hann window with zero overlap, a fast Fourier transform (FFT) size with 1 second time resolution and 1 Hz frequency resolution (Dugan et al., 2011; Estabrook et al., 2016). Each sound file was calibrated with the appropriate sensor characteristics. Table 4 below shows each dataset that was analyzed from each site.

Table 4. Recording durations, recording unit and sensitivity of audio data collected in Lake Erie.

Recording Start	Recording Stop	Sound Trap Serial Number	Sensitivity
REF1			
5/11/16	6/15/16	671100952	171.3 dB re: 1 µPa
6/16/16	7/6/16	671100952	171.3 dB re: 1 µPa
7/7/16	7/24/16	671100952	171.3 dB re: 1 µPa
7/24/16	9/6/16	671100952	171.3 dB re: 1 µPa
9/7/16	10/20/16	671117327	171.8 dB re. 1 µPa
ICE4			
5/11/16	6/15/16	671117327	171.8 dB re: 1 µPa
6/16/16	7/4/16	671117327	171.8 dB re: 1 µPa
7/7/16	8/17/16	671117327	171.8 dB re: 1 µPa
8/22/16	9/6/16	671117327	171.8 dB re: 1 µPa
9/7/16	10/19/16	671100952	171.3 dB re: 1 µPa

Most bioacoustic analysis relies on spectrograms (representation of the sound magnitude as frequency versus time) to detect individual calls that are typically on the order of seconds to minutes. Analyzing acoustic data from long-term surveys becomes very time consuming and often requires subsampling (Thomisch et al., 2015). Fine-scale analysis of spectrograms or listening to the data are not the best approach for looking at large scale changes over extended deployments at multiple locations (Sueur et al., 2012). An alternative method is to look at long-term patterns of acoustic activity that represent many months of sound in a single image. These long-term spectrograms (or long-term spectral averages; LTSAs) are created by integrating slices of a specified time interval throughout the recording and they show diel or seasonal patterns of acoustic activity that often cannot be seen at finer time scales. Using the SEDNA and Triton software packages for MATLAB (Dugan et al., 2011; Wiggins et al., 2010), LTSAs encompassing the entire survey period for each site were evaluated for the occurrence of fish chorusing activity. Spectrograms were created with the *pwelch* algorithm in 1 Hz bins and 10.24 s time slices, an FFT of 512 points and a 1 h integration time. With these representations, it is possible to see diel and seasonal trends in biological, anthropogenic and environmental acoustic activity at the ecosystem scale.

2.5.4 Aerial Surveys of Boating

Aerial surveys were conducted to monitor use of the project site and surrounding areas by recreational boaters.

Photo 10. Photo taken from Aerial Associates Photography on July 7, 2016.

Aerial surveys were scheduled offshore of Cleveland two times a week (one weekday and one weekend day), every three weeks from May 1 to November 1, 2016. Survey days were selected to coincide with days that ODNR was conducting creel surveys at area boat launches as well as when weather was adequate to fly safely, which generally were days suitable for boating. Aerial Associates Photography departed from Ann Arbor Municipal Airport to count commercial and recreational boats while taking high quality photographs to reference their location. Each 5-minute survey block has an ID and the numeric part of the ID (911 and 912) corresponds to the 10-minute size survey blocks that are used by ODNR to conduct boating surveys in Lake Erie. Boat activity was spatially grouped into 5-minute grids over Lake Erie with all Turbines falling within grid “911-NW” (Figure 5).

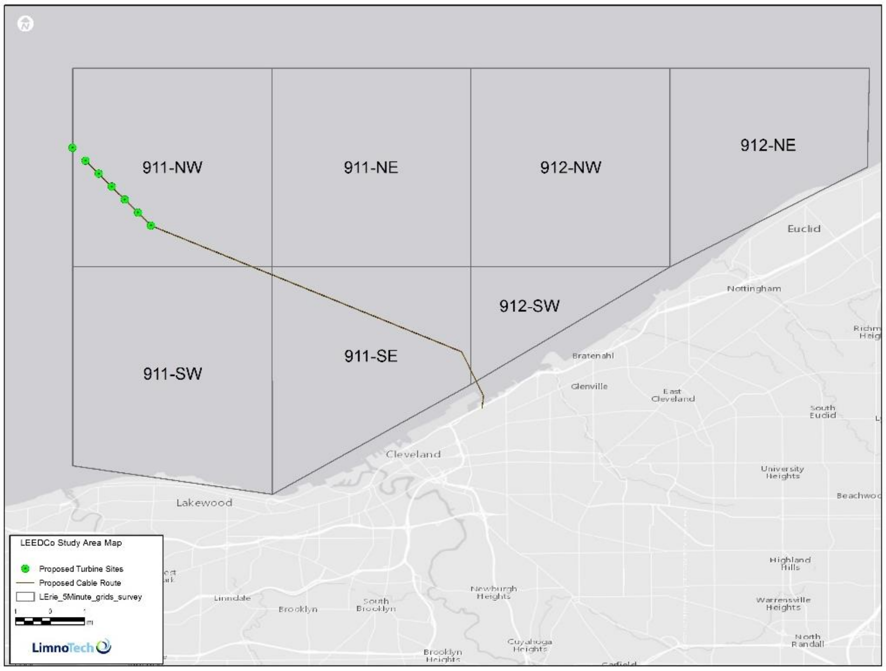


Figure 5: 5-minute grids offshore Cleveland for grouping boat activity.

2.6 Other Activities

2.6.1 Electromagnetic Field Review

LimnoTech conducted a review of current research and information regarding any potential impact of Electromagnetic Fields (EMFs) on fish movement and behavior (LimnoTech, 2016a). The memorandum, dated June 29, 2016, drew from studies conducted in the Great Lakes, other parts of the United States, and overseas. Specific details of the buried electric cable proposed for the Icebreaker Wind project were considered to provide an assessment of the likely impact to fish for this project.

2.6.2 Marina Boat Counts

In addition to the aerial survey of boaters, a recreational boat slip study was conducted in 2016 to count and classify power and sail boats in the recreational harbors, marinas, and yacht clubs in Lorain, Cuyahoga, and Lake Counties (LimnoTech, 2016b). Aerial imagery, with an on ground pixel resolution of approximately six inches, was obtained for 16 key harbor areas in the three county area surrounding Cleveland, Ohio on the morning of Wednesday, August 3, 2016. The imagery was captured by Aerial Associates under contract to LimnoTech using a Leica DMC III and post-processed to create a tiled image mosaic. For each of the 16 distinct harbor areas, LimnoTech staff delineated every visible boat slip and marked it as either empty or containing a power or sail boat. For slips containing a boat, a polyline was drawn from its stern to bow to allow for length measurements of each boat.

2.6.3 Impact Assessment

LimnoTech prepared a report that summarizes the site specific data collected in 2016 as part of a site characterization study and potential impact assessment (LimnoTech, 2017a). The potential impact assessment was done utilizing a weight of evidence approach based on information presented from the following sources:

1. Review of risk factor maps created by ODNR to specifically map out key aquatic habitats and areas of low and high potential impact from offshore wind across the Ohio Waters of Lake Erie.
2. Review of recent reports authored by experts from around the Great Lakes region as part of the Great Lakes Wind Collaborative (GLWC) to identify categories of impacts from offshore wind in the Great Lakes.
3. Review of other studies and reports from similar projects in Lake Erie, on the east coast of the U.S., and abroad where offshore wind turbines have been installed in freshwater.
4. Collection of site specific ecological data in 2016 at the proposed project site to validate the impact assessments contained in GLWC reports and in ODNR's risk analysis maps.

3
Results and Discussion

3.1 Fish Community/Lower Trophic

3.1.1 Hydroacoustic

Overall, adult and juvenile fish densities were similar between the three mobile transects, which included one transect down the center of the project location and two transects in nearby areas to serve as a reference. Although transects were similar within months, there was a significant decline in total density across months. The results from the mobile hydroacoustic surveys are summarized in Figure 6 and Figure 7.

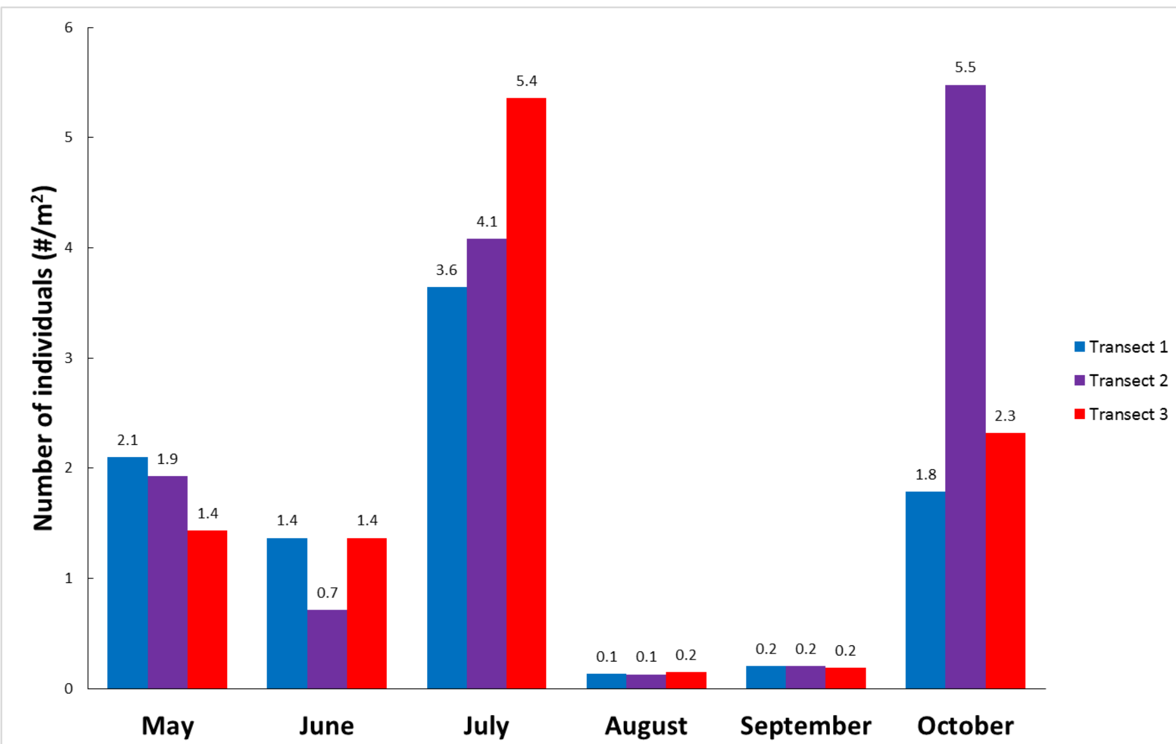


Figure 6. Summary of the mobile hydroacoustics across six months in 2016 for total density, individuals (#) per m² across each transect.

There was a considerable (5-30 fold) reduction in fish density in August and September compared to the other months. This trend is consistent with the absence of fish observed in the August juvenile trawls and follows the depletion in dissolved oxygen. During the July 5, 2016 event DO levels were still between 4-6 mg/L, whereas during the August and September events DO was nearly depleted (0-1 mg/L). This coincides with fish physiology estimates, which state that fish become distressed between 2-4 mg/L and DO levels less than 2 mg/L may be lethal to many species. It is therefore not surprising that most fish moved away from these regions during the late summer-early fall due to the presence of hypoxic waters.

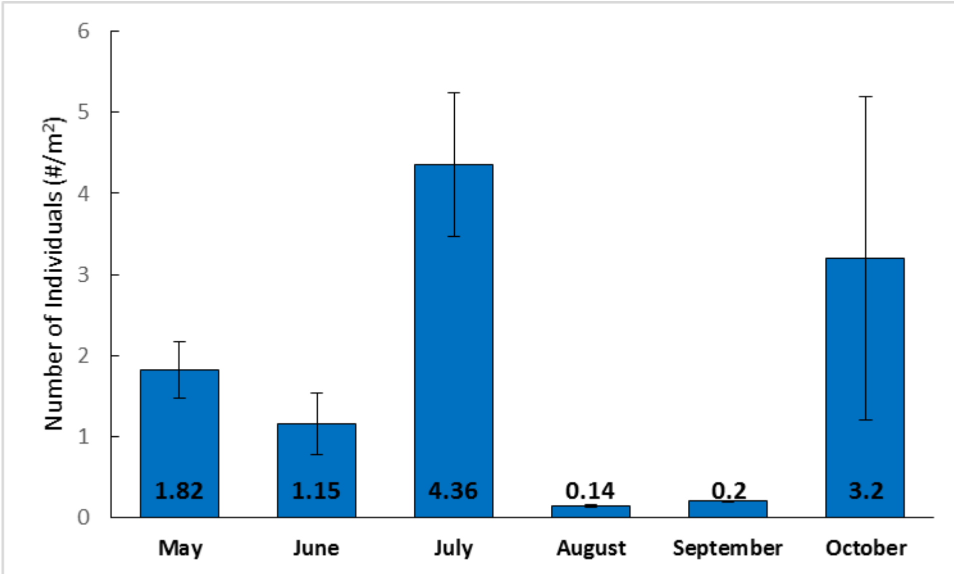


Figure 7. Summary of the mobile hydroacoustics across six months in 2016 for total density, individuals (#) per m² (Mean ± SD).

3.1.2 Larval Fish

The results from the larval fish collections are summarized in Table 5. There were no larval fish collected in the May or July events, and only five larval fish were collected in June. Overall, across all 29 trawls conducted in 2016, only five fish were collected. We also collected a sample near the Cleveland intake crib in June, which contained a total of 16 larval fishes. The relatively large number of larval fish found in the vicinity of the crib and closer to shore indicated that there was likely very low larval fish offshore near the project site. We consulted with ODNR prior to the July event (Jeff Tyson via email on July 19) about the methods and no change in collection methods was suggested as ODNR suspected that larval fish densities were also low at the project site due to its distance from shore.

Table 5. Ichthyoplankton results from the May, June and July 2016 sampling events.

Site	Date	Average (SD)
ICE2	5/24/2016	0 (0)
REF1	5/24/2016	0 (0)
ICE6	5/24/2016	0 (0)
ICE2	6/26/2016	< 1 (1)
REF1	6/26/2016	< 1 (1)
ICE6	6/26/2016	< 1 (1)
ICE2	7/20/2016	0 (0)
REF1	7/20/2016	0 (0)
ICE6	7/20/2016	0 (0)
Nearshore	*6/26/2016*	*16 (NA)*

3.1.3 Juvenile Fish

In the May 2016 event, the species composition was relatively consistent across all locations and replicates. White perch, yellow perch, and rainbow smelt dominated the trawls. Walleye, goby, and emerald shiners were collected in select trawls in low numbers (n=0-4). The results from this sampling event are summarized in Figure 8.

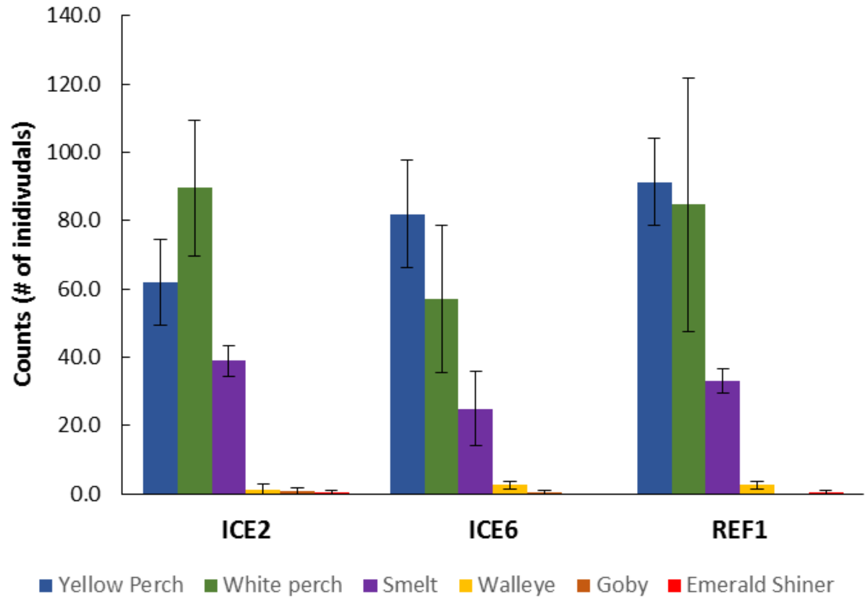


Figure 8. The mean (± SD) for each species collected at each location (n=3 replicate trawls) on the May 21, 2016 event.

The August event occurred when the thermocline was located 3-4 meters off the bottom, and was generally devoid of fish. The DO sensors deployed at ICE1 measured 0.45 mg/L and ICE7 measured 0.3 mg/L. These concentrations are below the level where fish could survive on the lake bottom (i.e. < 2-4 mg/l). Across all nine replicate tows only seven fish total were caught (six larger yellow perch and one large freshwater drum). Based on the severe bottom water hypoxia present during this sampling, it was likely that these fish were caught when the net was moving up or down through the water column. The results from this sampling event are summarized in Figure 9.

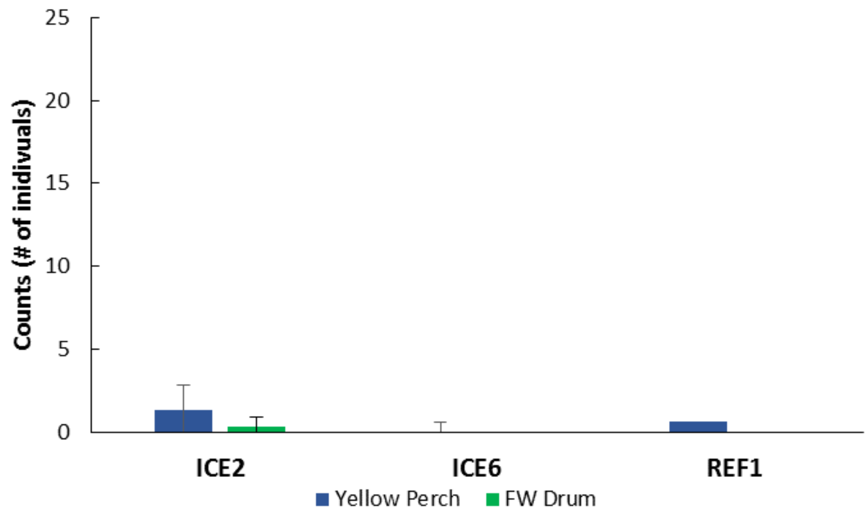


Figure 9. The mean (± SD) for each species collected at each location (n=3 replicate trawls) on the August 8, 2016 event.

The thermocline and associated bottom hypoxia had dissipated for the October 3, 2016 event. The species composition for this last event was relatively consistent across all locations and replicates. Smelt dominated all trawls, followed by white perch, and yellow perch. Freshwater drum, walleye, goby, ghost shiner and white bass were collected in select trawls in lower numbers. The results from the three replicate surveys at each location are summarized in Figure 10.

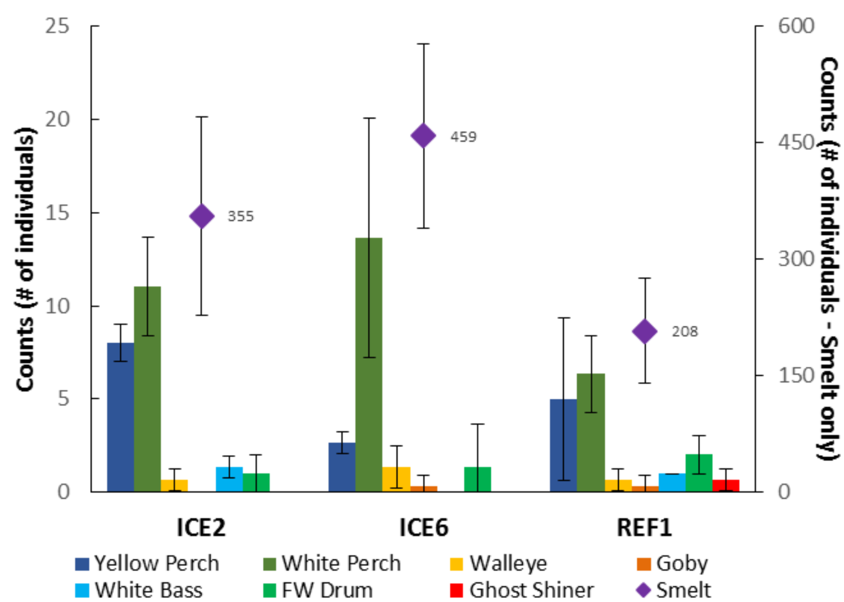


Figure 10. The mean (± SD) for each species collected at each location (n=3 replicate trawls) on the October 3, 2016 event. NOTE: Smelt values are on the right y-axis.

The combined results from the three replicate surveys at each location across the three events are summarized in Table 6.

Table 6. Summary of the juvenile fish sampling results from the 2016 spring, summer and fall events (Mean ± SD of individual fish).

Fish Species	ICE2			ICE6			REF1		
	May	August	October	May	August	October	May	August	October
Emerald Shiner	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (1)	0 (0)	0 (0)
Freshwater Drum	0 (0)	0 (1)	2 (2)	0 (0)	0 (0)	4 (1)	0 (0)	0 (0)	2 (1)
Ghost Shiner	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
Goby	1 (1)	0 (0)	0 (0)	0 (1)	0 (0)	1 (1)	0 (0)	0 (0)	1 (1)
Rainbow Smelt	39 (5)	0 (0)	355 (128)	25 (11)	0 (0)	459 (119)	33 (4)	0 (0)	208 (68)
Walleye	1 (2)	0 (0)	1 (1)	3 (1)	0 (0)	2 (1)	3 (1)	0 (0)	1 (1)
White Bass	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)
White Perch	90 (20)	0 (0)	11 (3)	57 (22)	0 (0)	14 (6)	85 (37)	0 (0)	6 (2)
Yellow Perch	62 (13)	1 (2)	8 (1)	82 (16)	0 (0)	3 (1)	91 (13)	1 (1)	5 (4)

3.1.4 Zooplankton

The results from each event are summarized in Table 7, by common numerical metrics, including number of species, numbers/L and the biomass for each month and station. The results were variable across all sites for biomass and numbers/L; however, in general, the species composition remained similar.

Table 7. The number of species, number of organisms/L and the biomass for all zooplankton in each sample - May through October 2016.

	ICE2						ICE4					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Species	20	14	11	10	14	-	-	14	11	7	10	16
Number/L	1094	933	876	2429	876	-	-	623	699	4915	528	804
Biomass (ug d.w./L)	400	289	162	1680	318	-	-	572	59	246	59	348
	ICE6						REF1					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Species	14	12	8	16	10	19	17	14	11	9	14	14
Number/L	2688	333	2635	2562	1879	787	1124	564	566	445	1116	825
Biomass (ug d.w./L)	1252	700	596	455	746	359	276	952	250	91	406	225
	REF2						REF3					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Species	14	15	10	14	9	-	15	13	10	11	11	17
Number/L	1606	2532	951	2061	1446	-	1669	1312	365	1099	1002	819
Biomass (ug d.w./L)	868	1272	119	380	257	-	648	1037	146	360	259	213
	REF4						REF5					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Species	19	14	11	12	10	-	15	13	10	14	10	-
Number/L	962	506	1472	1661	961	-	2393	318	2377	2022	742	-
Biomass (ug d.w./L)	410	475	185	282	752	-	709	403	337	636	97	-
	REF6						**All Sites**					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Species	16	16	8	13	13	13	16	14	10	12	11	16
Number/L	1613	953	821	2374	2230	998	1644	897	1196	2174	1198	847
Biomass (ug d.w./L)	580	974	157	323	205	392	643	742	223	495	344	307

The species composition across each month is summarized in Table 8. The native predatory water flea (*Leptodora kindtii*) was present in May and August samples and the invasive, predatory spiny water flea (*Bythotrephes longimanus*) was present in June, July, September, and October samples. This is consistent with the Forage Task Group's findings (FTG, 2016), which stated the densities of the invasive water flea are generally higher from July through September.

Table 8. The species present across all locations from the May through October 2016 sampling events are summarized.

Species	Species	Species	Species
Bosmina longirostris	*Leptodiaptomus ashlandi*	*Skistodiaptomus oregonensis*	*Epischura nevadensis*
Brachionus calyciflorus	*Leptodora kindtii*	*Ascomorpha ecaudis*	*Kertella earlinae*
calanoid copepodid	*nauplii*	*Collotheca sp.*	*Leptodora kindtii*
Conochilus unicornis	*Notholca laurentiae*	*Daphnia sp.*	*Ploesoma hudsoni*
cyclopoid copepodid	*Ploesoma truncatum*	*Kellicotia longispina*	*Trichocerca rattus*
Daphnia galeata	*Polyarthra vulgaris*	*Kertella crassa*	*Trichocerca similis*
Daphnia retrocurva	*Synchaeta spp.*	*Keretella quadrata*	*Tropocyclops prasinus*
Diacyclops thomasi	*veliger quagga*	*Liliferotrocha spp.*	*Trichocerca cylindra*
Dreissena veliger	*Asplanchna priodonta*	*nauplii*	*Bdelloid*
Eurytemora affinis	*Bosmina longirostris*	*Skistodiaptomus*	*Chydorus spp.*
Filinia terminalis	*Bythotrephes longimanus*	*zebra veliger*	*Kellicottia bostoniensis*
Kellicottia longispina	*Corbicula fluminea veliger*	*Brachionus havaensis*	*Trichocerca multicrinus*
Keratella cochlearis	*Gastropus stylifer*	*Conochiloides dossuarius*	*Trichcerca procellus*
Keratella quadrata	*Mesocyclops edax*	*Diaphanosoma brachyrum*	

Overall, zooplankton biomass and composition in the project area is consistent with the ongoing Great Lakes Fisheries Commission (GLFC) monitoring across the basin, suggesting there is no unique zooplankton structure at the project site. Alterations to zooplankton community composition and structure are not anticipated as part of the construction or operation of the Icebreaker Wind project. An ongoing monitoring program will continue to monitor zooplankton populations through all phases of the project.

3.1.5 Phytoplankton

The results from each event are summarized in Table 9, including the numerical metrics, including number of genus, cells/L and the total biovolume for each month and station.

Table 9. The number of genera, number of cells per liter and the total biovolume for all phytoplankton in each sample are summarized from May through October 2016.

	ICE2						ICE4					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Genus	15	12	21	15	19		-	10	14	25	21	32
Cells/L	1.E+07	5.E+05	1.E+07	6.E+06	3.E+06		-	8.E+06	2.E+07	3.E+07	1.E+07	5.E+07
Total Biovolume (um^3/L)	7.E+09	3.E+08	4.E+08	5.E+08	7.E+08		-	8.E+08	3.E+08	3.E+08	4.E+08	2.E+09
	ICE6						REF1					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Genus	12	14	15	22	13	17	18	12	17	18	22	21
Cells/L	1.E+07	2.E+06	5.E+06	9.E+06	7.E+07	3.E+07	9.E+06	3.E+06	8.E+06	8.E+06	9.E+06	4.E+07
Total Biovolume (um^3/L)	3.E+09	8.E+07	3.E+08	5.E+08	9.E+08	3.E+09	2.E+09	3.E+08	4.E+08	7.E+08	2.E+08	4.E+09
	REF2						REF3					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Genus	15	9	16	21	24		18	9	15	12	16	18
Cells/L	8.E+06	3.E+06	8.E+06	5.E+06	2.E+07		1.E+07	5.E+05	6.E+06	4.E+07	6.E+06	5.E+07
Total Biovolume (um^3/L)	3.E+09	7.E+08	2.E+08	1.E+09	3.E+08		9.E+09	4.E+07	5.E+08	2.E+09	5.E+08	2.E+10
	REF4						REF5					
	May	June	July	August	Sept.	October	May	June	July	August	Sept.	October
Number of Genus	15	9	21	17	19		22	13	18	15	13	
Cells/L	1.E+07	5.E+05	1.E+07	9.E+06	9.E+06		8.E+06	5.E+05	7.E+06	1.E+07	1.E+07	
Total Biovolume (um^3/L)	3.E+09	1.E+08	1.E+09	5.E+08	3.E+08		2.E+09	1.E+08	5.E+08	7.E+08	8.E+08	
	REF6						**All Sites**					
	May	June	July	August	Sept.	October	**May**	**June**	**July**	**August**	**Sept.**	**October**
Number of Genus	13	11	17	16	14	28	16	11	17	18	18	23
Cells/L	1.E+07	2.E+06	1.E+07	6.E+06	1.E+07	2.E+07	1.E+07	2.E+06	9.E+06	1.E+07	2.E+07	4.E+07
Total Biovolume (um^3/L)	4.E+09	2.E+08	4.E+08	4.E+08	4.E+08	8.E+08	4.E+09	3.E+08	5.E+08	8.E+08	5.E+08	7.E+09

A summary of the composition of Genus across all months is found in Table 10. In May, August, and October the Bacillariophyta (diatoms) were the dominate plankton. In June, cyanobacteria (blue-green algae) were dominant. Cryptophyta were the dominant plankton in July. Pyrropyta (dinoflagellate) were dominant in September. Cyanobacteria were present in all months, with microcystis only present in September and October.

Table 10. The genera present across all locations from the May through October 2016.

Genus	Genus	Genus	Genus
Asterionella	Crucigenia	Kephyrion	Plagioselmis
Aphanizomenon	Cryptomonas	Kirchneriella	Planktolyngbya
Achnanthidium	Cyclotella	Lagerheimia	Planktothrix
Actinocyclus	Cylindrospermopsis	Lindavia	Pseudanabaena
Ankistrodesmus	Cymatopleura	Lyngbya	Pyramimonas
Aphanizomenon	Cymbella	Mallomonas	Quadrigula
Aphanocapsa	Diatoma	Merismopedia	Rhodomonas
Aulacoseira	Dictyosphaerium	Microcystis	Scenedesmus
Carteria	Dinobryon	Monactinus	Schroederia
Ceratium	Dolichospermum	Monoraphidium	Snowella
Chlamydomonas	Drepanochloris	Mougeotia	Sphaerocystis
Chlorella	Elakatothrix	Navicula	Stephanodiscus
Chlorella	Euglena	Nitzschia	Surirella
Chroococcus	Fragilaria	Ochromonas	Synechococcus
Chrysococcus	Glenodinium	Oocystis	Synedra
Closteriopsis	Gomphonema	Oscillatoria	Tetraedron
Cocconeis	Gomphosphaeria	Pantocsekiella	Tetrastrum
Coelastrum	Gymnodinium	Plagioselmis	

3.1.6 Benthos

The counts (mean ±SD) for each genus are summarized in Table 11. Most of the benthos collected fell into three main groups, Bivalves, Insecta, and Oligochaeta, with a few crustaceans and nematodes in the October sample. Their densities were relatively consistent across the three locations.

Table 11. The mean density (#/m²) and standard deviation (in parentheses) are presented of each taxa across three replicate at each location for the May and October events.

Taxa	May			October		
	ICE2	ICE6	REF1	ICE2	ICE6	REF1
Caecidotea sp.	0 (0)	0 (0)	0 (0)	38 (0)	19 (0)	0 (0)
Chironomus sp.	267 (87)	229 (41)	159 (74)	38 (0)	38 (19)	77 (19)
Corbicula fluminea	657 (334)	376 (74)	606 (320)	0 (0)	0 (0)	0 (0)
Dreisseniidae sp.	0 (0)	0 (0)	0 (0)	19 (0)	19 (0)	0 (0)
Nematomorpha sp.	0 (0)	0 (0)	0 (0)	57 (0)	0 (0)	38 (0)
Oligochaeta	548 (86)	663 (375)	491 (156)	670 (88)	1155 (345)	415 (387)
Procladius sp.	6.4 (9)	13 (18)	19 (15.6)	26 (11)	0 (0)	19 (0)
Sphaeriidae sp.	0 (0)	0 (0)	0 (0)	568 (173)	625 (173)	395 (385)
Tanytarsus sp.	13 (18)	38 (31)	13 (9)	0 (0)	0 (0)	0 (0)

Substrate type is often a key factor in controlling the composition and diversity of the benthic community. The offshore project site (~20 m) consists of primarily silty clay sediments and provides few natural, permanent structures for benthic invertebrates to attach to. While the featureless, silty bottom sediment is likely limiting taxa diversity, the absence of intolerant species (e.g., Mayflies) is also driven by the extended period of hypoxia. Dreissenids (e.g. zebra and quagga mussels) were found as part of this study. These mussels can cause significant biofouling of structures, however low summer DO prevents permanent populations to accumulate below the thermocline (about 40ft depth).

3.2 Physical Habitat

3.2.1 Water Chemistry: Discrete

Discrete grab sampling for water chemistry and water clarity measurements were conducted on May 12, June 16, July 7, August 17, September 7, and October 19, 2016 at REF1-6 and ICE2, ICE4 and ICE6 (

Table 12). The sampling event on May 12, 2016 did not include ICE4 as it was not required by ODNR, but was later added by LimnoTech to provide additional water chemistry results at the same station where continuous measurements are being recorded. Only REF1, REF3, REF6 and ICE4 and ICE6 were sampled in October due to inclement weather. Total Kjeldahl (TKN), TN, nitrate-nitrite, TP, and chlorophyll-*a* are summarized in Table 13. Water clarity results are summarized in Table 14. All water chemistry parameters decreased from May to October with the exception of phosphorus and chlorophyll-*a,* which began to increase in October. Average monthly water clarity was 6.5 feet in May before increasing to 24 feet in July and afterwards decreasing to 10.3 feet in October. An example of a water quality and photosynthetic active radiation profiles at REF 1 are shown in Figure 11 and Figure 12.

The integrated water sampler initially consisted of rubber hose, however after some low level contamination issues were discovered in July the hose was changed to polyethylene. Heidelberg University analyzed a sequence of samples from each hose material as shown in Table 15 below. The results for TP concluded that the equipment blanks (distilled water passed through the hose) averaged 6.2 µg/L for the rubber hose and 1.6 µg/L for the polyethylene hose, and the sample blanks (distilled water poured directly into a sample bottle) averaged 0.8 µg/L (Table 15). As a result the TP results from May, June, and July have a higher method detection limit of at least 7 ug/L All future sampling will utilize an integrated tube sampler made of polyethylene.

Table 12. Reference, Turbine, and Nearshore locations where discrete chemistry samples were taken from May to October 2016.

		Reference Stations 1-3																	
Task Description		1						2						3					
		May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct
Discrete Chemistry	Chlorophyll	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	Nitrate+NO2	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	Total P	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	TKN	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	PAR Extinction	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	Secchi Depth	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
	DO/Temp Profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

		Reference Stations 4-6																	
Task Description		4						5						6					
		May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct
Discrete Chemistry	Chlorophyll	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
	Nitrate+NO2	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
	Total P	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
	TKN	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
	PAR Extinction	x	x	x	x	x		x		x	x	x		x	x	x	x	x	x
	Secchi Depth	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x
	DO/Temp Profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

		Turbine Stations																		Nearshore			
Task Description		2						4						6									
		May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct	May	June	July	Aug	Sept	Oct	July	Aug	Sept	Oct
Discrete Chemistry	Chlorophyll	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	Nitrate+NO2	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	Total P	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	TKN	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	PAR Extinction	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	Secchi Depth	x	x	x	x	x	x			x	x	x		x	x	x	x	x	x			x	
	DO/Temp Profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	

Table 13. 2016 monthly results for Total Kjedahl Nitrogen, Total Nitrogen, Chlorophyll-a, Nitrate+Nitrite, and Total Phosphorus.

Water Chemistry Results

	Total Kjeldahl Nitrogen(mg/L)						Total Nitrogen (mg/L)					
Station ID	May	June	July	August	Sept	Oct	May	June	July	August	Sept	Oct
Ref 1	0.29	0.23	0.30	0.22	0.26	0.29	1.16	0.72	0.76	0.29	0.31	0.35
Ref 1-D	0.24	*	*	*	*	*	1.12	*	*	*	*	*
Ref 2	0.29	0.24	0.30	0.27	0.27	*	1.21	0.65	0.77	0.33	0.33	*
Ref 3	0.26	0.26	0.34	0.31	0.25	0.33	1.01	0.78	0.84	0.42	0.31	0.39
Ref 3-D	*	0.20	0.33	0.29	0.28	0.32	*	0.73	0.83	0.38	0.34	0.37
Ref 4	0.26	0.21	0.27	0.27	0.29	*	1.09	0.70	0.75	0.41	0.36	*
Ref 5	0.27	0.22	0.38	0.22	0.29	*	1.22	0.68	0.96	0.30	0.36	*
Ref 6	0.25	0.25	0.53	0.27	0.24	0.30	1.20	0.63	1.01	0.32	0.31	0.35
Ice 2	0.40	0.25	0.28	0.29	0.25	*	1.23	0.77	0.76	0.40	0.32	*
Ice 4	*	0.21	0.34	0.25	0.32	0.32	*	0.70	0.81	0.32	0.38	0.37
Ice 6	0.38	0.24	0.37	0.24	0.26	0.30	1.33	0.68	0.85	0.29	0.32	0.35
Near Shore	*	*	*	*	0.32	*	*	*	*	*	0.39	*
Field Blank	-0.01	-0.02	0.00	0.04	0.02	0.03	0.00	-0.02	0.00	0.04	0.02	0.04
	MDL: 0.036 mg/L						MDL: 0.038					

	Chlorophyll-a (µg/L)						Nitrate+Nitrite (mg/L)					
Station ID	May	June	July	August	Sept	Oct	May	June	July	August	Sept	Oct
Ref 1	7.49	0.77	1.54	3.13	2.29	13.20	0.878	0.491	0.464	0.066	0.054	0.054
Ref 1-D	7.65	*	*	*	*	*	0.881	*	*	*	*	*
Ref 2	5.78	0.68	1.39	2.67	1.80	*	0.926	0.406	0.471	0.065	0.059	*
Ref 3	6.05	0.83	1.54	3.66	1.52	10.55	0.747	0.521	0.500	0.117	0.058	0.058
Ref 3-D		0.87	1.80	3.22	2.85	12.25	*	0.526	0.491	0.096	0.066	0.054
Ref 4	6.71	0.69	1.81	3.88	1.29	*	0.835	0.478	0.478	0.137	0.065	*
Ref 5	8.86	1.61	1.47	2.77	2.21	*	0.950	0.462	0.579	0.083	0.064	*
Ref 6	7.73	0.75	1.29	2.48	2.43	12.34	0.955	0.386	0.480	0.054	0.061	0.049
Ice 2	8.13	0.75	2.02	2.72	1.83	*	0.829	0.520	0.479	0.101	0.066	*
Ice 4	*	0.83	2.47	1.12	2.73	11.34	*	0.484	0.466	0.068	0.058	0.048
Ice 6	6.55	0.75	1.33	2.43	1.27	12.27	0.952	0.433	0.481	0.056	0.056	0.047
Near Shore	*	*	*	*	2.88	*	*	*	*	*	0.062	*
Field Blank	0.00	0.06	-0.05	-0.06	0.61	0.61	0.011	0.001	0.000	0.005	-0.001	0.005
	MDL: 1.00 µg/L						MDL: 0.002 mg/L					

	Total Phosphorus (µg/L)					
ID	May	June	July	August	Sept	Oct
Ref 1	13.12	12.87	4.74	6.11	4.37	22.43
Ref 1-D	11.86	*	*	*	*	*
Ref 2	14.98	5.76	5.62	6.06	4.85	*
Ref 3	10.98	4.72	5.00	4.94	4.14	20.94
Ref 3-D	*	5.19	4.99	6.13	13.09	20.91
Ref 4	10.78	12.85	6.35	5.92	5.39	*
Ref 5	13.40	12.08	6.30	5.19	5.45	*
Ref 6	12.23	8.84	5.13	9.96	12.71	19.75
Ref 2	16.01	5.03	6.35	6.64	6.64	*
Ref 4	*	7.28	4.27	6.16	9.43	19.96
Ref 6	17.35	5.54	5.64	5.84	4.26	19.85
Near Shore	*	*	*	*	4.96	*
Field Blank	-1.80	-1.24	-0.34	-2.01	-1.32	0.20
	MDL: 3.15 µg/L					
	Values lower than the method detection level					
	Detection limit = 6.2 ug/L (high hose equipment blanks)					

Table 14. 2016 water clarity and light extinction results.

2016 Water Clarity Results

	Secchi Depth (m)						PAR Extinction Coeff. (m^{-1})					
Station ID	May	June	July	August	Sept	Oct	May	June	July	August	Sept	Oct
Ref 1	1.9	7.5	7.3	6.7	4.9	3.4	-0.24	-0.1	-0.09	-0.1	-0.08	-0.21
Ref 2	2.0	8.2	7.5	4.7	5.0	*	-0.2	-0.1	-0.09	-0.11	-0.1	*
Ref 3	2.3	7.9	6.4	5.6	5.2	*	-0.19	-0.15	-0.08	-0.1	-0.1	-0.22
Ref 4	2.2	10.1	7.0	5.5	4.6	*	-0.2	-0.1	**	-0.09	-0.1	*
Ref 5	1.8	7.3	7.9	5.5	4.9	*	-0.26	**	-0.08	-0.09	-0.08	*
Ref 6	1.9	8.1	8.7	4.6	5.5	2.9	-0.22	-0.09	-0.09	-0.08	-0.1	-0.24
Ice 2	2.0	10.4	6.8	5.5	4.7	*	-0.21	-0.1	-0.09	-0.07	-0.09	*
Ice 4	*	*	6.4	5.5	5.2	3.4	*	**	-0.1	-0.08	-0.09	-0.22
Ice 6	1.8	7.2	7.9	5.9	4.9	3.0	-0.22	-0.1	-0.08	**	-0.09	-0.24
Near Shore	*	*	*	*	5.3	*	*	*	*	*	-0.11	*

Note: * denotes no data taken and ** denotes low quality PAR measurements (passing clouds)

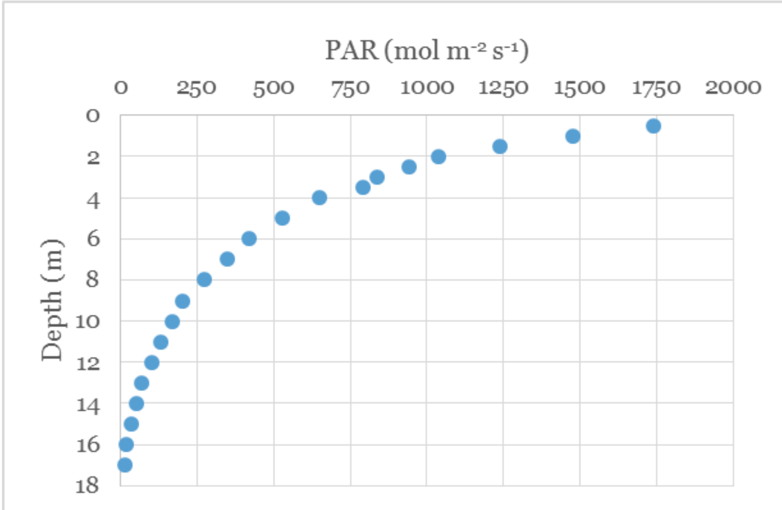


Figure 11: PAR measurements taken on 9/7/2016 at REF1.

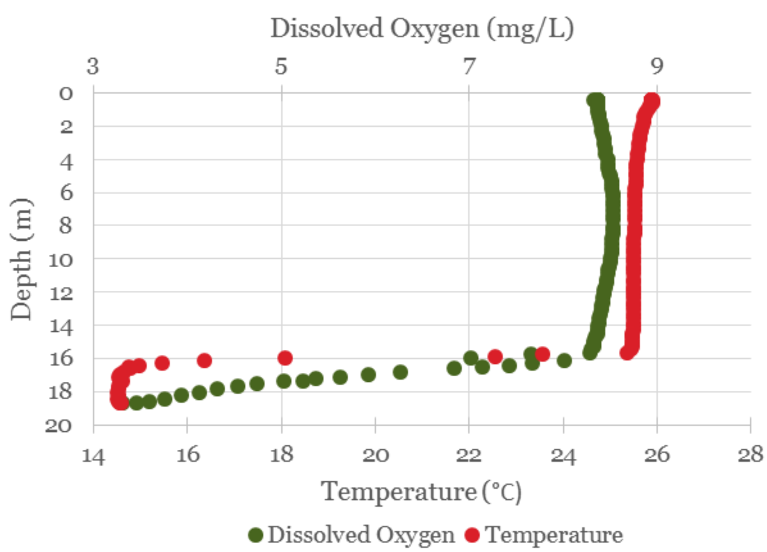


Figure 12: Water temperature and DO profile taken at REF1 on 8/17/2016.

Table 15. Total phosphorus results from the rubber and polyethylene hose and field blanks.

Equipment	TP
	ug/L
Field Blank	1.6
Field Blank	0.0
Rubber Hose	8.6
Rubber Hose	3.8
Polyethylene Hose	1.4
Polyethylene Hose	1.8
MDL	12.0

3.2.2 Water Chemistry: Continuous

A summary of the number of days when data was collected by continuous sensors is provided in Table 16 and 17. DO and temperature data were also retrieved from nearby buoys 45164 and 45176 to provide additional data from nearshore and offshore locations. Buoy 45164 was deployed ten miles northeast of the central turbine location in 70 feet of water and provided hourly water temperature from the surface to 60 feet below the surface at two meter increments. Buoy 45176 was located six miles southeast of the central turbine and measured lake bottom DO and temperature every ten minutes. PAR data are shown in Figure 12. PAR was generally similar between the two sites (ICE4 and REF1), with PAR values slightly higher at the reference site. This may be due to differences in the exact positioning of the sensor in the water column. Further analysis of this difference will continue into the 2017 monitoring year. It should also be noted that the wiper on the ICE4 PAR sensor broke and as a result PAR results at this station should not be compared with REF1. The PAR sensor wiper took six weeks to repair. For the 2016 season we will have a spare wiper on hand to avoid any future gaps in PAR data. Lake bottom DO and temperature from May 11, 2016 to October 19, 2016 are illustrated in Figure 14 and Figure 15. Bottom DO continually dropped until water became anoxic in early-August and did not permanently oxygenate until late-September. Weekly fluctuations in bottom lake temperature increased from offshore to nearshore as temperatures increased until the water column mixed down in late-September (Figure 15). Throughout 2016 surface water temperatures from nearshore to offshore had little deviation (Figure 16). Figure 17 illustrates the increase in temperature gradient from June through August as the thermocline strengthened and reached a maximum two meter temperature change of 11 °C in mid-August.

Table 16. Number of days each month data was collected by continuous sensors at REF1 and ICE4.

	Ref 1						Ice 4					
Task Description	May	June	July	August	Sept	Oct	May	June	July	August	Sept	Oct
Surface Water Temp	21	30	31	31	30	19	21	30	31	31	30	19
Bottom Water Temp	21	30	31	31	30	19	21	30	31	31	30	19
Bottom DO	0	15	31	26	30	19	21	30	31	26	30	19
PAR	21	30	31	31	10	0	21	30	31	31	30	19
Water Current	21	30	31	31	30	19	21	30	31	31	30	19
Background Noise	21	30	31	31	30	19	21	30	29	28	30	19

Table 17: Number of days each month data was collected by continuous sensors at ICE1, ICE2, ICE7.

	Ice 1				Ice 2			Ice 7			
Task Description	July	August	Sept	Oct	August	Sept	Oct	July	August	Sept	Oct
Bottom Water Temp	11	31	30	31	13	30	31	11	30	30	19
Bottom DO	11	31	30	31	13	30	31	11	30	30	19

Figure 13: 2016 photosynthetic active radiation at ICE4 and REF1.

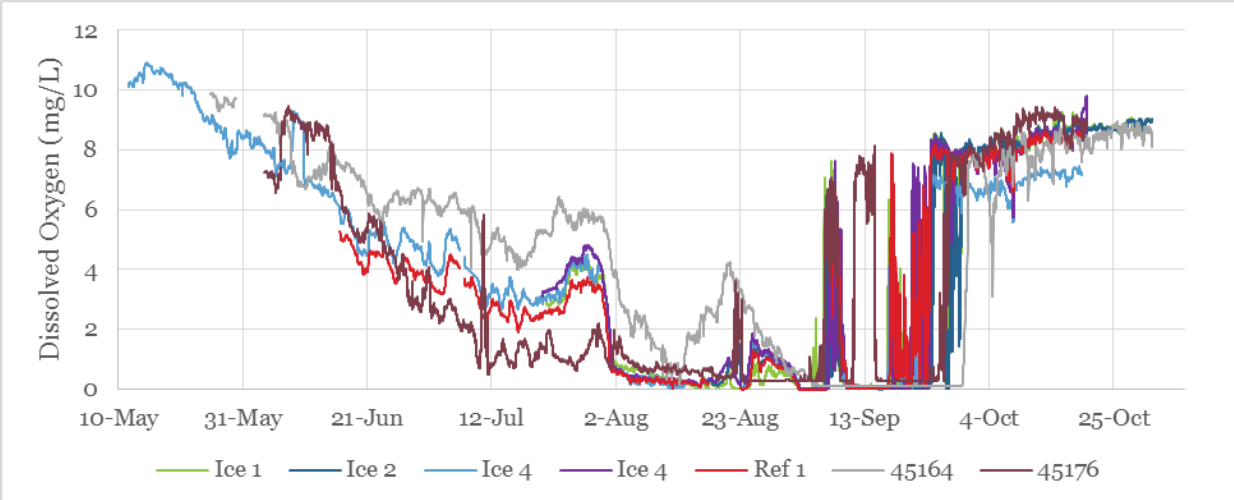


Figure 14: 2016 lake bottom DO at ICE1, ICE2, ICE4, ICE7, REF1, and buoy 45164 and 45176.

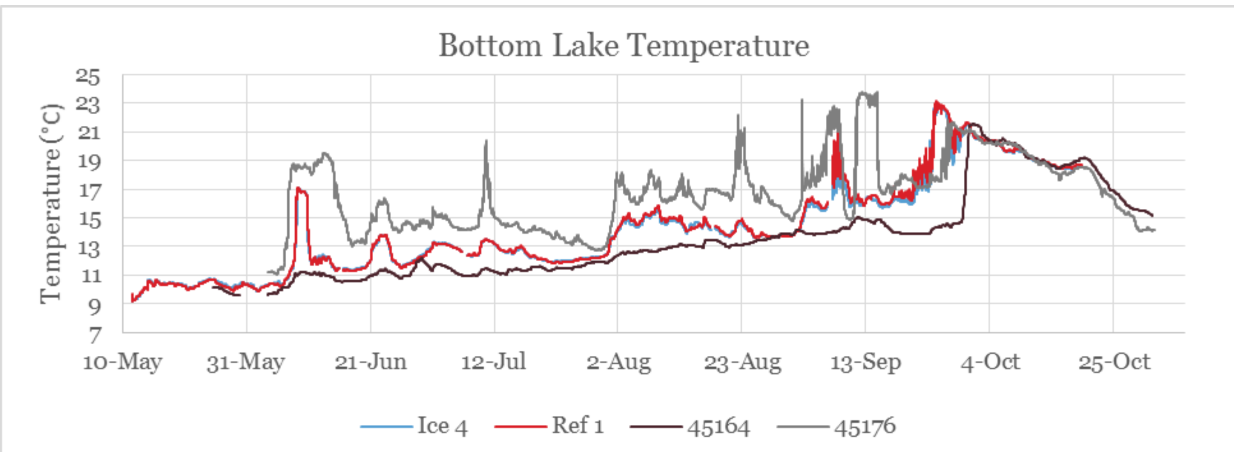


Figure 15: 2016 lake bottom temperature at ICE4, REF1, and buoys 45164 and 45176.

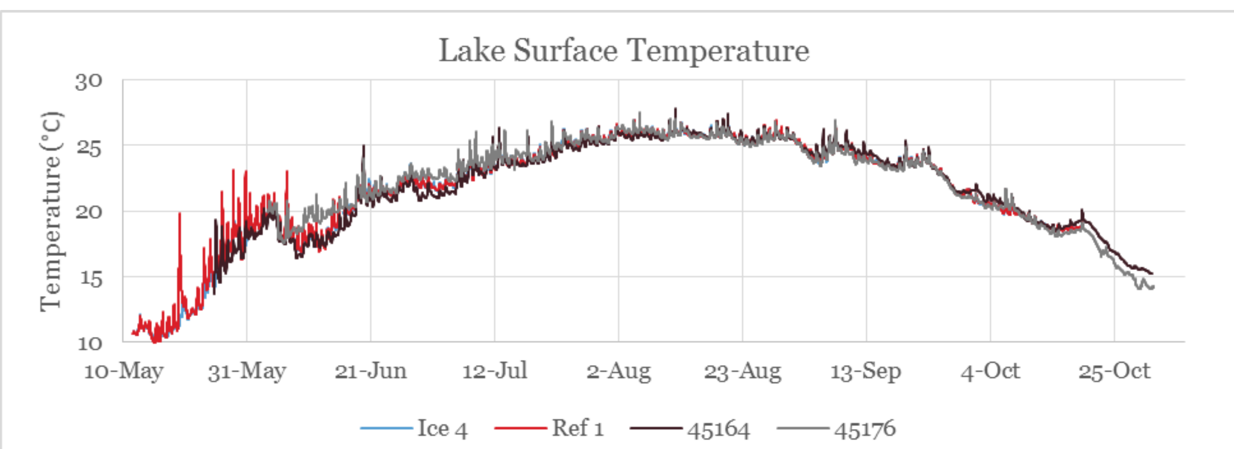


Figure 16: 2016 surface lake temperature at ICE4, REF1, and buoys 45164 and 45176.

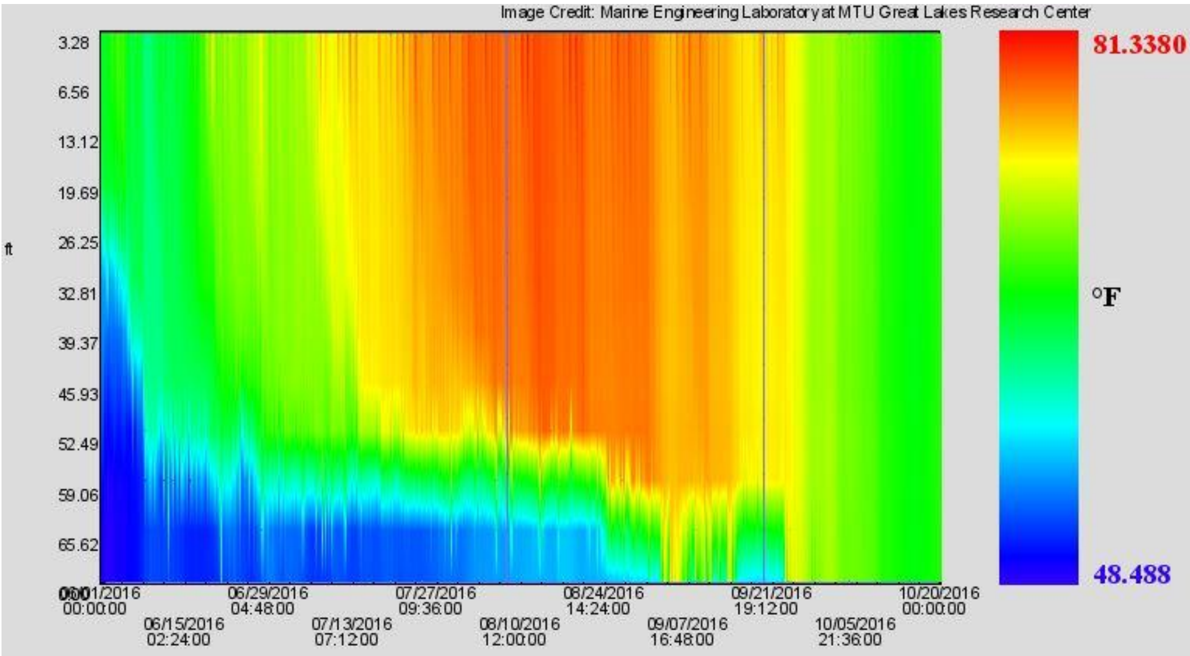


Figure 17: Buoy 45164 water temperature profile from June 1, 2016 to October 20, 2016.

3.2.3 Substrate Mapping

A complete geophysical analysis was conducted by Canadian Seabed Research in August 2016. The full results of that survey are contained in the CSR (2016) report. A snapshot of the output from the sidescan survey is shown below in Figure 18. The dark areas of the figure represent silt and clay, while the light brown areas represent sand and gravel areas. A closer look at the transition point between silt/clay and sand/gravel is shown in Figure 19 below. This figure shows a plan view of the surface sediments. The sidescan sonar data and sediment grab sample data is available upon request and is now included in the digital appendix to this report.

Figure 18. Side scan sonar mosaic of sediment type (dark brown= silt/clay, lt. brown =sand/gravel).

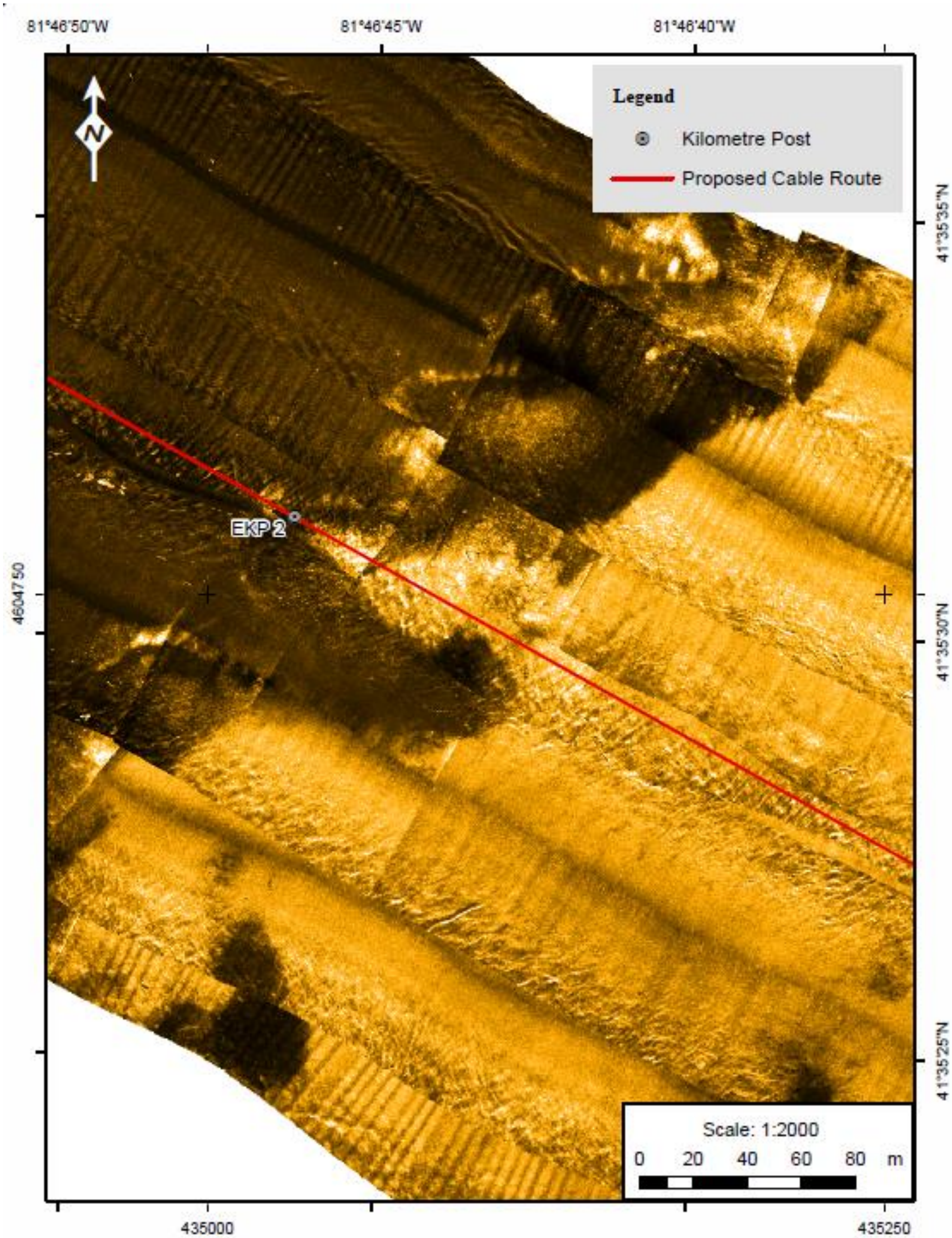


Figure 19. Sidescan sonar data illustrating the boundary between silt/clay and sand/gravel (Source: CSR, 2016 Figure 5.2.1.1)

3.2.4 Hydrodynamic

ICE4 exhibited small deviations between the top and bottom water velocity and direction throughout the year (Figure 20 and Figure 21). As summarized in Table 17, the average current velocity at the bottom of Lake Erie was 0.07-0.08 m/s while the surface was only slightly faster at 0.09 m/s. The average significant wave height and mean wave period for 2016 was 0.43 meters and 2.5 seconds. Winter data will be retrieved during the first field visit in April 2017.

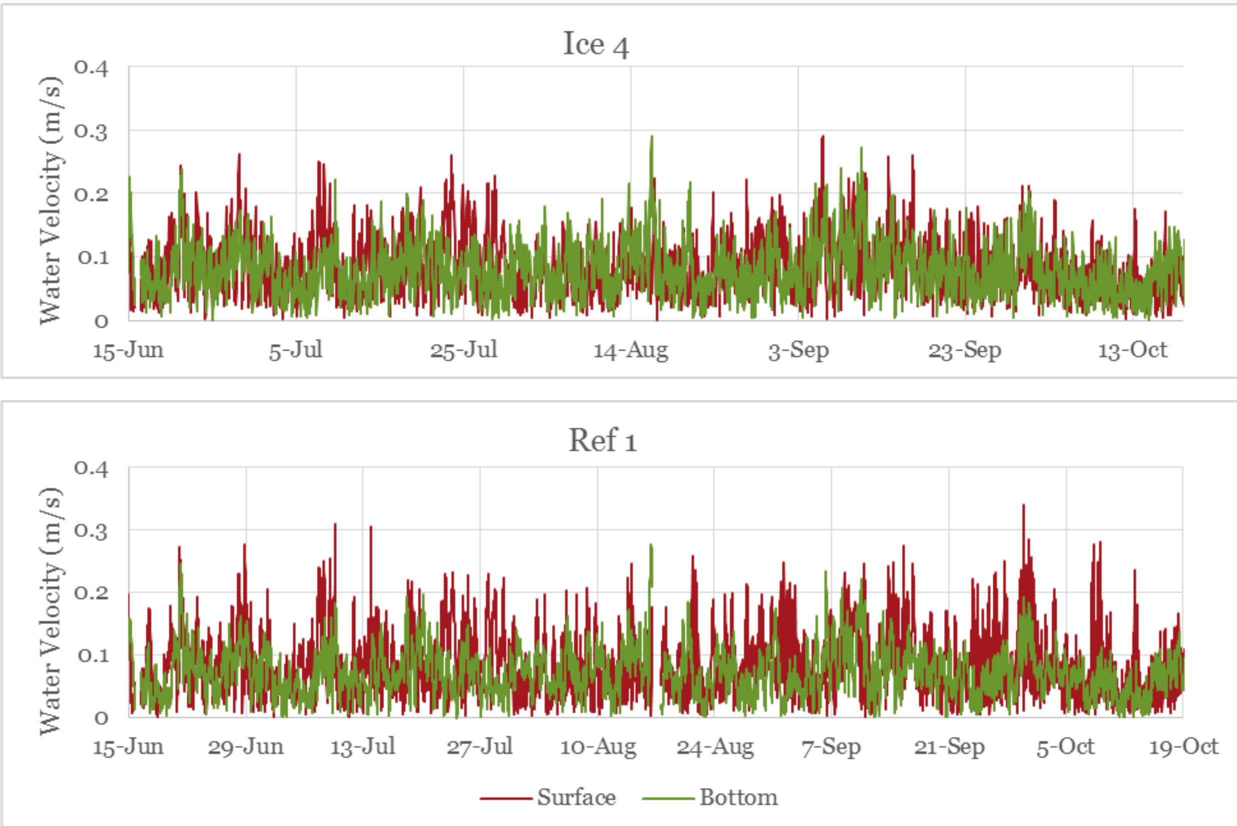


Figure 20: 2016 lake surface and bottom water velocity at ICE4 and REF1.

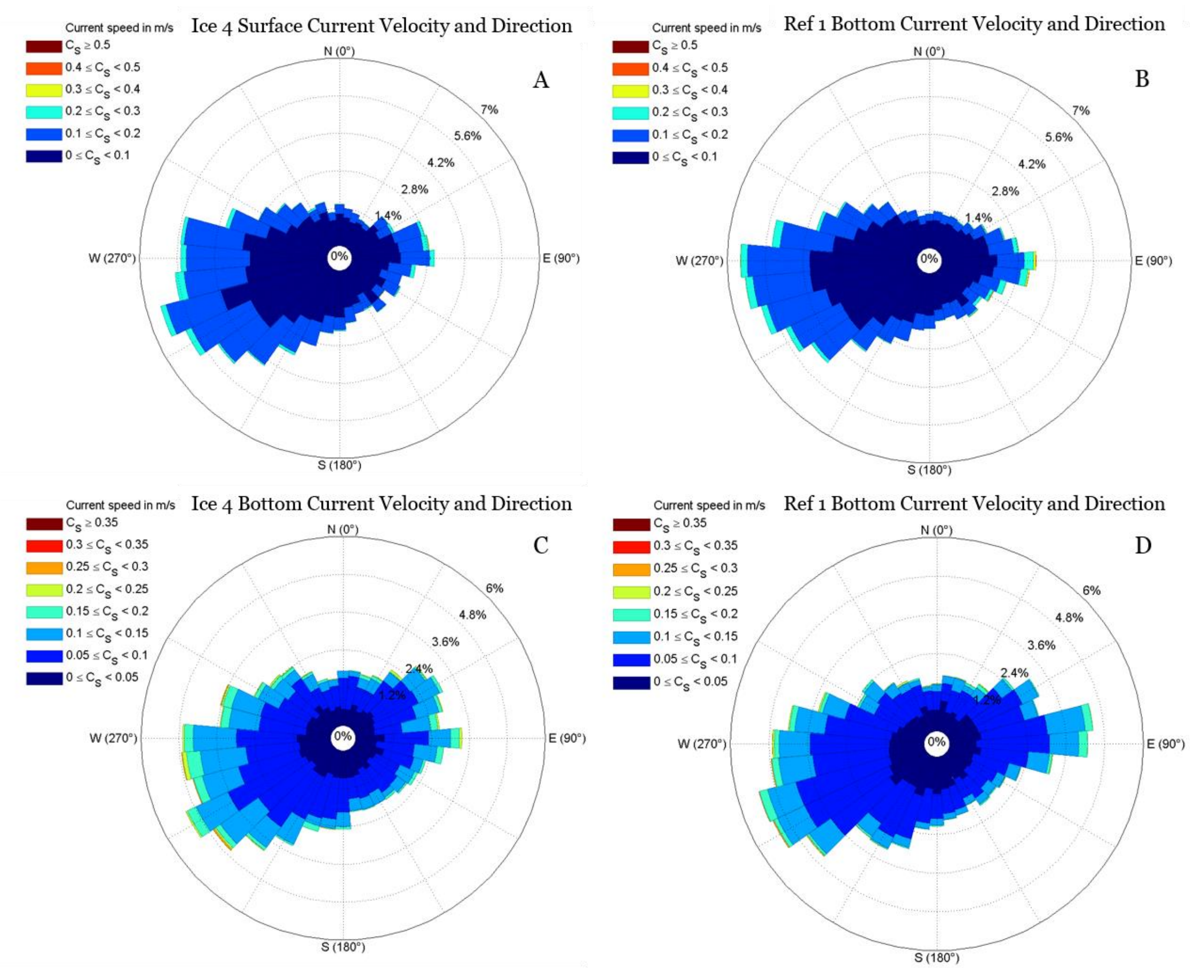


Figure 21: 2016 lake surface and bottom current velocity and direction at ICE4 (A, C) and REF1 (B, D). Spokes represent the frequency of currents moving towards a particular direction.

Table 18: 2016 average and maximum current velocity, wave height, and period at ICE4 and REF1.

	Current Velocity (m/s)				Wave Height (m)		Period (sec)	
	Bottom		Surface					
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
Ice 4	0.078	0.291	0.089	0.384	0.43	2.43	2.48	6.1
Ref 1	0.070	0.277	0.088	0.484	*	*	*	*

Note: * denotes no data taken

3.3 Fish Behavior

3.3.1 Acoustic Telemetry

The results of the range test are summarized in Figure 22, which indicate a greater than 80 detection rate up to our maximum tested distance, which was 1,200 meters away from the transmitter test tag. The detection percent was very high along the entire receiver test array. In addition, during the 8 hour range test, the test receivers picked up two tagged Walleye that were within range and later we discovered these fish were released from Sandusky Bay as part of an ODNR project. A third fish tag was also picked up, but its ID was unavailable in the GLATOS database. The receivers were put out on the final field day of the year. Data will be retrieved during the 2017 field season.

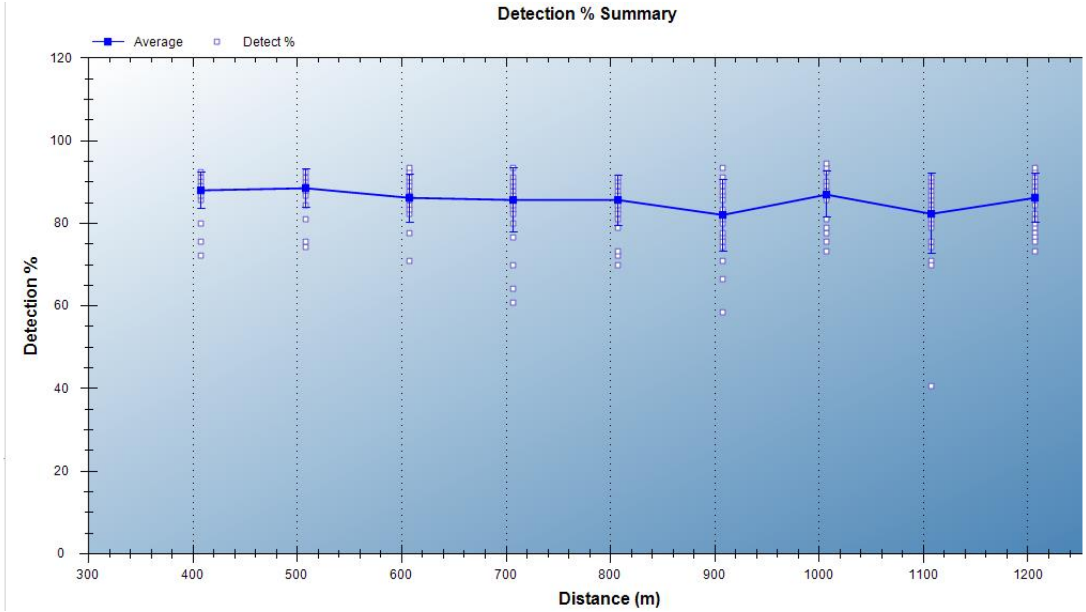


Figure 22. Summary of the detection results from the 8 hour range testing event.

3.3.2 Fixed Acoustics

Overall, the densities were similar between the two fixed locations, which included one at the project location and one to serve as a reference. Although the two locations were similar within months, there was a significant difference in total density across months. The results from the fixed hydroacoustic surveys are summarized in Figure 23.

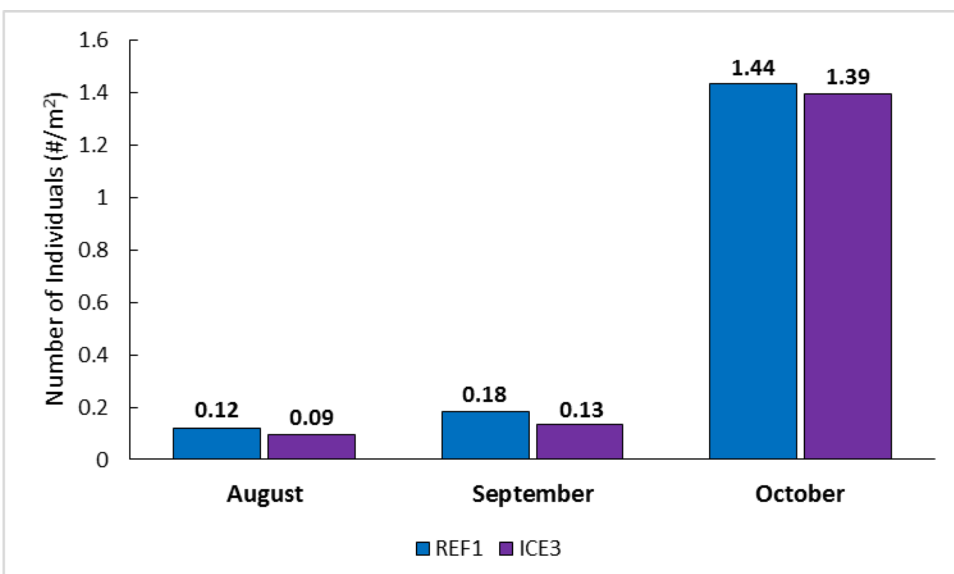


Figure 23. Summary of the average total fish densities, (individuals (#) per m²) for the fixed acoustics.

Similar to the mobile acoustics (Section 3.1.1), fish density was considerably lower in August and September compared to the October fish density. As mentioned in Section 3.1.1, this trend is consistent with the lack of fish observed in the August juvenile trawls and follows the depletion in dissolved oxygen.

3.3.3 Noise Production

The underwater sound data recorded at ICE4 and REF1 was analyzed by Aaron Rice at Cornell University. Relatively high levels of transient noise were observed throughout the entire study period. These are likely associated with passing ships or sporadic biological activity. ICE4 exhibited higher overall sound levels compared to REF1 (Figure 26). Background noise, both abiotic and anthropogenic, was detected and varied in intensity and duration, across the entire survey. Examination of long term spectral averages (LTSAs) spanning the entire survey period shows that REF1 and ICE4 recording locations exhibit a considerable amount of diversity in their respective acoustic environments (Figure 24 and Figure 25). Monthly LTSAs allow individual events to be examined in finer detail (Appendix C) where in many cases it can be concluded that intermittent broadband noise (appearing as short- and medium-duration vertical bands) is the result of passing ships and weather events. Weather events are typically multiple-hour long events and consistent across multiple sites, while ship noise is generally shorter in duration and not uniform across recording locations.

In 2014 Cornell University also deployed hydrophones east and west of the proposed turbine locations near Fairport and Sandusky, Ohio (Figure 27). The Fairport survey was conducted in ODNR's Walleye/Perch Habitat and within a Walleye Larval and Juvenile Production Area off of Sandusky. At both locations in June Cornell recorded seasonal chorusing events of freshwater drum (*Aplodinotus grunniens*) that were not seen in REF1 or ICE4 data, that are located in the Dead Zone and less than a mile from a Walleye/Perch Habitat.

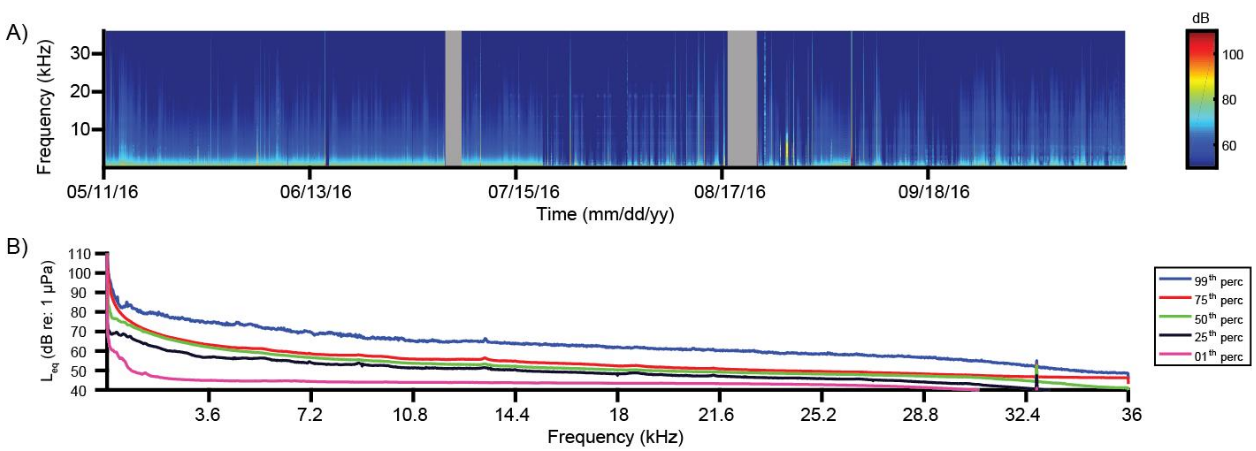


Figure 24: A) Long-term spectral average and B) statistical distribution of power spectra (in L_{eq}) at ICE4 from May 11 through October 19, 2016 for the entire available frequency bandwidth of 0-36 kHz. Spectrogram was created with FFT=512 points and 1 hour integration time. Grey boxes show periods of time with missing data.

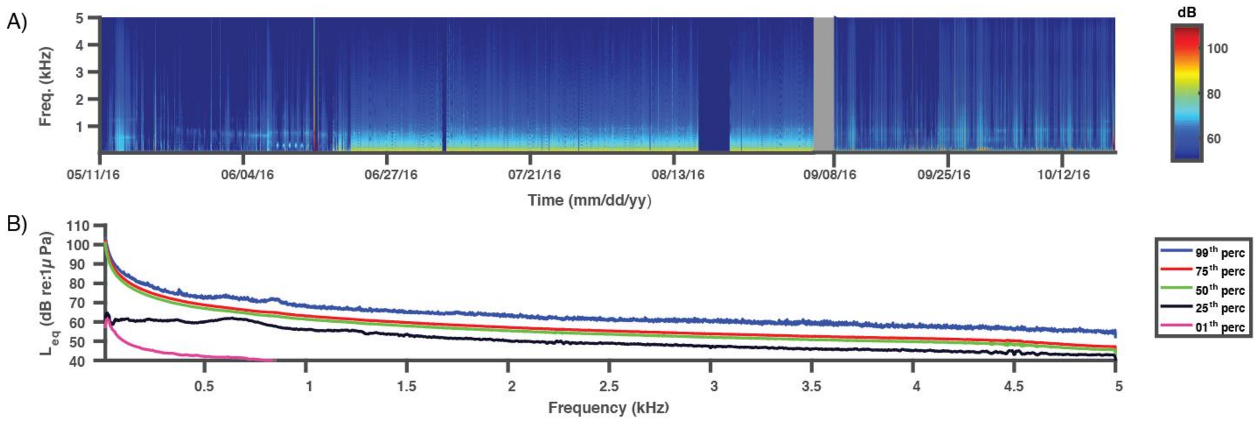


Figure 25: A) Long-term spectral average and B) statistical distribution of power spectra (in Leq) at REF1 from May 11 through October 19, 2016 between 0-5 kHz. Spectrogram was created with FFT=512 points and 1 hour integration time. Grey boxes show periods of time with missing data.

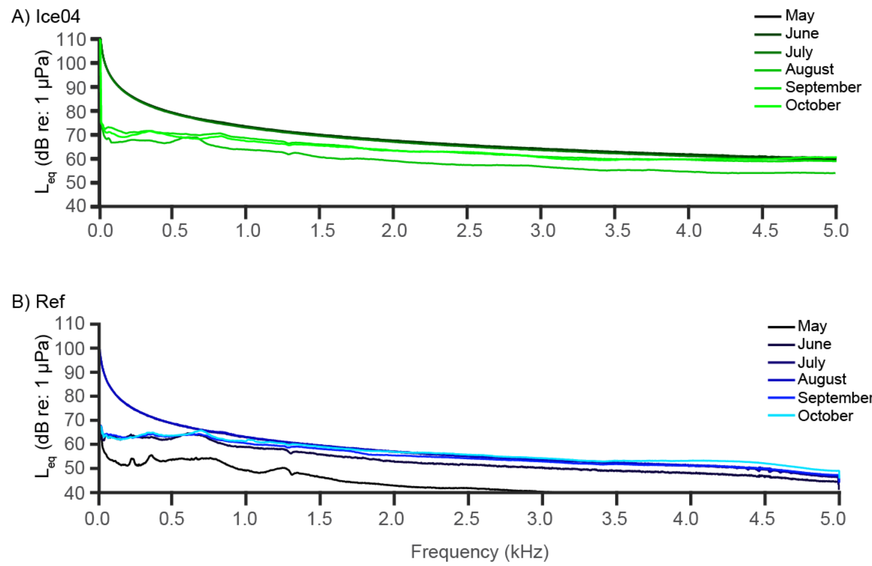


Figure 26: Monthly median power spectral density at A) ICE4 and B) REF1.

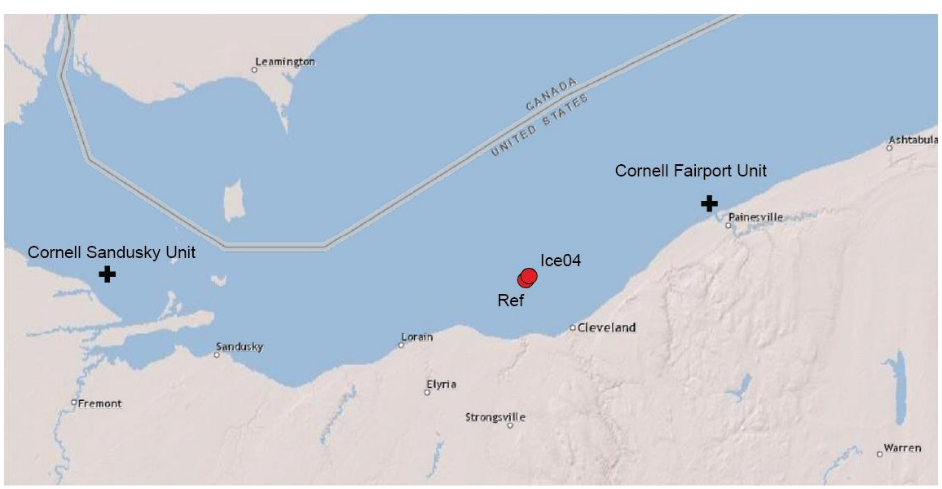


Figure 27: Recording locations of 2016 Ice04 and Ref locations (red circles), relative to previous Cornell acoustic recordings in 2014 (black crosses).

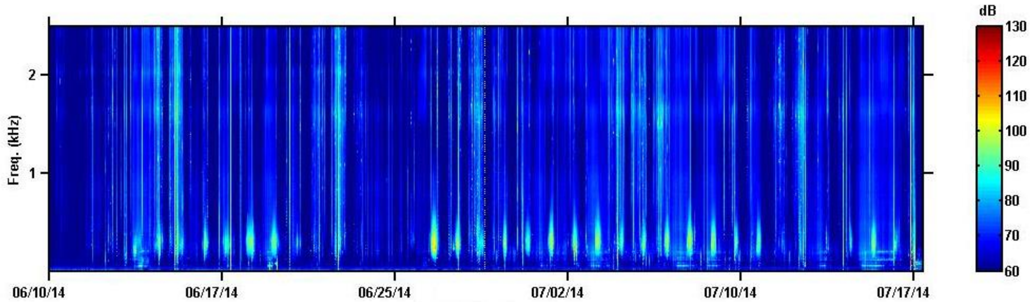


Figure 28: Long-term spectrogram from June 10-July 14, 2014 at recording unit deployed in Lake Erie near Fairport, OH. The freshwater drum nocturnal chorus from is visible between approximately 100-400 Hz.

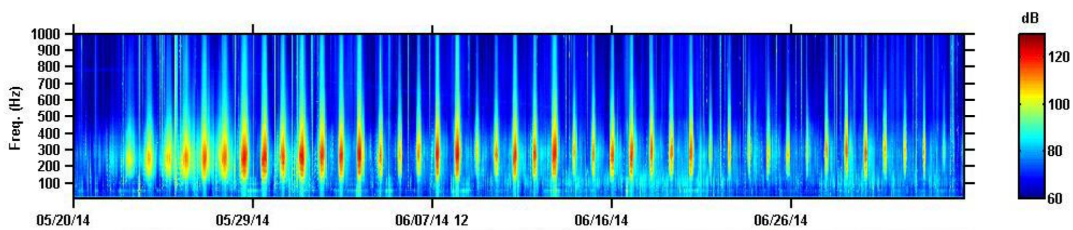


Figure 29: Long-term spectrogram from May 20-July 4, 2014 at recording unit deployed in Lake Erie near Sandusky, OH. The freshwater drum nocturnal chorus from is visible between approximately 100-400 Hz.

3.3.4 Aerial Surveys of Boating

Results from all of the boat surveys by 5-minute survey block are summarized in Table 19 below. Data from the aerial survey shows that boating activity and recreational fishing effort occurs closer to shore than is depicted in the ODNR developed sport fishery maps shown in Figure 30. Each 5-minute survey block has an ID and the numeric part of the ID (911 and 912) corresponds to the 10-minute size survey blocks that are used by ODNR to conduct boating surveys in Lake Erie. On July 3, 2016 only 6 out of 188 boats (~3%) counted that day were in the 5-minute block covering the project area. Across all dates only 2% of the boats counted were found within the 5-minute block covering the project area. This data shows that boating activity and recreational fishing effort occurs closer to shore and well away from the project site.

Table 19. Summary of all offshore boat counts from 2016 plane flyovers.

Date	911-NW	911-NE	912-NW	912-NE	911-SW	911-SE	912-SW	Total
5/20/2016	1	0	0	0	2	2	1	6
5/22/2016	0	3	1	3	7	5	3	22
6/5/2016	0	19	16	15	32	16	14	112
6/6/2016	0	0	0	0	4	1	0	5
6/30/2016	3	0	6	17	13	12	13	64
7/3/2016	6	27	35	20	38	53	9	188
8/28/2016	3	1	4	9	37	50	12	116
8/29/2016	1	0	1	2	4	1	2	11
9/18/2016	1	1	6	5	14	2	13	42
9/21/2016	2	4	1	6	12	14	10	49
10/15/2016	1	1	33	44	64	23	68	234
10/24/2016	0	0	0	0	0	0	0	0
Total	18	56	103	121	227	179	145	849
% of Total	2	7	12	14	27	21	17	100

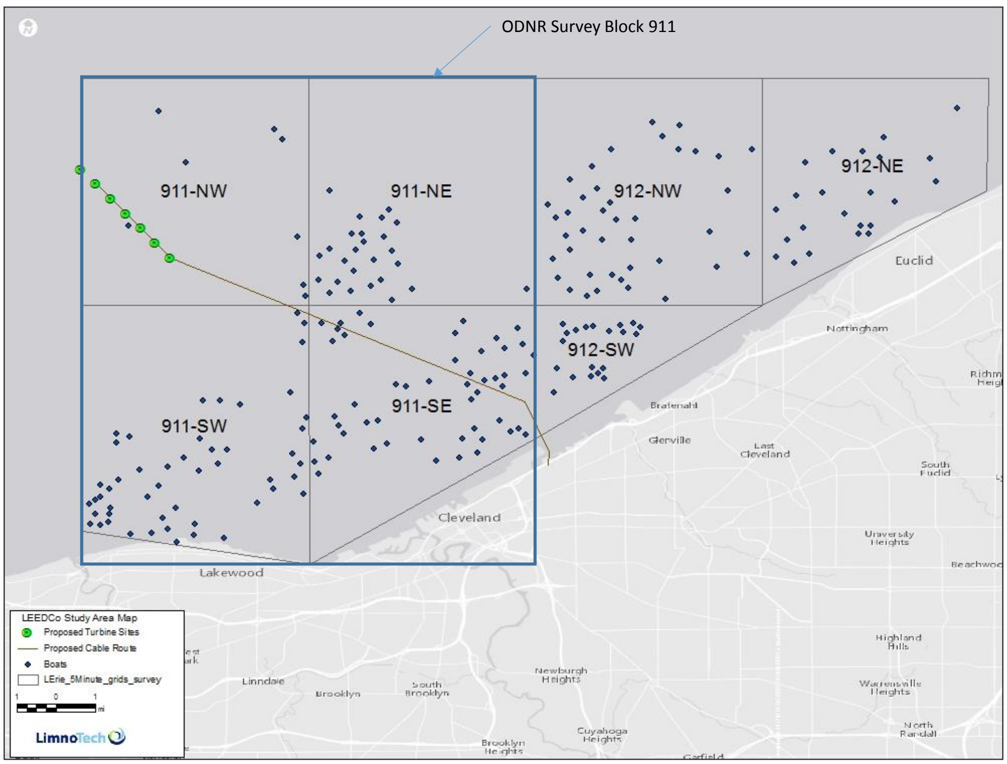


Figure 30. Map of recreational boats (dots) as counted by plane and turbine location (green dots) on July 3, 2016.

3.4 Other Activities

This section summarizes the results and conclusions from two memoranda that were created during the project as well as the outcome of a site characterization and impact assessment report.

3.4.1 Electromagnetic Field Review

The primary concern with submarine cables is the magnetic field that develops around the cable. A magnetic field cannot be contained by the cable shielding and can travel through sediment and water, to some degree. However, studies conducted on magnetic fields created by submarine transmission lines indicate that the magnetic fields are similar to background levels and decrease exponentially with distance from the transmission line. A comparison of EMF studies at existing buried cable installations found that the maximum magnetic field at the seabed was estimated to be 18 micro tesla units (µT). The average estimated magnetic field at the seabed for all 10 projects evaluated was found to be 7.8 µT, well below the level of the naturally occurring earth magnetic field, which is around 50 µT. Using available specifications for the cable and voltage for Icebreaker Wind, the estimated magnetic field at one meter from the cable is approximately 2 µT. The only known species that is sensitive to EMF is lake sturgeon, which has been shown to have a threshold effects level of 1000 µT. Figure 31 below shows the results of EMF projects, the estimate for the Icebreaker Wind project as well as background levels relative to the effects threshold.

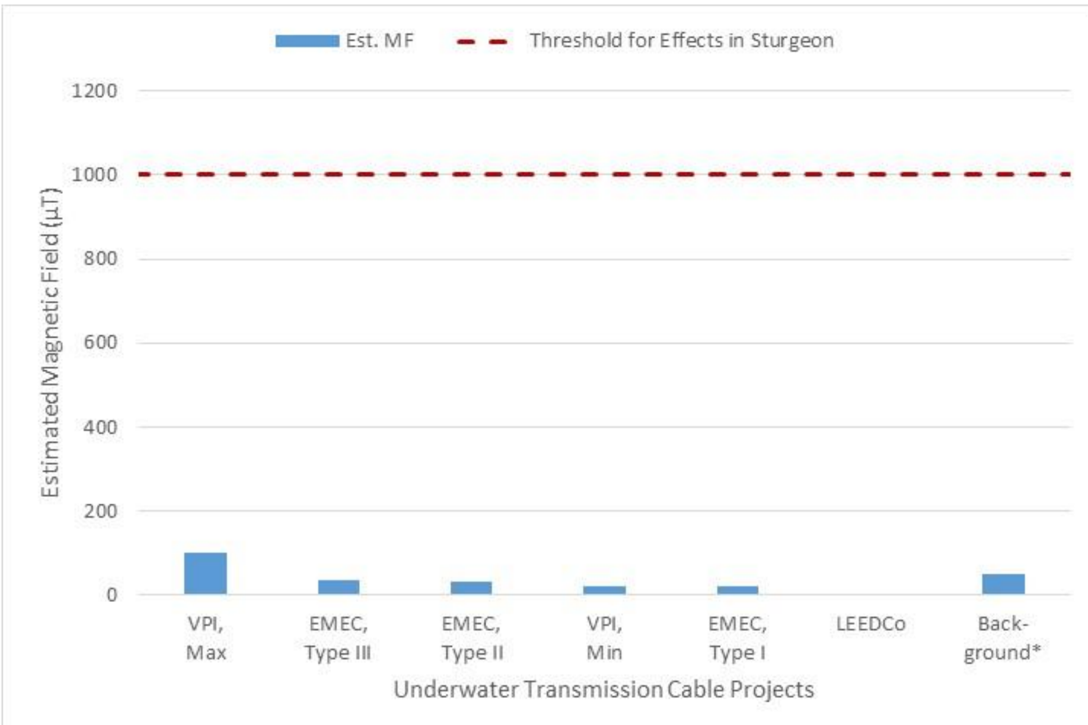


Figure 31. EMF levels (at 1 m above buried cables) for various transmission lines and LEEDCo estimate versus Sturgeon effects level.

California Power Cable Observation Study

A study released in June 2016 by the U.S. Department of the Interior, Bureau of Ocean Energy Management, summarized research from 2012 to 2014, which investigated the potential behavior and reaction of electromagnetic-sensitive species to energized and unenergized cables in a corridor on the seafloor in an offshore area of Southern California (Love et al., 2016). All of the cables in the Love et al. study are very similar to the Icebreaker Wind proposed cable (35kV AC cable with similar power loads) except the cables were not buried below the sediment surface (as will be the case for the Icebreaker Wind electric transmission cables). Over the course of the study, average EMF levels were between 73 µT and 91.4 µT, at the sediment surface which are significantly higher than the Icebreaker Wind estimated EMF levels (of no more than 2 µT one meter above the buried cable). The study did not find any biologically significant differences among fish and invertebrate communities between energized cables, pipe, and natural habitat. The authors noted there was not any compelling evidence that the EMF produced by the energized power cables in this study were either attracting or repelling fishes. The Love et al. study also corroborated the findings of previous studies which determined that EMF strength dissipates with distance from the transmission cable and approaches background levels at approximately one meter from the cable. Furthermore, Love et al. concluded that, "[i]n this and similar cases, cable burial at sufficient depth would be an adequate tool to prevent EMF emissions from being present at the seafloor." The Icebreaker Wind cables will be buried below the lakebed, more than enough to prevent EMF emissions from being present at the sediment water interface.

Lake Ontario Magnetic Field Study

A recent study conducted within the Great Lakes to monitor for the potential impacts of magnetic fields on fish, Dunlop (2016), concluded "…no detectable effects of the cable on the fish community were found. Local habitat variables, including substrate or depth, were more important in explaining variation in fish density than proximity to the cable". This project monitored the Wolfe Island wind power project which has a 7.8 km buried transmission line running from an island offshore to the mainland. The transmission line carries up to 200 MW of power at a maximum of 170kV, which is much larger than the Icebreaker Wind proposed transmission line voltage and power. The study involved nearshore electrofishing surveys and acoustic surveys paired with gill netting. Only minor differences between fish communities in transects near the cable and reference transects were detected by the survey. In the acoustic surveys, researchers did not see significant changes in fish density related to transmission cable proximity either.

Lake Erie Connector Project

The most relevant and nearby project is the ITC Lake Erie Connector project, which is a proposed 1,000 MW, 320 kV, DC transmission cable to link the Ontario Independent Electric System Operator (IESO) with the Pennsylvania PJM Interconnection (PJM). This cable would carry significantly more power compared with the Icebreaker Wind proposed transmission cable. More information on the project can be found at http://www.itclakeerieconnector.com/. Although this project does not enter Ohio waters, it is going through a similar permitting process with the Province of Ontario, State of Pennsylvania, US Department of Energy, Canada's National Energy Board, and US Army Corps of Engineers. The cable will span the entire width of Lake Erie and will cross both nearshore and offshore fish habitat areas. Based on personal conversations, we learned that to date, none of the relevant permitting agencies involved have focused on magnetic field concerns. ITC Holdings, LLC, the project owner, reviewed the relevant magnetic field concerns early on in the project and found no significant impacts were expected. Per conversations with project staff, impact concerns have centered on construction methods and shoreline directional drilling rather than magnetic field concerns. These concerns are being reviewed in Icebreaker Wind's permit applications to the Ohio Power Siting Board and U.S. Army Corps of Engineers, as well as in the Environmental Assessment being prepared for the U.S. Department of Energy's NEPA process.

Based on the expected low EMF levels to be generated by Icebreaker Wind and the current research regarding EMF impacts on fish behavior and habitat, including some studies that have been completed in the Great Lakes or on Great Lakes species of concern, it is our assessment that additional review or studies of potential EMF impacts from the planned electric cable are not necessary and will divert limited resources away from more productive areas of inquiry and research, as LimnoTech is confident that EMF generated by the electric transmission cable will not have an adverse impact on fish behavior and habitat.

3.4.2 Marina Boat Counts

A total of 6,057 boat slips were inventoried across the 16 marina areas. A summary of each of the 16 marina areas is shown in Data from this study helps to document the approximate pool of total boaters in this portion of Lake Erie and can be used to document any long term changes to boat ownership in the

Cleveland area. Data from the sailboat counts and mast height estimates can be used to support US Coast Guard and other related permits.

Table 20. A summary of boat lengths for all of the marina areas is shown in Table 21. For sail boats, an estimate of the mast height above the water was generated by looking up sail boat specifications common to sailboats in each sailboat range on http://sailboatdata.com. Catalina brand sailboats were used for lengths up to 36 feet and Oceanis brand sailboats were used for sailboats longer than 36 feet. Data from this study helps to document the approximate pool of total boaters in this portion of Lake Erie and can be used to document any long term changes to boat ownership in the Cleveland area. Data from the sailboat counts and mast height estimates can be used to support US Coast Guard and other related permits.

Table 20. Summary of boat slips and type by marina area.

Cty.	Marina	Empty	Powerboat	Sailboat	Total
Cuyahoga	Bicentennial Park	46	1	0	47
	East 55th ST	42	260	60	362
	Edgewater	133	235	254	622
	Euclid Creek	46	50	5	101
	Forest City YC	18	75	36	129
	Intercity YC	61	39	0	100
	Lakeside YC	67	127	42	236
	Northeast YC	50	85	17	152
	Olde River YC	82	170	3	255
	Rocky River	84	378	96	558
	Shoreby	50	59	6	115
	Whiskey Island	76	157	27	260
	Sub-Total	**755**	**1636**	**546**	**2937**
Lake	Fairport	270	449	92	811
	Mentor	277	448	52	777
	Sub-Total	**547**	**897**	**144**	**1588**
Lorain	Beaver Park	227	399	7	633
	Lorain	464	320	115	899
	Sub-Total	**691**	**719**	**122**	**1532**
Total		**1993**	**3252**	**812**	**6057**

Table 21. Summary of boat lengths and estimated mast heights above water.

Percentile of boats counted	Power Boat Length (feet)	Sailboats		
		Length (feet)	# of boats > or =	Min. Mast Height (feet)
25%	23	26	586	41
50%	27	29	396	45
75%	31	33	191	48
90%	36	36	74	50
95%	39	38	47	54

97%	42	40	20	58
99%	48	45	8	65

3.4.3 Impact Assessment

A review of the available information from federal, state, universities, and site specific data collected as part of the project concludes that Icebreaker Wind poses minimal risk to the aquatic ecological resources of Lake Erie. This conclusion was based on the following major assessment outcomes:

Aquatic habitat alteration

- The chosen project site is far from ODNR identified fish spawning or larval nursery areas, reefs, or shoals that offer enhanced fish habitat. ODNR identifies the turbine area as very favorable for development based on aquatic habitat. Data collected in 2016 at the site verify this assessment.
- Dissolved oxygen (DO) data collected in 2016 show the proposed turbine sites were all within the Lake Erie Dead Zone and therefore offer poorer habitat for fish and macroinvertebrates.
- Fish trawl and acoustic sonar survey data from 2016 show the turbine area has significantly lower numbers of fish in the summer and early fall months compared with other months due to the presence of hypoxic waters.
- The area impacted by the 17 meter diameter turbine foundations is 0.05 acres per turbine and 0.3 acres total. Spacing between turbines is approximately 0.5 mi. Therefore the footprint of the foundations represents an insignificant loss of habitat.

Sediment disturbance

- Construction related sediment resuspension and enhanced turbidity near the turbines is mitigated by the chosen mono bucket foundation, which has minimal and only temporary impact on surrounding sediments during installation.
- In the case of the foundation, most of the sediment will settle on the bucket lid, which will be in the same vicinity it was prior to the installation. In the case of the cable it will settle back to its original location. In neither case will settling of the sediment result in an addition of material to the area of these activities, so it is not properly considered a discharge. Nor is there any purposeful relocation of the sediment. Its settlement back into the areas from which it originated is incidental to these activities.
- Degradation of habitat by sediment resuspension during electric cable installation is expected to only last several hours and have a limited spatial extend beyond the point of installation. This is based on a review of sediment transport results from a similar project in Lake Erie with similar sediment type and ambient lake velocity.

Noise

- Icebreaker Windpower has chosen a mono bucket foundation, which eliminates the need for pile driving and significantly reduces potential construction related noise at the site.
- Construction related impacts due to increased noise levels at the site are temporary and similar to noise levels experienced consistently in the region by up to 1,000 passing lake freighters going in and out of the Port of Cleveland on an annual basis. Low levels of noise emitted by the turbines during operation do not transmit any significant distance. In addition, there are often less receptors (fish) within the region due to the hypoxia mentioned earlier.

Fish movement/behavior

- As cited previously, Icebreaker Wind is sited in a location with poor fish habitat as identified by ODNR to minimize any existing fish behavior changes.
- The mono bucket foundations chosen for Icebreaker Wind minimize sediment disturbance during installation and cover a limited area as cited above.
- A review of electromagnetic field (EMF) impacts on fish found that expected EMF levels at the sediment surface for Icebreaker Wind are well below background levels and below all threshold impact levels from existing EMF studies. The project's electrical transmission cables will be buried below the sediment surface to minimize or eliminate any electromagnetic impacts on fish in the water column.
- In 2016 Icebreaker Windpower monitored the location of boats offshore of Cleveland to ensure the chosen project site was not a frequent fishing or boating destination. The study found that only 2% of the boats counted in all of the surveys were within three miles of the project site.

Physical lake conditions

- The project is utilizing a circular foundation base that minimizes potential impacts to currents and sediment scour. The circular shape of the foundation and monopole minimizes eddy formation and allows currents to easily travel past the turbines with minimal interruption and disturbance. Each turbine base has a foundation diameter of 17 meters and a combined footprint from all six turbines of 0.3 acres.
- Installation of the buried electric cables will follow a jet plow installation method, which represents the industry standard for minimal impact to the surrounding area during installation compared with open trench cable laying. As cited previously, suspended sediments are expected to follow a similar fate as those of the ITC Connector Lake Erie project, which were estimated to remain suspended for several hours and travel less than a few hundred meters.

4
Conclusion

The 2016 sampling program kicked off the first year of data collection to support the characterization of the aquatic and biological environment at the proposed site of the nation's first freshwater offshore wind farm near Cleveland, OH in Lake Erie. The first year of sampling did not reveal any unusual site conditions that differ significantly from pre-existing understanding of the aquatic and biological make-up of this portion of Lake Erie. Observed trends in lake currents, temperature, dissolved oxygen, nutrients, water clarity, water quality conditions, sediments, benthic macroinvertebrates, phytoplankton, zooplankton, and larval and juvenile fish were all within ranges observed by others for this area of Lake Erie. Seasonal patterns were evident in almost every physical and biological parameter measured during the 2016 field season. The data presented in this report do provide fine scale and exact specificity to the range of values observed at the project site in 2016. These data can serve to represent baseline conditions that existed at these sites prior to the initiation of any construction activities. Later comparisons can be made between the data collected in 2016 with data collected during and after installation of wind turbines.

2017 Sampling Recommendations

The current permitting/construction/sampling plan proposes that additional pre-construction sampling continue into 2017 to collect a second year of data prior to the proposed 2018 construction activities. At this time LimnoTech recommends that all of the current sampling methods continue into 2017. The scope and range of the 2016 field program captured the physical, chemical/nutrient, and biological components of the lake well. However, LimnoTech recommends a reduction in the frequency of monthly sampling for water quality, phytoplankton, zooplankton, and fixed and mobile acoustics. The 2016 sampling was conducted monthly in May, June, July, August, September, and October. Specifically, we recommend eliminating sampling for the previously mentioned parameters for the months of June and August. Data collected in these months add little value to the annual dataset and merely show the seasonal gradients between May and July and July and September. Continuous data will still be collected at the project site during every month.

5
References

CSR, 2016. Icebreaker Offshore Wind Demonstration Project: 2016 Marine Geophysical Survey Results. Prepared by Canadian Seabed Research, Ltd. Submited to: Lake Erie Energy Development Corporation. Cleveland, OH. November 25, 2016.

Dugan, P. J., D. W. Ponirakis, J. A. Zollweg, M. S. Pitzrick, J. L. Morano, A. M. Warde, A. N. Rice, C. W. Clark, and S. M. Van Parijs. 2011. SEDNA – bioacoustic analysis toolbox. IEEE OCEANS 2011:1-10.

Dunlop, E. S., S. M. Reid, and M. Murrant. 2016. "Limited Influence of a Wind Power Project Submarine Cable on a Laurentian Great Lakes Fish Community." *Journal of Applied Ichthyology* 32 (1): 18–31. doi:10.1111/jai.12940.

Estabrook, B. J., D. Ponirakis, C. W. Clark, and A. N. Rice. 2016. Widespread spatial and temporal extent of anthropogenic noise across the Northeastern Gulf of Mexico shelf ecosystem. Endangered Species Research 30:267-282.

LimnoTech, 2016a. Memorandum: Summary of Current Information Related to Electromagnetic Field Impacts on Fish and LEEDCo Proposed Transmission Cable. June 29, 2016. Prepared for LEEDCo. Prepared by LimnoTech. Ann Arbor, MI.

LimnoTech, 2016b. Memorandum: Recreational Boat Slip Assessment for Cleveland Area Marinas. September 26, 2016. Prepared for LEEDCo. Prepared by LimnoTech. Ann Arbor, MI.

LimnoTech, 2017a. Aquatic Ecological Resource Characterization and Impact Assessment. January 24, 2017. Prepared for Icebreaker Windpower, Inc. Prepared by LimnoTech. Ann Arbor, MI.

LimnoTech, 2017b. Lake Erie Monitoring Plan for Offshore Wind Project: Icebreaker Wind. January 25, 2017. Prepared for Icebreaker Windpower, Inc. Prepared by LimnoTech. Ann Arbor, MI.

Love, M. S., M. M. Nishimoto, S. Clark, and A. S. Bull. 2016. Renewable Energy in situ Power Cable Observation. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study 2016-008. 86 pp. www.lovelab.id.ucsb.edu.

ODNR, 2013. Aquatic Sampling Protocols for Offshore Wind Development for the Purpose of Securing Submerged Land Leases. Ohio Department of Natural Resources. Revision 1.

Parker-Stetter, S. L., L. G. Rudstam, P. J. Sullivan and D. M. Warner. 2009. Standard operating procedures for fisheries acoustic surveys in the Great Lakes. Great Lakes Fish. Comm. Spec. Pub. 09-01.

Sueur, J., A. Gasc, P. Grandcolas, and S. Pavoine. 2012. Global estimation of animal diversity using automatic acoustic sensors. Pages 101–119 in Sensors for Ecology: Towards Integrated Knowledge of Ecosystems (J. F. Le Galliard, J. M. Guarini, and F. Gaill, eds.). CNRS, Paris.

Thomisch, K., O. Boebel, D. P. Zitterbart, F. Samaran, S. Van Parijs, and I. Van Opzeeland. 2015. Effects of subsampling of passive acoustic recordings on acoustic metrics. Journal of the Acoustical Society of America 138:267-278.

Wiggins, S. M., M. A. Roch, and J. A. Hildebrand. 2010. TRITON software package: Analyzing large passive acoustic monitoring data sets using MATLAB. Journal of the Acoustical Society of America 128:2299.

6 Appendices

Appendix A – Electronic Copy of Field Data

This appendix will be included on a thumb drive that will be delivered to ODNR and USFWS in March 2017. Additional copies can be obtained by emailing everhamme@limno.com directly.

Appendix B – Field Notes, Chain of Custodies, and Field Photos

This appendix will be transmitted to ODNR and USFWS separately in March 2017. Additional copies can be obtained by emailing everhamme@limno.com directly.

Appendix C – Noise Production Additional Figures

This appendix is included below.

Appendix D – Letter from ODNR to LimnoTech approving the sampling plan.

APPENDIX C

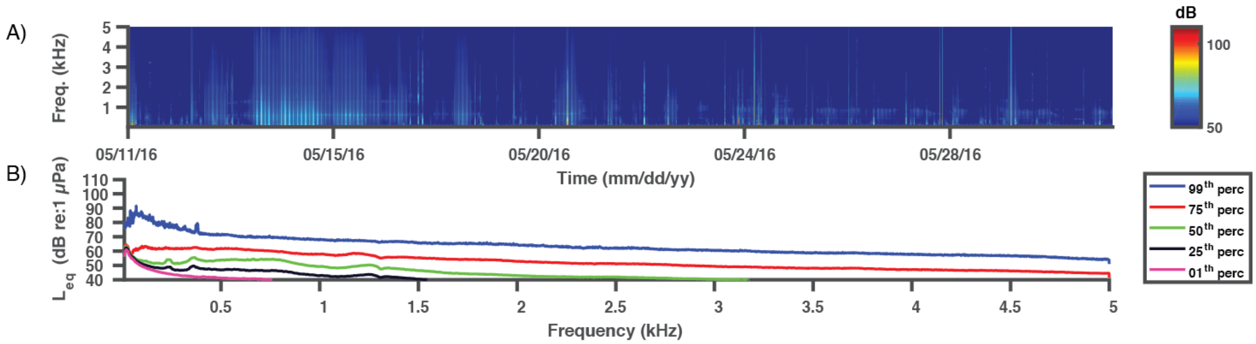


Figure 32: REF1 A) Long-term spectrogram and B) power spectrum from May 11-31, 2016.

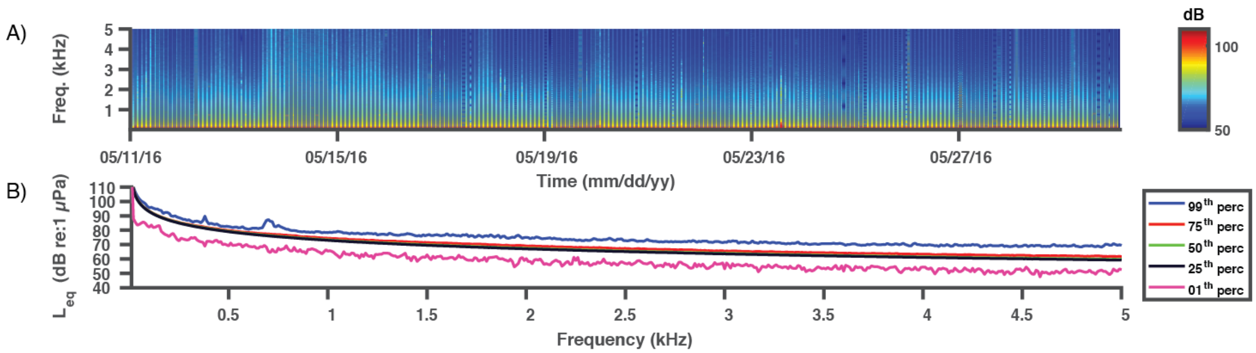


Figure 33: ICE4 A) Long-term spectrogram and B) power spectrum from May 11-31, 2016.

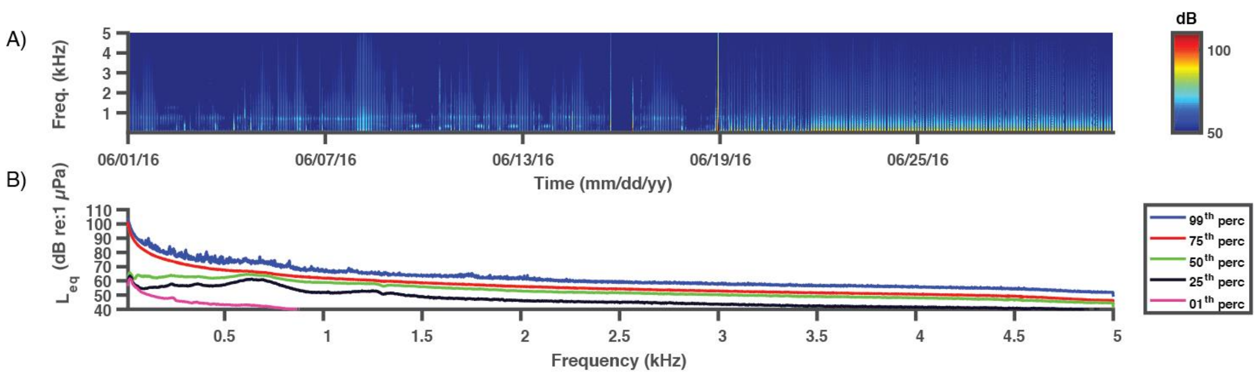


Figure 34: REF1 A) Long-term spectrogram and B) power spectrum from June 1-30, 2016. Spectrogram has 10 minute integration time.

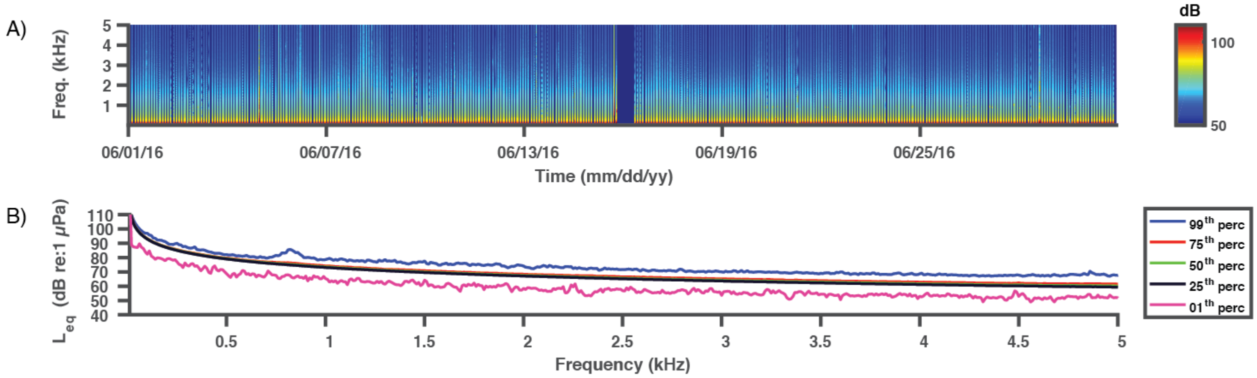


Figure 35: ICE4 A) Long-term spectrogram and B) power spectrum from June 1-30, 2016.

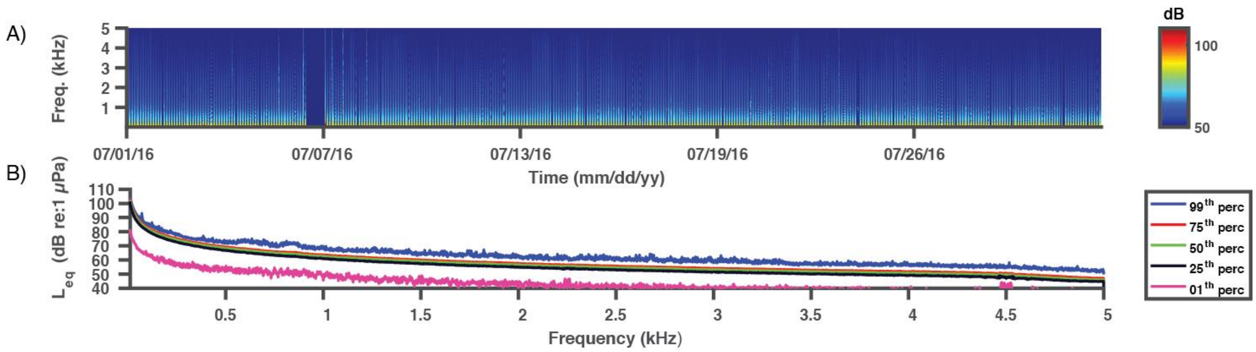


Figure 36: REF1 A) Long-term spectrogram and B) power spectrum from July 1-31, 2016.

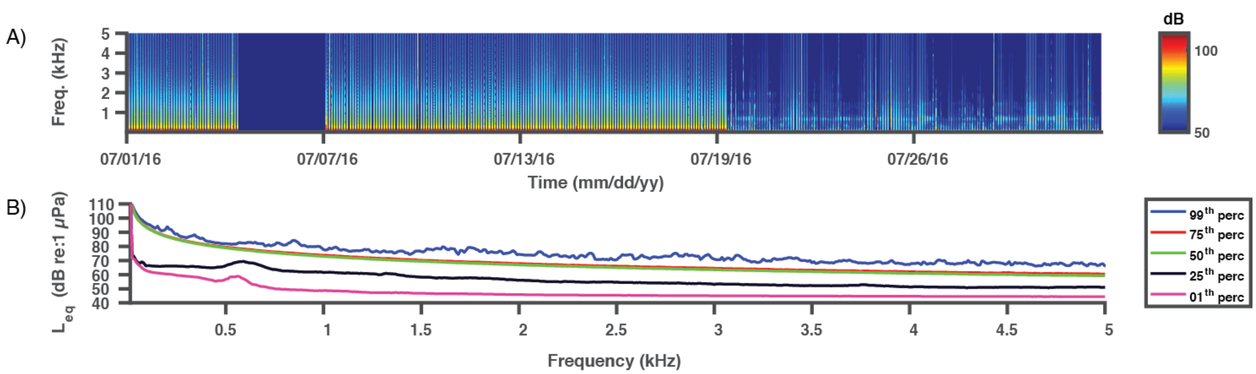


Figure 37: ICE4 A) Long-term spectrogram and B) power spectrum from July 1-31, 2016.

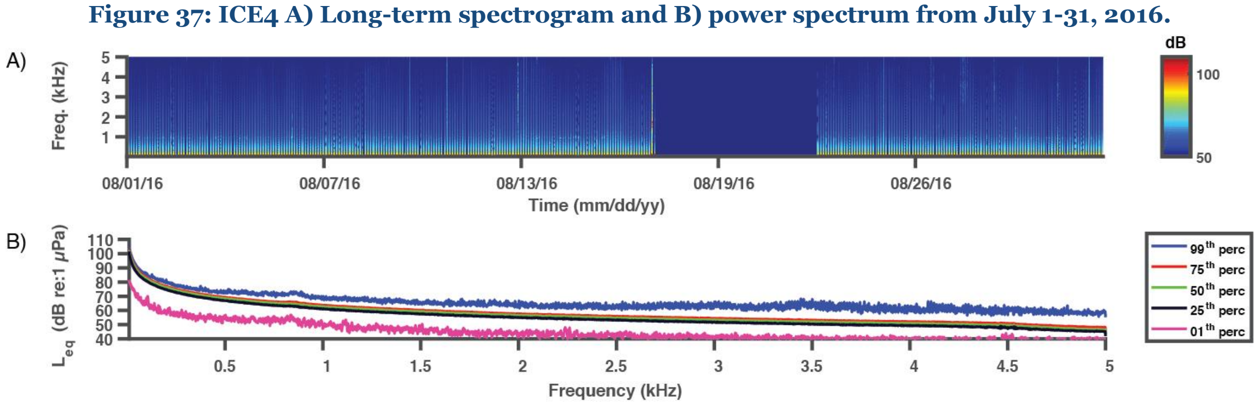


Figure 38: REF1 A) Long-term spectrogram and B) power spectrum from August 1-31, 2016.

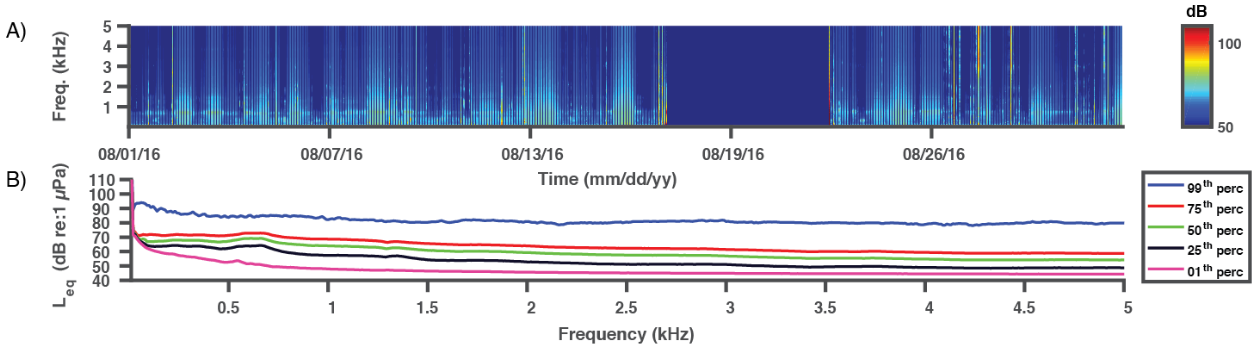


Figure 39: ICE4 A) Long-term spectrogram and B) power spectrum from August 1-31, 2016.

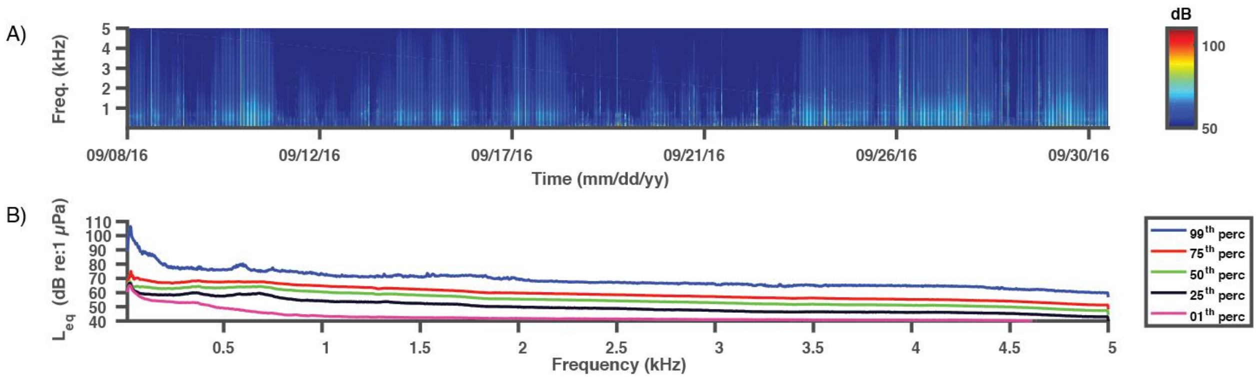


Figure 40: REF1 A) Long-term spectrogram and B) power spectrum from September 8-30, 2016.

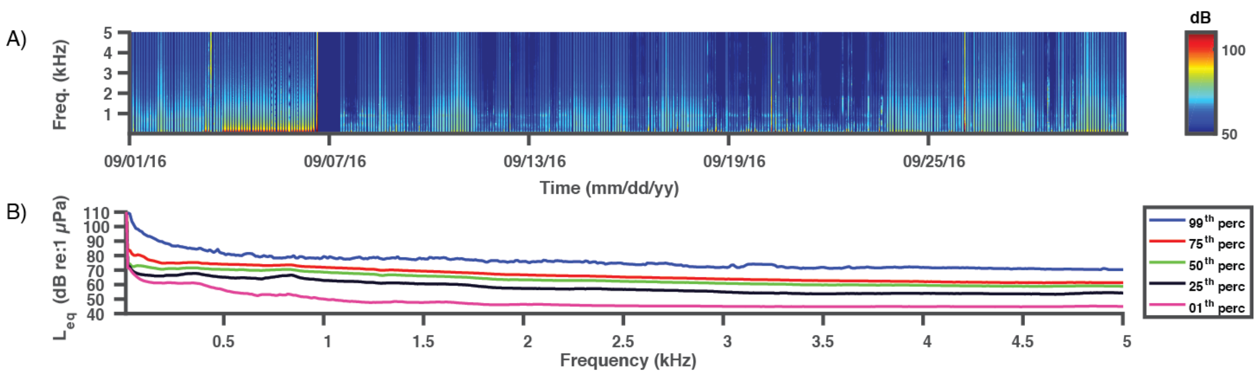


Figure 41: ICE4 A) Long-term spectrogram and B) power spectrum from September 1-30, 2016.

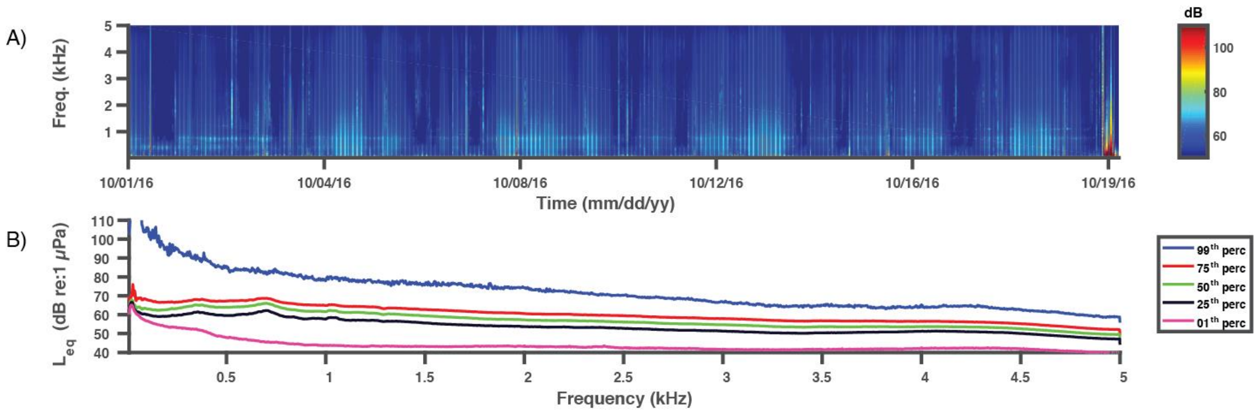


Figure 42: REF1 A) Long-term spectrogram and B) power spectrum from October 1-19, 2016.

APPENDIX D

Ohio Department of Natural Resources

JOHN R. KASICH, GOVERNOR JAMES ZEHRINGER, DIRECTOR

Ohio Division of Wildlife
Raymond W. Petering, Chief
2045 Morse Road, Bldg. G
Columbus, OH 43229-6693
Phone: (614) 265-6300

February 1, 2017

Mr. Edward Verhamme
Project Engineer
LimnoTech
501 Avis Drive
Ann Arbor, MI 48108

Re: LimnoTech Lake Erie Monitoring Plan

Dear Mr. Verhamme:

The purpose of this letter is to formally acknowledge that the January 25, 2017 version of the *LimnoTech Lake Erie Monitoring Plan for the Offshore Wind Project: Icebreaker Wind* received via email on January 25, 2017 meets the requirements of the Ohio Department of Natural Resources (ODNR) Division of Wildlife (Division) Fish Management & Research Group. All Division comments have been addressed in this version of the plan.

The Division will work to develop adaptive language in a forthcoming Memorandum of Understanding (MOU) between ODNR, the United States Fish & Wildlife Service (USFWS), LEEDCo, and LimnoTech that obligates LEEDCo and LimnoTech to fully implement the agreed-to monitoring plan. The MOU will include provisions for an annual performance review, a comprehensive analysis of data, and an option to adjust the monitoring plan based on changes in project design and/or results-driven knowledge gained from the monitoring work.

Please feel free to contact me by email at rich.carter@dnr.state.oh.us or phone at (614) 265-6345 if you have any questions.

Sincerely,

Rich Carter

Rich Carter
Executive Administrator
Fish Management and Research
ODNR-Division of Wildlife

cc: Robert Boyles, Deputy Director – ODNR
Raymond Petering, Chief, Division of Wildlife – ODNR
Scott Hale, Assistant Chief, Division of Wildlife - ODNR
Dr. Scudder Mackey, Chief, Office of Coastal Management – ODNR
Dave Kohler, Wildlife Administrator, Division of Wildlife - ODNR
Travis Hartman, Division of Wildlife - ODNR
Dr. Janice Kerns, Division of Wildlife - ODNR
Megan Seymour, Wildlife Biologist - USFWS

Office of the Director • 2045 Morse Rd • Columbus, OH 43229-6693 • ohiodnr.gov